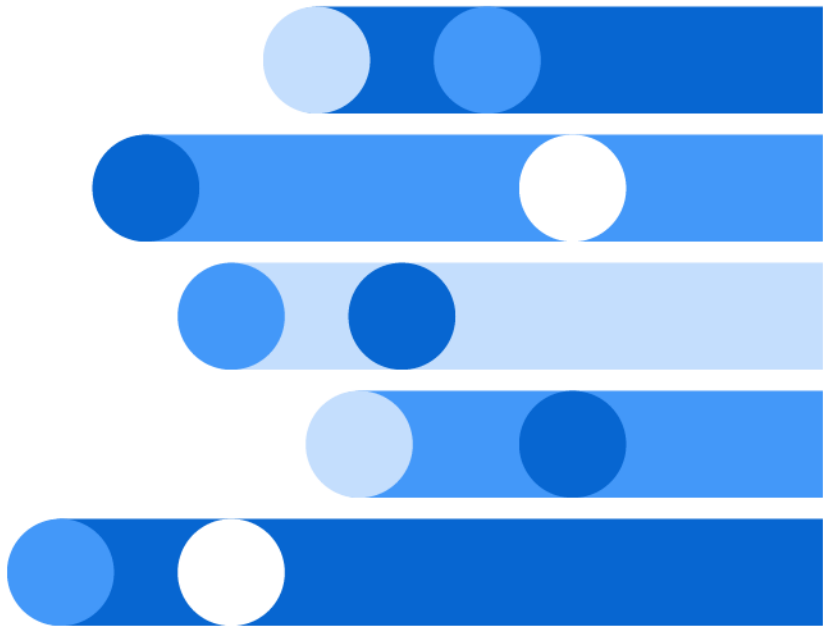
Base SAS® 9.4 Procedures Guide, Seventh Edition



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SAS Institute Inc., SAS Campus Drive, Cary, NC 27513-2414

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Contents

Syntax Conventions for the SAS Language

Overview of Syntax Conventions for the SAS Language

SAS uses standard conventions in the documentation of syntax for SAS language elements. These conventions enable you to easily identify the components of SAS syntax. The conventions can be divided into these parts:

- syntax components
- style conventions
- special characters
- references to SAS libraries and external files

Syntax Components

The components of the syntax for most language elements include a keyword and arguments. For some language elements, only a keyword is necessary. For other language elements, the keyword is followed by an equal sign (=). The syntax for arguments has multiple forms in order to demonstrate the syntax of multiple arguments, with and without punctuation.

keyword
specifies the name of the SAS language element that you use when you write your program. Keyword is a literal that is usually the first word in the syntax. In a CALL routine, the first two words are keywords.

In these examples of SAS syntax, the keywords are bold:

CHAR (*string, position*)

CALL RANBIN (*seed, n, p, x*);

ALTER (*alter-password*)

BEST *w*.

REMOVE <*data-set-name*>

In this example, the first two words of the CALL routine are the keywords:

CALL RANBIN(*seed*, *n*, *p*, *x*)

The syntax of some SAS statements consists of a single keyword without arguments:

DO;
... *SAS code* ...
END;

Some system options require that one of two keyword values be specified:

DUPLEX | **NODUPLEX**

Some procedure statements have multiple keywords throughout the statement syntax:

CREATE <UNIQUE> **INDEX** *index-name* **ON** *table-name* (*column-1* <, *column-2*, ...>)

argument
specifies a numeric or character constant, variable, or expression. Arguments follow the keyword or an equal sign after the keyword. The arguments are used by SAS to process the language element. Arguments can be required or optional. In the syntax, optional arguments are enclosed in angle brackets (< >).

In this example, *string* and *position* follow the keyword CHAR. These arguments are required arguments for the CHAR function:

CHAR (*string, position*)

Each argument has a value. In this example of SAS code, the argument *string* has a value of 'summer', and the argument *position* has a value of 4:

```
x=char('summer', 4);
```

In this example, *string* and *substring* are required arguments, whereas *modifiers* and *startpos* are optional.

FIND(*string, substring* <, *modifiers*> <, *startpos*>

argument(s)
specifies that one argument is required and that multiple arguments are allowed. Separate arguments with a space. Punctuation, such as a comma (,) is not required between arguments.

The MISSING statement is an example of this form of multiple arguments:

MISSING *character(s)*;

<LITERAL_ARGUMENT> *argument-1* <<LITERAL_ARGUMENT> *argument-2* ... >
specifies that one argument is required and that a literal argument can be associated with the argument. You can specify multiple literals and argument

pairs. No punctuation is required between the literal and argument pairs. The ellipsis (...) indicates that additional literals and arguments are allowed.

The BY statement is an example of this argument:

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...>;

argument-1 <*options*> <*argument-2* <*options*> ...>
specifies that one argument is required and that one or more options can be associated with the argument. You can specify multiple arguments and associated options. No punctuation is required between the argument and the option. The ellipsis (...) indicates that additional arguments with an associated option are allowed.

The FORMAT procedure PICTURE statement is an example of this form of multiple arguments:

PICTURE name <(*format-options*)>
<*value-range-set-1* <(*picture-1-options*)>
<*value-range-set-2* <(*picture-2-options*)> ...>>;

argument-1=*value-1* <*argument-2*=*value-2* ...>
specifies that the argument must be assigned a value and that you can specify multiple arguments. The ellipsis (...) indicates that additional arguments are allowed. No punctuation is required between arguments.

The LABEL statement is an example of this form of multiple arguments:

LABEL *variable-1*=*label-1* <*variable-2*=*label-2* ...>;

argument-1 <, *argument-2*, ...>
specifies that one argument is required and that you can specify multiple arguments that are separated by a comma or other punctuation. The ellipsis (...) indicates a continuation of the arguments, separated by a comma. Both forms are used in the SAS documentation.

Here are examples of this form of multiple arguments:

AUTHPROVIDERDOMAIN (*provider-1:domain-1* <, *provider-2:domain-2*, ...>

INTO :*macro-variable-specification-1* <, :*macro-variable-specification-2*, ...>

Note: In most cases, example code in SAS documentation is written in lowercase with a monospace font. You can use uppercase, lowercase, or mixed case in the code that you write.

Style Conventions

The style conventions that are used in documenting SAS syntax include uppercase bold, uppercase, and italic:

UPPERCASE BOLD
identifies SAS keywords such as the names of functions or statements. In this example, the keyword ERROR is written in uppercase bold:

ERROR <*message*>;

UPPERCASE
identifies arguments that are literals.

In this example of the CMPMODEL= system option, the literals include BOTH, CATALOG, and XML:

CMPMODEL=BOTH | CATALOG | XML |

italic
identifies arguments or values that you supply. Items in italic represent user-supplied values that are either one of the following:

- nonliteral arguments. In this example of the LINK statement, the argument *label* is a user-supplied value and therefore appears in italic:

  LINK *label*;

- nonliteral values that are assigned to an argument.

  In this example of the FORMAT statement, the argument DEFAULT is assigned the variable *default-format*:

  FORMAT *variable(s)* <*format* > <DEFAULT = *default-format*>;

Special Characters

The syntax of SAS language elements can contain the following special characters:

=
an equal sign identifies a value for a literal in some language elements such as system options.

In this example of the MAPS system option, the equal sign sets the value of MAPS:

MAPS=*location-of-maps*

< >
angle brackets identify optional arguments. A required argument is not enclosed in angle brackets.

In this example of the CAT function, at least one item is required:

CAT (*item-1* <, *item-2*, ...>)

|
a vertical bar indicates that you can choose one value from a group of values. Values that are separated by the vertical bar are mutually exclusive.

In this example of the CMPMODEL= system option, you can choose only one of the arguments:

CMPMODEL=BOTH | CATALOG | XML

...
an ellipsis indicates that the argument can be repeated. If an argument and the ellipsis are enclosed in angle brackets, then the argument is optional. The repeated argument must contain punctuation if it appears before or after the argument.

In this example of the CAT function, multiple *item* arguments are allowed, and they must be separated by a comma:

CAT (*item-1* <, *item-2*, ...>)

'*value*' or "*value*"
indicates that an argument that is enclosed in single or double quotation marks must have a value that is also enclosed in single or double quotation marks.

In this example of the FOOTNOTE statement, the argument *text* is enclosed in quotation marks:

FOOTNOTE <*n*> <*ods-format-options* '*text*' | "*text*">;

;
a semicolon indicates the end of a statement or CALL routine.

In this example, each statement ends with a semicolon:

```
data namegame;
   length color name $8;
   color = 'black';
   name = 'jack';
   game = trim(color) || name;
run;
```

References to SAS Libraries and External Files

Many SAS statements and other language elements refer to SAS libraries and external files. You can choose whether to make the reference through a logical name (a libref or fileref) or use the physical filename enclosed in quotation marks.

If you use a logical name, you typically have a choice of using a SAS statement (LIBNAME or FILENAME) or the operating environment's control language to make the reference. Several methods of referring to SAS libraries and external files are available, and some of these methods depend on your operating environment.

In the examples that use external files, SAS documentation uses the italicized phrase *file-specification*. In the examples that use SAS libraries, SAS documentation uses the italicized phrase *SAS-library* enclosed in quotation marks:

```
infile file-specification obs = 100;
libname libref 'SAS-library';
```

What's New in Base SAS 9.4 Procedures

Overview

The following procedures are new:

- PROC AUTHLIB
- PROC DELETE
- PROC DS2
- PROC DSTODS2
- PROC FEDSQL
- PROC FMTC2ITM
- PROC HDMD
- PROC JSON
- PROC LUA
- PROC PRESENV
- PROC PRODUCT_STATUS
- PROC S3
- PROC SCOREACCEL
- PROC SQOOP
- PROC STREAM

The following Base SAS procedures have been enhanced:

PROC APPEND	PROC IMPORT
PROC CIMPORT	PROC MIGRATE
PROC CONTENTS	PROC OPTIONS
PROC COPY	PROC PRINT
PROC CPORT	PROC PRINTTO
PROC DATASETS	PROC PROTO

PROC EXPORT	PROC PWENCODE
PROC FCMP	PROC QDEVICE
PROC FONTREG	PROC REPORT
PROC FORMAT	PROC SOAP
PROC HADOOP	PROC SORT
PROC HDMD	PROC SQOOP
PROC HTTP	PROC XSL

New Base SAS Procedures

The AUTHLIB Procedure

The AUTHLIB procedure is a utility procedure that enables you to manage metadata-bound libraries. For more information, see Chapter 8, "AUTHLIB Procedure," on page 125.

SAS 9.4M1 has a new option for the AUTHLIB procedure. By using the REQUIRE_ENCRYPTION=YES option in the CREATE or MODIFY statements, an administrator can require that all data sets in a metadata-bound library be automatically encrypted when created. For more information, see "Requiring Encryption for Metadata-Bound Data Sets" on page 134.

SAS 9.4M3 has the following changes and enhancements for the MODIFY statement of the AUTHLIB procedure:

- The PURGE statement removes any retained metadata-bound library credentials older than a given date of replacement. For more information, see "PURGE Statement" on page 148 and "Retaining and Purging Metadata-Bound Library Credentials" on page 133.
- The MODIFY statement has a PURGE= option that automatically removes all retained metadata-bound library credentials if all tables in the library are successfully modified to the newer credentials. For more information, see "PURGE=YES | NO" on page 146 and "Retaining and Purging Metadata-Bound Library Credentials" on page 133.

SAS 9.4M5 adds a stronger encryption AES2 algorithm.

The DELETE Procedure

The DELETE procedure enables you to delete SAS files from the disk or tape on which they are stored. For more information, see Chapter 19, "DELETE Procedure," on page 785.

The DS2 Procedure

The DS2 procedure enables you to submit DS2 language statements from a Base SAS session. DS2 is a SAS programming language that is appropriate for advanced data manipulation and data modeling applications. For more information, see *SAS DS2 Language Reference*. DS2 supports many data types besides SAS character and numeric. When appropriate SAS/ACCESS software is installed, DS2 can manipulate data in some, but not all, SAS/ACCESS data sources. In SAS 9.0, the language supports access to SAS data sets, SAS Scalable Performance Data (SPD) Engine data sets, and tables from Aster, DB2 for UNIX and Windows operating environments, Greenplum, Netezza, SAP, Sybase IQ, and Teradata databases. For more information, see Chapter 21, "DS2 Procedure," on page 801.

SAS 9.4M1 has a new name for the INDB= procedure option. The name changed to DS2ACCEL=. The default value for the option also changed from YES to NO, which prevents DS2 code from executing in the database unless requested. INDB= is still supported as an alias. SAS 9.4M1 adds support for SAP HANA as a data source, when appropriate SAS/ACCESS software is installed.

SAS 9.4M2 has a new XCODE= procedure option that controls the behavior of the SAS session when an NLS transcoding failure occurs. In addition, the SYSCC macro variable now contains the current SAS condition code that is returned to your operating environment. SAS 9.4M2 adds support for Hive and PostgreSQL as data sources, when appropriate SAS/ACCESS software is installed.

SAS 9.4M3 adds a new LIBS= procedure option that enables you to override the default data source connection string that is sent the DS2 program, which includes all active librefs. LIBS= restricts the data source connection to the specified libref(s) and the Work library or User library (if a User library is defined). LIBS= can facilitate connections when many librefs are active in the SAS session. SAS 9.4M3 adds support for HAWQ and Impala as data sources, when appropriate SAS/ACCESS software is installed.

SAS 9.4M4 adds SAS Scalable Performance Data (SPD) Server tables as a data source. PROC DS2 can access SPD Server 5.3 and later.

SAS 9.4M5 adds the following new features:

- Support for Amazon Redshift, Microsoft SQL Server, and Vertica as data sources, when appropriate SAS/ACCESS software is installed.

- Support for SAS Cloud Analytic Services (CAS) tables as a data source. You must have SAS Viya 3.3 software in addition to SAS 9.4M5 software. You must start a CAS session. You connect to the CAS session by specifying a new SESSREF= or new SESSUUID= procedure option. The SESSREF= procedure option identifies the CAS session by its session name. The SESSUUID= procedure option identifies the session by its universally unique identifier (UUID). You work with data in memory. PROC DS2 provides no way to promote or persist data in CAS.

SAS 9.4M6 adds support for JDBC-compliant databases as data sources, when appropriate SAS/ACCESS software is installed.

PROC DS2 is included in SAS Viya beginning with SAS Viya 3.1. In SAS Viya 3.1, PROC DS2 supports SAS data sets and SAS Cloud Analytic Services (CAS) tables as data sources. The DS2 functionality of SAS 9.4 is available for SAS data sets. Most DS2 functionality is available in CAS, but not all of it. For information about the differences, see *SAS DS2 Programmer's Guide*. You must start a CAS session. You connect to the CAS session by specifying the SESSREF= or SESSUUID= procedure option. You must create tables or explicitly load tables in your CAS session before you can manipulate them with PROC DS2. All work is in the default caslib, unless you assign a caslib. For more information, see *SAS Cloud Analytic Services: User's Guide*. You work with CAS tables in memory. PROC DS2 cannot be used to persist tables to the CAS server or to promote them to other CAS sessions.

In SAS Viya 3.2, PROC DS2 can automatically load tables into the CAS session when you reference a caslib that specifies a SAS data connector.

SAS Viya 3.3 adds support for SPD Engine data sets and for all SAS 9.4 external data sources, except SPD Server, as data sources in SAS Viya. The procedure operates on the data sources on the SAS Compute Server by default. You can process external data sources that have a data connector in CAS by assigning a caslib and specifying the SESSREF= or SESSUUID= procedure option on the PROC DS2 statement. Not all data sources have data connectors. See information about available data connectors in *SAS Cloud Analytic Services: User's Guide*.

SAS Viya 3.4 adds the following features:

- Support for JDBC-compliant databases as data sources in SAS Viya. When appropriate SAS/ACCESS software is installed and a SAS library is assigned, you can process JDBC databases with all of the DS2 functionality that is available for a SAS library. When you start a CAS session and assign a caslib, you can process data from JDBC databases on the CAS server.
- Support for accessing SPD Server tables from SAS Viya. SPD Server tables are accessed by assigning a libref for the server using the SAS Viya client for SPD Server, SASSPDS. A SAS data connector is not available for SPD Server.

Beginning in April 2019, the MongoDB and Salesforce non-relational databases are supported as data sources for SAS 9.4M6. Access to both databases is Read-only and through a SAS library. Appropriate SAS/ACCESS software must be installed.

Beginning in August 2019, the Google BigQuery and Snowflake databases are supported as data sources for SAS 9.4M6 and for SAS Viya 3.4. Read and write access is supported from a SAS library and on the CAS server. Appropriate SAS/ACCESS software must be installed.

Beginning in November 2019 on SAS 9.4M6 and with SAS Viya 3.5, write access is available for MongoDB and Salesforce data sources. The write support is available through a SAS library and on the CAS server. Appropriate SAS/ACCESS software must be installed.

In addition in SAS Viya 3.5, the VARBINARY data type is supported for DS2 programming in CAS.

Beginning with SAS 9.4M7, Spark and Yellowbrick are supported as data sources, when appropriate SAS/ACCESS software is installed. Access is read and write through a SAS library only.

The DSTODS2 Procedure

SAS Viya 3.4 adds support for the new OUTDIR= argument that enables you to specify the output directory name for the file.

SAS 9.4M5 adds support for the DSTODS2 procedure. This procedure enables you to translate a subset of your SAS DATA step code into DS2 code. Then, if necessary, you can revise your program to take advantage of DS2 features and submit your program using PROC DS2. For more information, see Chapter 22, "DSTODS2 Procedure," on page 837.

The FEDSQL Procedure

The FEDSQL procedure enables you to submit FedSQL language statements from a Base SAS session. The FedSQL language is the SAS implementation of ANSI SQL:1999 core standard. FedSQL supports many more data types than SAS character and numeric and supports federated access to data.For more information about the FedSQL language, see *SAS FedSQL Language Reference*. When appropriate SAS/ACCESS software is installed, FedSQL can create, query, and update data in some, but not all, SAS/ACCESS data sources. In SAS 9.0, the language supports access to SAS data sets, SAS Scalable Performance Data (SPD) Engine data sets, and tables from Aster, DB2 for UNIX and Windows operating environments, Greenplum, Netezza, SAP, Sybase IQ, and Teradata databases. For more information, see Chapter 27, "FEDSQL Procedure," on page 1001.

SAS 9.4M1 adds support for SAP HANA as a data source, when appropriate SAS/ACCESS software is installed.

SAS 9.4M2 adds the new XCODE= option that controls the behavior of the SAS session when an NLS transcoding failure occurs. SAS 9.4M2 adds support for Hive and PostgreSQL as data sources, when appropriate SAS/ACCESS software is installed.

SAS 9.4M3 adds the following features:

- The new LIBS= procedure option enables you to override the default data source connection string that is sent the FedSQL program, which includes all

active librefs. LIBS= restricts the data source connection to the specified libref(s) and the Work library or User library (if a User library is assigned). LIBS= can facilitate connections when many librefs are active in the SAS session.

- Support for HAWQ and Impala as data sources, when appropriate SAS/ACCESS software is installed.
- The behavior of the QUIT statement is documented.

SAS 9.4M4 adds SAS Scalable Performance Data (SPD) Server tables as a data source. PROC FEDSQL can access SPD Server 5.3 and later. The documentation has been enhanced to include an example that shows how to use a DS2 package method as an expression.

SAS 9.4M5 adds the following new features:

- Support for Amazon Redshift, Microsoft SQL Server, and Vertica as data sources, when appropriate SAS/ACCESS software is installed.
- Support for SAS Cloud Analytic Services (CAS) tables as a data source. You must have SAS Viya 3.3 software in addition to SAS 9.4M5 software. You must start a CAS session. You connect to the CAS session by specifying a new SESSREF= or SESSUUID= procedure option. The SESSREF= option identifies the CAS session by its session name. The SESSUUID= option identifies the session by its universally unique identifier (UUID). You must load tables into CAS before you can operate on them using the CAS server. FedSQL functionality in CAS is limited. For more information, see *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*. You operate on tables in memory. PROC FEDSQL cannot be used to persist a table to the CAS server or to promote a table to another CAS session.

SAS 9.4M6 adds support for JDBC-compliant databases as data sources, when appropriate SAS/ACCESS software is installed.

PROC FEDSQL is included in SAS Viya applications beginning with SAS Viya 3.1. In SAS Viya 3.1, PROC FEDSQL supports SAS data sets and SAS Cloud Analytic Services (CAS) tables as data sources. The FedSQL functionality of SAS 9.4 is available for SAS data sets. A subset of the functionality that FedSQL has in SAS 9.4 is available for CAS tables. For information about CAS functionality, see *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*. You connect to a CAS session by specifying the SESSREF= or SESSUUID= procedure option. The SESSREF= option identifies the CAS session by its session name. The SESSUUID= option identifies the session by its universally unique identifier (UUID). You must explicitly load tables in your CAS session before you can submit FedSQL statements. You work with the CAS tables in memory. PROC FEDSQL cannot be used to persist tables to the CAS server or promote them to other CAS sessions.

SAS Viya 3.1 adds two procedure options. The new _METHOD procedure option prints a text description of the FedSQL query plan for executing the specified FedSQL statements. The new _POSTOPTPLAN procedure option prints an XML tree illustrating the FedSQL query plan.

In SAS Viya 3.2, PROC FEDSQL can automatically load tables into CAS when you reference a caslib that specifies a SAS data connector.

SAS Viya 3.3 adds support for SPD Engine data sets and for all SAS 9.4 external data sources, except SPD Server, as data sources in SAS Viya. The procedure

operates on the data sources on the SAS Compute Server by default. You can process external data sources that have a data connector in CAS by assigning a caslib and specifying the SESSREF= or SESSUUID= procedure option on the PROC DS2 statement. Not all data sources have data connectors. See information about available data connectors in *SAS Cloud Analytic Services: User's Guide*.

In addition, SAS Viya 3.3 adds the following new features in CAS:

- FedSQL implicit pass-through is available for SQL-based caslibs. In the previous SAS Viya release, with SAS data connector software, FedSQL automatically loaded data into CAS for processing. In SAS Viya 3.3, the FedSQL language supports single-source, full query implicit pass-through in CAS. When a request is accessing a single data source, an attempt is made to implicitly pass the full query down to the data source for processing. If pass-through is not possible, the request is loaded for processing in CAS. FEDSQL output is always an in-memory CAS table.
- PROC FEDSQL supports a new procedure option, CNTL=. CNTL= specifies optional control parameters for the FedSQL query planner in CAS.

SAS Viya 3.4 adds the following functionality:

- Support for JDBC-compliant databases as data sources in SAS Viya, when appropriate SAS/ACCESS software is installed. You can process JDBC databases with all of the FedSQL functionality that is available for a SAS library. When a caslib is assigned, you can process JDBC databases with the FedSQL functionality that is available in CAS.
- Support for explicit pass-through in CAS libraries. For more information, see *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*.
- Support for accessing SPD Server tables from SAS Viya. SPD Server tables are accessed by assigning a libref for the server using the SAS Viya client for SPD Server (SASSPDS). A SAS data connector is not available for SPD Server.

Beginning in April 2019, the MongoDB and Salesforce non-relational databases are supported as data sources for SAS 9.4M6. Access to both databases is Read-only and through a SAS library. Appropriate SAS/ACCESS software must be installed.

Beginning in August 2019, the Google BigQuery and Snowflake databases are supported as data sources for SAS 9.4M6 and for SAS Viya 3.4. Read and Write access is supported from a SAS library and on the CAS server. Appropriate SAS/ACCESS software must be installed.

Beginning in November 2019 on SAS 9.4M6 and with SAS Viya 3.5, write access is available for MongoDB and Salesforce data sources. The write support is available from a SAS library and on the CAS server. Appropriate SAS/ACCESS software must be installed.

Also in SAS Viya 3.5:

- use of the UNION set operator is supported for FedSQL programming in CAS
- the VARBINARY data type is supported for FedSQL programming in CAS
- there are several CNTL= options for optimizing FedSQL performance on the CAS server: DYNAMICCARDINALITY, OPTIMIZEVARBINARYPRECISION, and

OPTIMIZEVARCHARPRECISION. For more information, see "CNTL=(*parameter*)" on page 1011.

- the output of the _METHOD procedure option has changed. This procedure option no longer returns the stage query and number of threads used by a FedSQL query plan in its textual description of the plan.
- there is a new CNTL= option, showStages, which returns the information previously printed by the _METHOD procedure option. In addition, showStages returns query execution details such as whether the tables in a query were partitioned, the number of rows and columns processed by each stage of the query, and the elapsed time for each processing stage.

Beginning with SAS 9.4M7, Spark and Yellowbrick are supported as data sources, when appropriate SAS/ACCESS software is installed. Access is read and write through a SAS library only.

The FMTC2ITM Procedure

The December 2017 release of SAS 9.4M5 adds support for the FMTC2ITM procedure. This procedure converts one or more format catalogs into a single CAS item store.

The HDMD Procedure

The HDMD procedure generates metadata that is defined in SAS for tables or files. It does not rely on Hive or HiveServer2.

The JSON Procedure

May 2022: The documentation has been updated to clarify the behavior of the KEYS | NOKEYS and SASTAGS | NOSASTAGS options. In addition, there are new examples: "Example 3: Suppressing SAS Variable Names in Observation Data When Using the EXPORT Statement" and "Example 5: Writing Values and Exporting Data in the Same Program".

The JSON procedure reads data from a SAS data set and writes it to an external file in JSON representation. For more information, see Chapter 38, "JSON Procedure," on page 1357.

The LUA Procedure

SAS 9.4M3 adds support for the LUA procedure. This procedure enables you to run Lua code within a SAS session and to call SAS functions within Lua commands. For more information, see Chapter 39, "LUA Procedure," on page 1403.

In SAS 9.4M5, the following enhancements were made for PROC LUA:

- For customers running SAS Viya, PROC LUA enables you to call CAS actions.
- The LUA_PATH environment variable was added. Use this environment variable to identify multiple locations for Lua scripts when one or more locations contains a special character, such as a single quotation mark.
- The SAS.OPEN function accepts data set options, such as KEEP=, DROP=, or WHERE=.
- The SAS.PUT_VALUE function replaces the SAS.PUT function from previous releases. The SAS.PUT_VALUE function requires you to identify a variable by its name only (and does not accept its position in the data set).
- Support for several functions from the TABLE library has been added. These functions are TABLE.CONCAT, TABLE.INSERT, TABLE.REMOVE, and TABLE.SORT.

In SAS Viya 3.3, support was added for the VARCHAR data type.

In SAS Viya 3.4, the following changes and enhancements were made:

- The Lua constant Math.Huge is now represented in SAS as the value 1.7976931348623E308. In previous releases, SAS represented this value as nil.
- Support has been added for the following string-manipulation functions. These functions are SAS extensions to the Lua language and can be used only within PROC LUA:

  STRING.ENDS_WITH STRING.STARTS_WITH
  STRING.RESOLVE STRING.TRIM
  STRING.SPLIT

In SAS 9.4M6, information about the scope of variables and other objects that are defined for PROC LUA was added to the documentation. For more information, see "Scope for PROC LUA" on page 1410.

The PRESENV Procedure

The PRESENV procedure preserves all global statements and macro variables in your SAS code from one SAS session to another. For more information, see Chapter 47, "PRESENV Procedure," on page 1739.

The PRODUCT_STATUS Procedure

The PRODUCT_STATUS procedure returns a list of the SAS Foundation products that are installed on your system, along with the version numbers of those products. For more information, see Chapter 50, "PRODUCT_STATUS Procedure," on page 1881.

Note: PROC PRODUCT_STATUS is deprecated for SAS Viya 3.5 and will not be available in future SAS Viya releases. PROC PRODUCT_STATUS is available to SAS 9.4 users.

The S3 Procedure

SAS 9.4M4 adds support for the S3 procedure. The S3 procedure enables you to perform object management for objects in Amazon S3. These objects include buckets, files, and directories. For more information, see Chapter 60, "S3 Procedure," on page 2259.

SAS 9.4M5 adds the following enhancements:

- PROC S3 can read AWS CLI configuration files. The AWSCONFIG= and PROFILE= options were added to the PROC S3 statement to support this feature. For more information, see "PROC S3 Configuration" on page 2261.
- Transfer acceleration is available when data is uploaded or downloaded. The BUCKET and GETACCEL statements were added to support this feature. For more information, see "Transfer Acceleration" on page 2265.

The S3 procedure is now available in SAS Viya 3.3.

The following enhancements were made in SAS Viya 3.4:

- Additional regions are supported in the configuration file and the REGION= argument. These additional regions are apindia, apseoul, cacentral, cnbeijing, cnningxa, eulondon, euparis, and useastoh.
- The AWSCREDENTIALS= option was added. This option enables you to specify alternative locations for the credentials file.
- The CREDENTIALSPROFILE= option was added. This option enables you to specify the profile to use in the credentials file.

In SAS 9.4M6, support was added for encryption when working with the Amazon S3 or Amazon Redshift environment. This support includes the new ENCKEY statement that enables you to register encryption keys. There are also new options available with the COPY, GET, GETDIR, INFO, PUT, and PUTDIR statements that

enable encryption. For more information, see "Using Server-Side Encryption with AWS Data" on page 2264.

In SAS 9.4M7 and SAS Viya 3.5, support was added for the OUT= option in the LIST statement. This option enables you to save LIST output to an external file.

Also in SAS 9.4M7, support was added for the ROLENAME= and ROLEARN= options in the PROC S3 statement.

In the May 2021 update for SAS 9.4M7 and SAS Viya 3.5, support was added for the SESSION= option in the PROC S3 statement. This option enables you to specify an AWS session token.

In the July 2021 update for SAS Viya 3.5, support was added for the REGION statement for PROC S3. This statement enables you to define a custom region.

In the August 2021 update for SAS Viya 3.5, support was added for the HOST= option in the REGION statement.

In the May 2022 update for SAS 9.4M7 and SAS Viya 3.5, the CREDENTIALSPROFILE= option is no longer supported.

In SAS 9.4M8, support has been added for EC2 Instance Metadata Service version 2 (IMDSv2) and the REGION statement.

The SCOREACCEL Procedure

SAS Viya 3.3 adds support for the SCOREACCEL procedure. You can use this procedure to publish and execute DATA step and DS2 models in CAS, or in an external database.

In SAS Viya 3.4, the following enhancements have been made to the SCOREACCEL procedure:

- The DELETEMODEL statement enables you to delete models previously published to CAS, Teradata, and Hadoop.
- The AUTHDOMAIN option is added to the PUBLISHMODEL, RUNMODEL, and DELETEMODEL statements. This option enables you to specify the name of the authentication domain that contains the credentials that are used to access Teradata.
- The PUBLISHMODEL statement now supports the FORMATITEMSTOREFILE and STORETABLES options. The FORMATITEMSTOREFILE option enables you to specify the file containing the format item store to be published. The STORETABLES option enables you to specify one or more CAS blob table names that contain the analytic stores to be published.
- The KEEPLIST option in the PUBLISHMODEL statement enables you to specify whether to include a KEEP statement in the DS2 model program that was automatically generated from an analytic store model.
- The PLATFORM option in the RUNMODEL statement enables you to specify MAPRED or SPARK as the platform where the Hadoop Embedded Process is to be executed.

- The CONFIGPATH option in the RUNMODEL statement enables you to specify a folder where the Hadoop and Spark configuration files reside.

SAS Viya 3.5 adds support for publishing a model to a global model table. The PUBLISHGLOBAL= option in the PUBLISHMODEL statement enables you to publish a model to a global model table, and the DELETEGLOBAL= option in the DELETEMODEL statement enables you to delete a model from a global model table.

SAS Viya 3.5 (August 2021 release, or earlier if you apply a hot fix) adds the following options:

- The WEBHDFSURL= option specifies a URL to delete, publish, or run a model in a platform that is configured to access the distributed file system through the REST API.
- The JOBMANAGEMENTURL= option specifies a URL to submit execution requests over a REST interface to services such as Apache Livy.
- The INDATASET= and OUTDATASET= options provide additional support for Spark.

For more information, see Chapter 62, "SCOREACCEL Procedure," on page 2305.

The SQOOP Procedure

SAS 9.4M3 adds support for the SQOOP procedure. You can use this procedure to access Apache Sqoop within a SAS session so that you can transfer data between a database and HDFS. A separate license to SAS/ACCESS Interface to Hadoop is required to use this procedure. For more information, see Chapter 66, "SQOOP Procedure," on page 2413.

The STREAM Procedure

The STREAM procedure enables you to process an input stream that consists of arbitrary text that can contain SAS macro specifications. It can expand macro code and store it in a file. For more information, see Chapter 68, "STREAM Procedure," on page 2441.

Enhanced Base SAS Procedures

The APPEND Procedure

The following enhancements have been made to the APPEND procedure:

- ENCRYPTKEY= option specifies the key value for an AES-encrypted data set. For more information, see ENCRYPTKEY= on page 616.
- Extended attributes are customized metadata for your SAS files. They are user-defined characteristics that you associate with a SAS data set or variable. For more information, see “Extended Attributes” on page 567.

The CIMPORT Procedure

The following enhancements have been made to the CIMPORT procedure:

- PROC CIMPORT does not import data miner database catalog entries that were generated from SAS 9.3 or earlier versions of SAS. A warning message is logged.
- Extended attributes in data sets are supported in SAS 9.4. Transporting a file using PROC CIMPORT where the data sets contain extended attributes requires that you use SAS 9.4 or later. Refer to information about Extended Attributes in Chapter 17, “DATASETS Procedure,” on page 561 and to “Error and Warning Messages for Transport Files ” in *Moving and Accessing SAS Files* for details.
- In SAS 9.4, when you use PROC CPORT to create a transport file that is encoded with US-ASCII on an ASCII platform, regardless of the session encoding, the encoding value is set to US-ASCII encoding. If you then use PROC CIMPORT to transport the data set to an ASCII platform, the US-ASCII encoding is preserved and not transcoded.
- In SAS 9.4, the COMPRESS= option is added to allow compressing the CIMPORT data set. You can specify the type of compression used.
- SAS 9.4M1 has the following changes and enhancements:
  - The ENCODINGINFO=option provides the ability to determine the encoding of the data sets in the transport file. The encoding information is written to the SAS log. For more information, see ENCODINGINFO= on page 394.

  - Data sets with time zone offsets can now be transported using PROC CPORT (with the DATECOPY option specified) and PROC CIMPORT. For more information, see "DATECOPY" on page 542.

- SAS 9.4M2 adds the SORT option to PROC CIMPORT. This option causes the data set that is being imported to be re-sorted according to the destination operating system's collating sequence. For more information, see "SORT" on page 398.
- SAS 9.4M3 adds support to PROC CIMPORT for importing data sets created in non-UTF-8 SAS sessions into UTF-8 SAS sessions. Prior to this release, transport files were encoded in a Windows encoding that corresponded to the SAS session encoding.
- In SAS Viya 3.5, PROC CIMPORT can be used to import a file that was created in UTF-8 encoding into non-UTF-8 SAS sessions and output corresponding data sets.
- SAS Viya 3.5 adds options EXTENDVAR= and the EXTENDFORMAT = options to PROC CIMPORT. When a transport file is imported, the original string variable length might not be large enough for the transcoded strings.To ensure that your destination buffer size is sufficient for the transcoded data, specify the EXTENDVAR= and the EXTENDFORMAT = options.

  Note: The EXTENDAVAR= and EXTENDFORMAT= options are not supported in SAS 9.

For more information, see CIMPORT Procedure on page 389.

The CONTENTS Procedure

The following enhancements have been made to the CONTENTS procedure:

- ENCRYPTKEY= option specifies the key value for an AES-encrypted data set. For more information, see ENCRYPTKEY= on page 616.
- Extended attributes are customized metadata for your SAS files. They are user-defined characteristics that you associate with a SAS data set or variable. For more information, see "Extended Attributes" on page 567.
- The TRANSCODE option indicates whether the variable is transcoded. For more information, see "The OUT= Data Set" on page 683.

SAS 9.4M5 adds support for the VARCHAR data type. PROC CONTENTS output shows the number of bytes and characters for variables.

The COPY Procedure

The following enhancements have been made to the COPY procedure:

- ENCRYPTKEY= option specifies the key value for an AES-encrypted data set. For more information, see ENCRYPTKEY= on page 616.
- Extended attributes are customized metadata for your SAS files. They are user-defined characteristics that you associate with a SAS data set or variable. For more information, see "Extended Attributes" on page 567.

SAS 9.4M5 adds support for the VARCHAR data type.

In SAS 9.4M5, you can copy a CAS table to another CAS table on the CAS server.

The CPORT Procedure

The following enhancements have been made to the CPORT procedure:

- PROC CPORT does not export data miner database catalog entries that were generated from SAS 9.3 or earlier versions of SAS. A warning message is logged.
- Extended attributes in data sets are supported in SAS 9.4. Transporting a file using PROC CPORT where the data sets contain extended attributes requires that you run SAS 9.4 or later. Refer to information about Extended Attributes in Chapter 17, "DATASETS Procedure," on page 561 and to "Error and Warning Messages for Transport Files " in *Moving and Accessing SAS Files* for details.
- In SAS 9.4, when you use PROC CPORT to create a transport file that is encoded with US-ASCII on an ASCII platform, regardless of the session encoding, the encoding value is set to US-ASCII encoding. If you then use PROC CIMPORT to transport the data set to an ASCII platform, the US-ASCII encoding is preserved and not transcoded.
- SAS 9.4M1 adds support for transporting data sets that have time zone offsets using PROC CPORT (with the DATECOPY option specified) and PROC CIMPORT. For more information, see "DATECOPY" on page 542.

For more information, see CPORT Procedure on page 537.

The DATASETS Procedure

The following enhancements have been made to the DATASETS procedure:

- The DATASETS procedure supports extended attributes. For more information, see "Extended Attributes" on page 567. The following statements were added to the DATASETS procedure to enable you to manage extended attributes.
  - XATTR ADD on page 660 statement adds extended attributes to variables or data sets.
  - XATTR DELETE on page 661 statement deletes extended attributes from variables or data sets.
  - XATTR OPTIONS on page 662 statement specifies options for extended attributes.

  - XATTR REMOVE on page 662 statement removes extended attributes to variables or data sets.
  - XATTR SET on page 663 statement updates or adds extended attributes to variables or data sets.
  - XATTR UPDATE on page 664 statement updates extended attributes in variables or data sets.
- The APPEND, COPY, and CONTENTS statements support AES encryption. For more information, see "Appending AES-Encrypted Data Sets" on page 592, "Copying AES-Encrypted Data Files" on page 623, and "Library Contents and AES Encryption" on page 498.
- The CONTENTS statement prints the International Components for Unicode (ICU) revision number. For more information, see "Displaying the ICU Revision Number" on page 498.

SAS 9.4M5 adds support for the VARCHAR data type for the COPY and CONTENTS statements.

The EXPORT Procedure

The following enhancements have been made to the EXPORT procedure:

- SAS Viya 3.5 adds support for all access types that are available in the FILENAME statement.
- SAS 9.4M5 adds support for the VARCHAR data type.
- SAS 9.4M1 adds support for exporting CSV files with a SAS data set name that contains a single quotation mark when the VALIDMEMNAME=EXTEND system option is specified. Using VALIDMEMNAME= expands the rules for SAS data set names. For more information, see "Using the External File Interface (EFI) " in *SAS/ACCESS Interface to PC Files: Reference*.
- The following is true for JMP files:
  - SAS 9.4 imports data from JMP files that are saved in JMP 7 or later formats, and it exports to files in JMP 7 or later formats. File formats in JMP 3 through 6 are no longer supported. Support for these newer formats enables you to access JMP files for viewing in a variety of ways, such as with the JMP Graph Builder iPad app.
  - The META data type for JMP files is no longer supported. Instead, extended attributes are automatically used. META can remain in programs but doing so generates a NOTE in the log and the statement is ignored.
  - The META statement for PROC EXPORT is no longer supported for JMP files and is ignored. Instead, extended attributes are automatically used.
  - JMP variable names can be up to 255 characters in length.
  - The ROWSTATE data type is generated by JMP and is used to store several row-level characteristics. When PROC EXPORT sees a column named **_rowstate_**, it converts it back into row state information in the output JMP

file. (If the JMP file contains row state information, then PROC IMPORT stores this information as a new variable with the name **_rowstate_**.)

- For more information, see Chapter 23, "EXPORT Procedure," on page 849.

For more information, see Chapter 23, "EXPORT Procedure," on page 849.

The FCMP Procedure

The following enhancements have been made to the FCMP procedure:

- The FCMP procedure now contains an example that compares the RUN_MACRO function and the DOSUBL function. In the RUN_MACRO invocation, all variables are passed as arguments so that they can be set. In the DOSUBL invocation, all macro variables are imported to the code to be executed and then exported on completion. For more information, see "RUN_MACRO Function" on page 971.
- PROC OPTMODEL has been added to the table that lists the procedures which you can use for functions and subroutines that you create in PROC FCMP. For more information, see Overview: FCMP Procedure on page 874.

SAS 9.4M3 adds the STATIC statement. For more information see "STRUCT Statement" on page 896 .

SAS 9.4M5 adds dictionary and ASTORE support to PROC FCMP. For more information see "Dictionaries" on page 918 and "PROC FCMP and ASTORE" on page 918.

SAS 9.4M6 adds these options:

OUTFILE=*filename*
: writes referenced functions and the main program to a text file. Programs that have been parsed by PROC FCMP, including macro variables, can be exported.

OUTITEMSTORE=*path name*
: exports symbols, referenced functions, and the main program to the specified item store. OUTITEMSTORE does not support a fileref. You must use a quoted path.

In SAS Viya 3.5, the quoted string size limit and label size limit for PROC FCMP were updated to match the DATA step size limits. PROC FCMP now supports quoted strings up to 32,767 bytes and labels up to 256 bytes.

The FMTC2ITM Procedure

SAS 9.4M5 adds support for the ENCODING= option. The new option enables you to specify an encoding for a format catalog or for all format catalogs in a list. For more information, see "ENCODING=*encoding-name*" on page 1051.

The FONTREG Procedure

SAS 9.4M2 has the following changes and enhancements to the FONTREG procedure:

- The OPENTYPE statement was added. This statement specifies one or more directories to be searched for valid OpenType font files.
- The ability to use a fileref was added. This ability enables you to use the FILENAME statement and its features.

For more information, see Chapter 29, "FONTREG Procedure," on page 1057.

The FORMAT Procedure

The following enhancements have been made to the FORMAT procedure:

- A month can be formatted using a shortened version by specifying the number of characters to use in the %*n*B directive.
- The range to specify a default length of an informat, picture, or format 1-32767.
- You can create a format based on a Perl regular expression by using the INVALUE statement options REGEXP and REGEXPE.

For more information, see FORMAT Procedure on page 1075.

The HADOOP Procedure

The following enhancements have been made to the HADOOP procedure:

- The HADOOP procedure now provides the PROPERTIES statement to submit configuration properties to the Hadoop server.
- You can now specify the NOWARN option in the HDFS statement to suppress the Warning message when there is an attempt to delete a file that does not exist.
- SAS 9.4M3 has the following changes and enhancements:
  - The HDFS statement supports the CAT= option to display the contents of files, the CHMOD= option to change file access permissions, and the LS= option to list HDFS files.
  - Several HDFS statement options support wildcard characters when you specify HDFS files and request recursive action to execute the operation on the specified directory as well as subdirectories.

- You can connect to the Hadoop cluster by copying the Hadoop cluster configuration files to a physical location that is accessible to the SAS client machine, and then set a SAS environment variable to the location of the configuration files.
- You can submit a MapReduce program and Pig language code to a Hadoop cluster through the Apache Oozie RESTful API.

The HADOOP procedure is available in both SAS 9.4 and in SAS Viya. However, the HADOOP procedure is not supported in a CAS session

For more information, see Chapter 33, "HADOOP Procedure," on page 1233.

The HDMD Procedure

The HDMD procedure is available in SAS Viya 3.4, but it is not supported in a CAS session.

SAS 9.4M5 supports the NAME= option, where you can specify Hadoop or the new Spark data source.

In SAS 9.4M6, Hive 3.0 supports managed, external, and transactional tables. By default, a new table is created as managed and transactional.

The HTTP Procedure

The following enhancements were made to the HTTP procedure:

- SAS 9.4 adds the SSLCALISTLOC system option to configure the trust source for connections that use the HTTPS protocol. The Java system options that were used to configure this trust source in previous versions of SAS software are no longer supported.
- SAS 9.4M1 has the following changes and enhancements:
  - The HTTP_TOKENAUTH option is added to enable you to generate a one-time password from the metadata server that can be used to access the SAS Content Server.
  - PROC HTTP supports user identity authentication. If the server that you are connecting to support the NTLM (for Windows only) or the Kerberos authentication protocols, then you do not need to specify a user name and password. As long as your current user identity has permissions, authentication is established.
- SAS 9.4M3 expands method support for PROC HTTP to include all methods that support the HTTP/1.1 standard and are supported by the target server. It also adds a HEADER statement, authentication type specification, and HTTP/1.1 features such as persistent connections, cookie caching, and EXPECT_100_CONTINUE support. Input data can be specified in a quoted string or submitted from a fileref. Custom request headers can be specified as

name=value pairs in a HEADERS statement or by submitting a fully formatted input file from a fileref. For web servers that support it, the procedure uses connection caching and cookie caching by default. You can toggle the behavior of both types of caching and clear the caches within the procedure by specifying procedure arguments. Or you turn cookie caching off by using a macro variable. A HEADEROUT_OVERWRITE argument is also provided to manage response headers for requests that involve redirects.

- The SSLCALISTLOC= system option is configured globally for the SAS system. It should not be changed for a specific PROC HTTP request.
- SAS 9.4M5 adds a DEBUG statement, TIMEOUT= procedure option, and PROC HTTP response status macro variables. The DEBUG statement and macro variables expand the messaging available for the procedure. TIMEOUT= specifies the number of seconds of inactivity to wait before canceling an HTTP request. SAS 9.4M5 also adds the OAUTH_BEARER= procedure option. OAUTH_BEARER= sends an OAuth token along with the HTTP call.

  SAS 9.4M6 adds a new statement, SSLPARMS, new options for the DEBUG statement, and changes the default DEBUG output format for body components to binary. The settings in the SSLPARMS statement enable you to override the global secure communication settings for the SAS system with local settings for the PROC HTTP request. The local settings last for the duration of the HTTP request. The new DEBUG options enable you to request debugging information about individual components of the PROC HTTP request instead of or in addition to messages for a debug level. The request header body and response header body are now written as binary by default. An OUTPUT_TEXT option is provided to request them as text.

The HTTP procedure is available in both SAS 9.4 and in SAS Viya. The initial versions of SAS Viya have the same functionality as SAS 9.4M3.

- SAS Viya 3.3 adds the DEBUG statement, the TIMEOUT= procedure option, and the PROC HTTP response status macro variables to SAS Viya. It also adds a new OAUTH_BEARER= procedure option and a new value for OAUTH_BEARER=, the constant SAS_SERVICES. The SAS_SERVICES constant is supported in SAS Viya only.
- In May 2019, the documentation was updated to include the following:
  - three new procedure options: AUTH_NONE, FOLLOWLOC, and NOFOLLOWLOC. AUTH_NONE specifies not to use basic authentication, NTLM authentication, or to negotiate authentication, even when authentication using one of these methods is possible. The OAUTH_BEARER= procedure option can be used with AUTH_NONE. FOLLOWLOC enables methods that write data to be automatically redirected to an alternate URL. NOFOLLOWLOC prevents the GET method from following URL redirections.
  - Aliases for the WEBUSERNAME= and WEBPASSWORD= procedure options. WEBUSERNAME= supports the alias USERNAME=. WEBPASSWORD= supports the alias PASSWORD=.

  In addition:

  - The CLEAR_COOKIE_CACHE procedure option has been renamed to CLEAR_COOKIES.

- The NO_COOKIE_CACHE option has been renamed to NO_COOKIES.
- Support for the OAUTH_BEARER= procedure option has been clarified.

- SAS Viya 3.5 adds the SSLPARMS statement to SAS Viya.

  In addition, SAS Viya 3.5 and the November 2019 release of SAS 9.4M6 add two new procedure options, two new parameters for the IN= procedure option, change quoting requirements for the METHOD= procedure option, and include a documentation enhancement.

  - The MAXWAITS= procedure option enables you to specify the maximum number of redirects that are allowed.
  - The QUERY= procedure option enables you to submit URL-encoded query parameters for the URL= argument.
  - The FORM parameter to the IN= procedure option enables you to send input data as a standard HTML form.
  - The MULTI parameter to the IN= procedure option enables you to upload generic multipart data or generic form data, when it is used with the FORM option. When the FORM option is used, the upload is performed using the specialized multipart type known as multipart/form-data.
  - The METHOD= procedure option no longer requires the *http-method* argument to be quoted.
  - The documentation now describes how to send chunked data in the HEADERS statement.

- In May 2022, the documentation was updated to include a new example: "Specify Local Options for Two-Way Encryption in UNIX".

For more information, see Chapter 35, "HTTP Procedure," on page 1279.

The IMPORT Procedure

The following enhancements have been made to the IMPORT procedure:

- SAS Viya 3.5 adds support for all access types that are available in the FILENAME statement.
- SAS 9.4M5 adds support for the VARCHAR data type.
- SAS 9.4M1 adds support for exporting CSV files with a SAS data set name that contains a single quotation mark when the VALIDMEMNAME=EXTEND system option is specified. Using VALIDMEMNAME= expands the rules for SAS data set names. For more information, see "Using the External File Interface (EFI) " in *SAS/ACCESS Interface to PC Files: Reference*.
- The following is true for JMP files:
  - SAS 9.4 imports data from JMP files that are saved in JMP 7 or later formats, and it exports to files in JMP 7 or later formats. File formats in JMP 3 through 6 are no longer supported. Support for these newer formats enables

you to access JMP files for viewing in a variety of ways, such as with the JMP Graph Builder iPad app.

- The META data type for JMP files is no longer supported. Instead, extended attributes are automatically used. META can remain in programs but doing so generates a NOTE in the log and the statement is ignored.
- The META statement for PROC IMPORT is no longer supported for JMP files and is ignored. Instead, extended attributes are automatically used. When importing a JMP file with extended attributes, the attributes are automatically attached to the new SAS data set.
- JMP variable names can be up to 255 characters in length.
- The ROWSTATE data type is generated by JMP and is used to store several row-level characteristics. When the JMP file contains row state information, PROC IMPORT stores this information as a new variable with the name **_rowstate_**. (If PROC EXPORT sees a column named **_rowstate_**, then it converts it back into row state information in the JMP output file.)

For more information, see "JMP Files" in *SAS/ACCESS Interface to PC Files: Reference* and Chapter 36, "IMPORT Procedure," on page 1323.

The MEANS Procedure

- Beginning with SAS 9.4M5, PROC MEANS summarization can be executed on the CAS server.
- SAS supports In-Database processing for PROC MEANS.
  - SAS 9.4M3 supports In-Database processing for PROC MEANS with the Impala, HAWK, and SAP HANA database management systems.

The MIGRATE Procedure

The following enhancements have been made to the MIGRATE procedure:

- Extended attributes are supported for data sets. For more information, see MIGRATE Procedure on page 1559.
- SAS 9.4M3 has a new default value for BUFSIZE. The new default is the buffer page size of the current session. To continue using the previous behavior, which is to clone the page size of the members from the source library, specify BUFSIZE=KEEPSIZE.

The OPTIONS Procedure

The following enhancements have been made to the OPTIONS procedure:

- The LISTOPTSAVE option lists the system options that can be saved by using the OPTSAVE procedure or the DMOPTSAVE command. For more information, see "PROC OPTIONS Statement" on page 1582.
- SAS 9.4M2 enhances the OPTIONS procedure to display passwords in the SAS log as eight Xs, regardless of the actual password length.

The PRINT Procedure

The following enhancements have been made to the PRINT procedure:

- The PROC PRINT SUMLABEL= option and the GRANDTOTAL_LABEL= option enable you to specify labels for the BY group total and grand total values.
- The PROC PRINT statement STYLE= option style attributes for the HEADER location no longer affect the Obs column heading. You specify style attributes for the Obs column heading using the OBSHEADER location.
- In SAS 9.4M6, the PROC PRINT CONTENTS= option on page 1759 accepts #BY directives.
- SAS 9.4M5 adds support for the VARCHAR data type.

For more information, see PRINT Procedure on page 1857.

The PRINTTO Procedure

The PROC PRINTTO PRINT= statement opens the LISTING destination. You no longer need to specify the ODS LISTING statement before you use the PRINTTO procedure. For more information, see Chapter 49, "PRINTTO Procedure," on page 1857.

SAS 9.4M3 has an enhancement to restore the previous location of the SAS log and LISTING output files. SAS saves the path of the SAS log and LISTING output files in automatic macro variables. For more information, see Chapter 49, "PRINTTO Procedure," on page 1857.

The PROTO Procedure

SAS 9.4M6 has a new system option, PROTOLIBS, that SAS administrators can use to control the function of the LINK statement. Controlling the function of the LINK statement can prevent security issues that might occur by calling third-party software to a valid path for a load module that contains your functions. For more information, see "The PROTOLIBS System Option" on page 1897.

The PWENCODE Procedure

The following enhancements have been made to the PWENCODE procedure:

- Encoding method SAS004 is added. SAS004 uses AES encryption with a 256-bit fixed key and a 64-bit random salt value. The salt size was increased to 64 bits to comply with the minimum recommended salt size for PKCS #5: Password Based Cryptography Specification Version 2.0.
- SAS 9.4M5 adds encoding method SAS005. SAS005 uses AES encryption with a 256-bit fixed key and a 64-bit random salt value. SAS005 increases security for stored passwords by using the SHA-256 hashing algorithm and is hashed for additional iterations.

The QDEVICE Procedure

The following enhancements have been made to the QDEVICE procedure:

- The PROC QDEVICE DEVLOC= option enables you to specify a device library other than the SAS/GRAPH Gdevice*n* libraries and the Sashelp library. You can report on the first occurrence of a device, or you can report on all occurrences of a device in the Gdevice*n* and Sashelp libraries.
- The PROC QDEVICE CATALOG= option enables you to specify a catalog, other than the DEVICES catalog, to search.
- The DEVICE statement and the PRINTER statement allow the wildcards * and ? in device names and printer names.
- The value for a Windows printer device type, as reported by the TYPE variable, is Printer Interface Device. Printer Interface Device replaces the value System Printer.
- For all reports, the NAMETYPE variable has been renamed to TYPE.
- The General report includes new this information:
  - The ALIAS variable reports font aliases.

  - The ANIMATION variable reports on the status of printer animation.
  - The FVERSION variable reports the font version.
  - The COMPRESSION variable now indicates a condition under which compression is used.
  - The COMPMETHOD variable indicates the compression method.
  - The MODULE variable reports the name of the device driver module.
  - The character variable lengths in a report output data set are now a fixed length.
- The Font reports now include information for font aliases and font versions. The new variables are ALIAS and FVERSION, respectively.
- For all reports, except the General report, information about prototypes has been removed. The PROTOTYPE variable information is now reported in only the General report.
- Character variable lengths in report output data sets have a fixed length of 128 characters. The LENGTH statement is no longer required when reports are merged or concatenated.

For more information, see QDEVICE Procedure on page 1951.

The REPORT Procedure

The following enhancements have been made to the REPORT procedure:

- In SAS 9.4M6, the following options are supported.
  - the CONTENTS= option in the PROC REPORT statement accepts #BY directives when the ACCESSIBLETABLE system option is specified.
  - the CAPTION= option can be specified in the PROC REPORT statement and creates visual and accessible table captions when the ACCESSSIBLETABLE system option is specified.
- In-Database processing for PROC REPORT is supported as follows:
  - In-Database processing for PROC REPORT supports the Aster, Greenplum, and Hadoop database management systems.
  - SAS 9.4M6 supports In-Database processing for PROC REPORT with the Google BigQuery database management system.
  - SAS 9.4M7 supports In-Database processing for PROC REPORT with the Yellowbrick database management system.
- NOWINDOWS (NOWD) is now the default windowing environment for PROC REPORT.
- SAS 9.4M2 has the following changes and enhancements:
  - A new section was added to describe the use of ODS Styles with PROC REPORT. For more information, see "Using ODS Styles with PROC REPORT" on page 2142.

  - PROC REPORT now supports statistical keywords P20, P30, P40, P60, P70, and P80. For information, see "Statistics That Are Available in PROC REPORT" on page 2140.

- In SAS 9.4M6, the PROC PRINT CONTENTS= option on page 1759 accepts #BY directives.

Beginning with SAS 9.4M5, PROC REPORT summarization can be executed on the CAS server.

For more information, see Chapter 58, "REPORT Procedure," on page 2047.

Starting with SAS 9.4M6, you can specify the CAPTION= option in the PROC REPORT statement and specify the ACCESSIBLETABLE system option to add visible captions to the tables. Starting with SAS 9.4M6, when BY directives are specified in the CAPTION= and CONTENTS= options, labels for the BY group tables are displayed in the table of contents in PDF output and in the contents file in HTML output. The labels are based on the values of the BY variable.

The SOAP Procedure

SAS 9.4M2 removed support for the SOAP procedure when SAS is in a locked-down state. For more information, see Chapter 63, "SOAP Procedure," on page 2341.

The SORT Procedure

The following enhancements have been made to the SORT procedure:

- PROC SORT supports extended attributes. PROC SORT copies the attributes that are defined for the data set to the output data set. For more information, see "Extended Attributes" on page 567.
- The page size of the utility file that is used by PROC SORT is influenced by the new STRIPESIZE= system option. For more information, see "STRIPESIZE= System Option" in *SAS System Options: Reference*.
- In SAS 9.4, the International Components for Unicode (ICU) library used by PROC SORT is 4.8.1. This ICU version uses locale data from version 2.0 of the Unicode Common Locale Data Repository (CLDR), improves language support, and provides software fixes. For more information, see Download the ICU 4.8 Release and CLDR 2.0 Release Note.

  A change in the ICU version used by SAS can affect the interpretation of some data sets sorted by previous versions of SAS. For information about these effects, see Chapter 64, "SORT Procedure," on page 2355, Chapter 15, "COPY Procedure," on page 521, and Chapter 41, "MIGRATE Procedure," on page 1559.
- The CONTENTS procedure or CONTENTS statement output shows the ICU version number of a data set that is linguistically sorted. See "Example 5: Linguistic Sorting Using ALTERNATE_HANDLING=" on page 2401.

- SAS supports In-Database processing for PROC SORT.
  - SAS 9.4M3 supports In-Database processing for PROC SORT with the Impala, HAWK, and SAP HANA database management systems.
  - SAS 9.4M6 supports In-Database processing for PROC SORT with the Google BigQuery database management system.
  - SAS 9.4M7 supports In-Database processing for PROC SORT with the Yellowbrick database management system.
- SAS Viya 3.4 supports ICU version 56. This ICU version uses locale data from version 28 of the Unicode Common Locale Data Repository (CLDR). For in-depth information, see Download ICU 56 and CLDR 28 Release Note.
- In SAS Viya 3.5, PROC SORT supports the ability to run the duplicate detection and manipulation options (NODUPKEY, NOUNIKEY, DUPOUT=, UNIOUT=) in CAS. This functionality is provided to facilitate migration of code for users of SAS Viya. This task is performed by using the deduplicate Action.

For more information, see Chapter 64, "SORT Procedure," on page 2355.

The SQOOP Procedure

For SAS 9.4M5, PROC SQOOP supports workflows and Kerberos on Linux, and the WFHDFSPATH= option is now optional.

In SAS Viya 3.5, support was added for the HIVE_SERVER= and HIVE_URI= options.

The SUMMARY Procedure

- Beginning with SAS 9.4M5, PROC SUMMARY summarization can be executed on the CAS server.
- SAS supports In-Database processing for PROC SUMMARY.
  - SAS 9.4M3 supports In-Database processing for PROC SUMMARY with the Impala, HAWK, and SAP HANA database management systems.
  - SAS 9.4M7 supports In-Database processing for PROC SUMMARY with the Yellowbrick database management system.

The TABULATE Procedure

The following enhancements have been made to the TABULATE procedure:

- In SAS 9.4M6, the CONTENTS= option in the TABLE statement and the PROC TABULATE statement now accepts #BY directives.

- In SAS 9.4M6, the CAPTION= option is new for the TABLE statement.
- In SAS 9.4M6, PROC TABULATE provides the ability to create accessible output tables when used with the ACCESSIBLETABLE system option.
- Beginning with SAS 9.4M5, PROC TABULATE summarization can be executed on the CAS server.
- SAS supports In-Database processing for PROC TABULATE.
  - SAS 9.4M6 supports In-Database processing for PROC TABULATE with the Google BigQuery database management system.
  - SAS 9.4M7 supports In-Database processing for PROC TABULATE with the Yellowbrick database management system.

The TRANSPOSE Procedure

Beginning with SAS 9.4M5, PROC TRANSPOSE summarization can be executed on the CAS server.

-
-
- SAS supports In-Database processing for PROC TRANSPOSE.
  - SAS 9.4 supports In-Database processing for PROC TRANSPOSE with the HADOOP and Terradata database management system.

The XSL Procedure

The XSL procedure now provides the PARAMETER statement to pass a parameter value to an XSL style sheet. For more information, see Chapter 73, "XSL Procedure," on page 2685.

Software Enhancements

SAS supports access to files that are created with the Advanced Encryption Standard (AES). For more information, see "AES Encryption" on page 25.

The International Components for Unicode (ICU) libraries have been upgraded from version 4.2 to version 4.8. The ICU is used by SAS for linguistic collation of character data. For more information about ICU version 4.8, see the ICU website at https://icu.unicode.org/download/48.

Data sets that are sorted linguistically by one release of SAS might not be recognized as sorted by another release. For more information about the effect of a change in the ICU version, see:

- " Linguistic Sorting of Data Sets and ICU" on page 2362
- Chapter 14, "CONTENTS Procedure," on page 489
- Chapter 15, "COPY Procedure," on page 521
- Chapter 41, "MIGRATE Procedure," on page 1559

Documentation Enhancements

The following changes have been made to the *Base SAS Procedures Guide*:

- "Threaded Processing for Base SAS Procedures" on page 26 contains information about SAS procedures that support threaded processing.
- "Using PROC FCMP Component Objects" on page 918 contains more information about hashing.
- SAS 9.4M1 adds a link and supporting text for Microsoft Excel functions that are available to PROC FCMP.
- Information about the Chapter 34, "HDMD Procedure" was moved to this document from *SAS/ACCESS for Relational Databases: Reference*.
- Chapter 41, "MIGRATE Procedure," on page 1559 contains more information about using the BUFSIZE= option to improve the performance of migrated data sets.

PART 1

Concepts

1

Choosing the Right Procedure

Functional Categories of Base SAS Procedures

Report Writing

These procedures display useful information, such as data listings (detail reports), summary reports, calendars, letters, labels, multipanel reports, and graphical reports.

CALENDAR	PLOT	SQL[1]
CHART[1]	PRINT	SUMMARY[1]
FREQ[1]	QDEVICE[1]	TABULATE [1]

MEANS[1]	REPORT[1]	TIMEPLOT

1 These procedures produce reports and compute statistics.

Statistics

These procedures compute elementary statistical measures that include descriptive statistics based on moments, quantiles, confidence intervals, frequency counts, crosstabulations, correlations, and distribution tests. They also rank and standardize data.

CHART	RANK	SUMMARY
CORR	REPORT	TABULATE
FREQ	SQL	UNIVARIATE
MEANS	STANDARD	

Utilities

These procedures perform the following basic utility operations:

- create, edit, sort, and transpose data sets
- create and restore transport data sets
- create user-defined formats
- provide basic file maintenance such as copy, append, and compare data sets
- deletes permanent or temporary data files from disk or tape

APPEND	FEDSQL	PRESENV
AUTHLIB	FONTREG	PRINTTO
CATALOG	FSLIST	PRTDEF
CIMPORT	GROOVY	PRTEXP
COMPARE	HADOOP	PWENCODE
CONTENTS	IMPORT[4]	REGISTRY

CONVERT[1]	INFOMAPS [5]	RELEASE[1]
COPY	JAVAINFO	SCAPROC
CPORT	JSON	SORT
CV2VIEW[3]	METADATA[6]	SOURCE
DATASETS	METALIB[6]	SQL[1]
DELETE	MIGRATE	TAPECOPY
DISPLAY	OPTIONS	TAPELABEL [1]
DOCUMENT [2]	OPTLOAD	TEMPLATE
DS2	OPTSAVE	TRANSPOSE[1]
EXPORT[4]	PDS	TRANSTAB [2]
FCMP	PDSCOPY[1]	XSL
	PMENU[1]	

1 See the SAS documentation for your operating environment for a description of this procedure.
2 For a description of this procedure, see the *SAS Output Delivery System: User's Guide*.
3 For a description of this procedure, see the *SAS/ACCESS for Relational Databases: Reference*.
4 For a description of this procedure, see the *SAS/ACCESS Interface to PC Files: Reference*.
5 For a description of this procedure, see the *Base SAS Guide to Information Maps*.
6 For a description of this procedure, see the *SAS Language Interfaces to Metadata*.

Report-Writing Procedures

The following table lists report-writing procedures according to the type of report.

Table 1.1 *Report-Writing Procedures by Task*

Report Type	Procedure	Description
Detail reports	PRINT	Produces data listings quickly; can supply titles, footnotes, and column sums.

Report Type	Procedure	Description
	REPORT	Offers more control and customization than PROC PRINT; can produce both column and row sums; has DATA step computation abilities.
	SQL	Combines Structured Query Language and SAS features such as formats; can manipulate data and create a SAS data set in the same step that creates the report; can produce column and row statistics; does not offer as much control over output as PROC PRINT and PROC REPORT.
Summary reports	MEANS or SUMMARY	Computes descriptive statistics for numeric variables; can produce a printed report and create an output data set.
	PRINT	Produces only one summary report; can sum the BY variables.
	QDEVICE	Produces reports about graphics devices and universal printers.
	REPORT	Combines features of the PRINT, MEANS, and TABULATE procedures with features of the DATA step in a single report-writing tool that can produce a variety of reports; can also create an output data set.
	SQL	Computes descriptive statistics for one or more SAS data sets or DBMS tables; can produce a printed report or create a SAS data set.
	TABULATE	Produces descriptive statistics in a tabular format; can produce stub-and-banner reports (multidimensional tables with descriptive statistics); can also create an output data set.
Miscellaneous highly formatted reports		
Calendars	CALENDAR	Produces schedule and summary calendars; can schedule tasks around nonwork periods and holidays, weekly work schedules, and daily work shifts.
Multipanel reports (telephone book listings)	REPORT	Produces multipanel reports.
Low-resolution graphical reports [1]		

Report Type	Procedure	Description
	CHART	Produces bar charts, histograms, block charts, pie charts, and star charts that display frequencies and other statistics.
	PLOT	Produces scatter diagrams that plot one variable against another.
	TIMEPLOT	Produces plots of one or more variables over time intervals.

1 These reports quickly produce a simple graphical picture of the data. To produce high-resolution graphical reports, use SAS/GRAPH software.

Statistical Procedures

Available Statistical Procedures

The following table lists statistical procedures according to task. Table A1.1 on page 2701 lists the most common statistics and the procedures that compute them.

Table 1.2 *Elementary Statistical Procedures by Task*

Report type	Procedure	Description
Descriptive statistics	CORR	Computes simple descriptive statistics.
	MEANS or SUMMARY	Computes descriptive statistics; can produce printed output and output data sets. By default, PROC MEANS produces printed output, and PROC SUMMARY creates an output data set.
	REPORT	Computes most of the same statistics as PROC TABULATE; allows customization of format.
	SQL	Computes descriptive statistics for data in one or more DBMS tables; can produce a printed report or create a SAS data set.
	TABULATE	Produces tabular reports for descriptive statistics; can create an output data set.

Report type	Procedure	Description
	UNIVARIATE	Computes the broadest set of descriptive statistics; can create an output data set.
Frequency and crosstabulation tables	FREQ	Produces one-way to *n*-way tables; reports frequency counts; computes chi-square tests; computes test and measures of association and agreement for two-way to *n*-way crosstabulation tables; can compute exact tests and asymptotic tests; can create output data sets.
	TABULATE	Produces one-way and two-way crosstabulation tables; can create an output data set.
	UNIVARIATE	Produces one-way frequency tables.
Correlation analysis	CORR	Computes Pearson's, Spearman's, and Kendall's correlations and partial correlations. Also, computes Hoeffding's measures of dependence (D) and Cronbach's coefficient alpha.
Distribution analysis	UNIVARIATE	Computes tests for location and tests for normality.
	FREQ	Computes a test for the binomial proportion for one-way tables; computes a goodness-of-fit test for one-way tables; computes a chi-square test of equal distribution for two-way tables.
Robust estimation	UNIVARIATE	Computes robust estimates of scale, trimmed means, and Winsorized means.
Data transformation		
Computing ranks	RANK	Computes ranks for one or more numeric variables across the observations of a SAS data set and creates an output data set; can produce normal scores or other rank scores.
Standardizing data	STANDARD	Creates an output data set that contains variables that are standardized to a given mean and standard deviation.
Low-resolution graphics[1]		
	CHART	Produces a graphical report that can show one of the following statistics for the chart variable: frequency counts, percentages, cumulative frequencies, cumulative percentages, totals, or averages.

Report type	Procedure	Description
	UNIVARIATE	Produces descriptive plots such as stem-and-leaf plot, box plots, and normal probability plots.

1 To produce high-resolution graphical reports, use SAS/GRAPH software.

Efficiency Issues

Quantiles

For a large sample size *n*, the calculation of quantiles, including the median, requires computing time proportional to *n*log(*n*). Therefore, a procedure, such as UNIVARIATE, that automatically calculates quantiles might require more time than other data summarization procedures. Furthermore, because data is held in memory, the procedure also requires more storage space to perform the computations. By default, the report procedures PROC MEANS, PROC SUMMARY, and PROC TABULATE require less memory because they do not automatically compute quantiles. These procedures also provide an option to use a new fixed-memory, quantiles estimation method that is usually less memory-intense. For more information, see "Quantiles" on page 1512 in the PROC MEANS documentation.

Computing Statistics for Groups of Observations

To compute statistics for several groups of observations, you can use any of the previous procedures with a BY statement to specify BY-group variables. However, BY-group processing requires that you previously sort or index the data set, which for very large data sets might require substantial computer resources. A more efficient way to compute statistics within groups without sorting is to use a CLASS statement with one of the following procedures: MEANS, SUMMARY, or TABULATE.

Additional Information about the Statistical Procedures

Appendix 1, "SAS Elementary Statistics Procedures," on page 2699 lists standard keywords, statistical notation, and formulas for the statistics that Base SAS procedures compute frequently. The sections on the individual statistical

procedures discuss the statistical concepts that are useful to interpret a procedure output.

Utility Procedures

The following table groups utility procedures according to task.

Table 1.3 *Utility Procedures by Task*

Tasks	Procedure	Description
Supply information	COMPARE	Compares the contents of two SAS data sets.
	CONTENTS	Describes the contents of a SAS library or specific library members.
	JAVAINFO	Conveys diagnostic information about the Java environment that SAS is using.
	OPTIONS	Lists the current values of all SAS system options.
	SCAPROC	Implements the SAS Code Analyzer, which captures information about input, output, and the use of macro symbols from a SAS job while it is running.
	SQL	Supplies information through dictionary tables on an individual SAS data set as well as all SAS files active in the current SAS session. Dictionary tables can also provide information about macros, titles, indexes, external files, or SAS system options.
Manage SAS system options	OPTIONS	Lists the current values of all SAS system options.
	OPTLOAD	Reads SAS system option settings that are stored in the SAS registry or a SAS data set.
	OPTSAVE	Saves SAS system option settings to the SAS registry or a SAS data set.
Affect printing and Output Delivery System output	DOCUMENT[2]	Manipulates procedure output that is stored in ODS documents.

Tasks	Procedure	Description
	FONTREG	Adds system fonts to the SAS registry.
	FORMAT	Creates user-defined formats to display and print data.
	PRINTTO	Routes procedure output to a file, a SAS catalog entry, or a printer; can also redirect the SAS log to a file.
	PRTDEF	Creates printer definitions.
	PRTEXP	Exports printer definition attributes to a SAS data set.
	TEMPLATE[2]	Customizes ODS output.
Create, browse, and edit data	FCMP	Enables creation, testing, and storage of SAS functions and subroutines before they are used in other SAS procedures.
	FSLIST	Browses external files such as files that contain SAS source lines or SAS procedure output.
	INFOMAPS[6]	Creates or updates a SAS Information Map.
	PRESENV	Preserves all global statements and macro variables in your SAS code from one SAS session to another. When this procedure is invoked at the end of a SAS session, all of the global statements and macro variables are written to a file.
	SQL	Creates SAS data sets using Structured Query Language and SAS features.
	FORMAT	Creates user-defined informats to read data and user-defined formats to display data.
	SORT	Sorts SAS data sets by one or more variables.
	SQL	Sorts SAS data sets by one or more variables.
	STREAM	Enables you to process an input stream that consists of arbitrary text that can contain SAS macro specifications. It can expand macro code and store it in a file.

Tasks	Procedure	Description
	TRANSPOSE	Transforms SAS data sets so that observations become variables and variables become observations.
	TRANTAB[4]	Creates, edits, and displays customized translation tables.
	XSL	Transforms an XML document into another format, such as HTML, text, or another XML document type.
Manage SAS files	APPEND	Appends one SAS data set to the end of another.
	AUTHLIB	Manages metadata-bound libraries.
	CATALOG	Manages SAS catalog entries.
	CIMPORT	Restores a transport sequential file that PROC CPORT creates (usually in another operating environment) to its original form as a SAS catalog, a SAS data set, or a SAS library.
	CONVERT[1]	Converts BMDP system files, OSIRIS system files, and SPSS portable files to SAS data sets.
	COPY	Copies a SAS library or specific members of the library.
	CPORT	Converts a SAS catalog, a SAS data set, or a SAS library to a transport sequential file that PROC CIMPORT can restore (usually in another operating environment) to its original form.
	CV2VIEW[3]	Converts SAS/ACCESS view descriptors to PROC SQL views.
	DATASETS	Manages SAS files.
	DELETE	Deletes permanent or temporary SAS files.
	EXPORT[5]	Reads data from a SAS data set and writes them to an external data source.
	IMPORT[5]	Reads data from an external data source and writes them to a SAS data set.

Tasks	Procedure	Description
	JSON	Reads data from a SAS data set and writes it to an external file in JSON representation.
	MIGRATE	Migrates members in a SAS library forward to the most current release of SAS.
	PDS[1]	Lists, deletes, and renames the members of a partitioned data set.
	PDSCOPY[1]	Copies partitioned data sets from disk to tape, disk to disk, tape to tape, or tape to disk.
	PROTO	Enables registration, in batch mode, of external functions that are written in the C or C++ programming languages.
	REGISTRY	Imports registry information to the USER portion of the SAS registry.
	RELEASE[1]	Releases unused space at the end of a disk data set under the z/OS environment.
	SOURCE[1]	Provides an easy way to back up and process source library data sets.
	SQL	Concatenates SAS data sets.
	TAPECOPY[1]	Copies an entire tape volume or files from one or more tape volumes to one output tape volume.
	TAPELABEL[1]	Lists the label information of an IBM standard-labeled tape volume in the z/OS environment.
Control windows	PMENU	Creates customized menus for SAS applications.
Miscellaneous	DISPLAY	Executes SAS/AF applications.
	DS2	Submits DS2 language statements from a Base SAS session.
	FEDSQL	Submits FedSQL language statements from a Base SAS session.
	GROOVY	Enables SAS code to execute Groovy code on the Java Virtual Machine (JVM).

Tasks	Procedure	Description
	HADOOP	Enables SAS to run Apache Hadoop code against Hadoop data.
	PWENCODE	Encodes passwords for use in SAS programs.
Manage metadata in a SAS Metadata Repository	METADATA[7]	Sends a method call, in the form of an XML string, to a SAS Metadata Server.
	METALIB[7]	Updates metadata to match the tables in a library.
	METAOPERATE[7]	Performs administrative tasks on a metadata server.

1 See the SAS documentation for your operating environment for a description of these procedures.
2 For a description of this procedure, see the *SAS Output Delivery System: User's Guide*.
3 For a description of this procedure, see the *SAS/ACCESS for Relational Databases: Reference*.
4 For a description of this procedure, see the *SAS National Language Support (NLS): Reference Guide*
5 For a description of this procedure, see the *SAS/ACCESS Interface to PC Files: Reference*.
6 For a description of this procedure, see the *Base SAS Guide to Information Maps*.
7 For a description of this procedure, see the *SAS Language Interfaces to Metadata*.

Brief Descriptions of Base SAS Procedures

APPEND procedure
: adds observations from one SAS data set to the end of another SAS data set.

AUTHLIB procedure
: manages metadata-bound libraries, which are physical libraries that are tied to corresponding metadata secured table objects. Each physical table within a metadata-bound library has information in its header that points to a specific metadata object.

CALENDAR procedure
: displays data from a SAS data set in a monthly calendar format. PROC CALENDAR can display holidays in the month, schedule tasks, and process data for multiple calendars with work schedules that vary.

CATALOG procedure
: manages entries in SAS catalogs. PROC CATALOG is an interactive, non-windowing procedure that enables you to display the contents of a catalog; copy an entire catalog or specific entries in a catalog; and rename, exchange, or delete entries in a catalog.

CHART procedure
: produces vertical and horizontal bar charts, block charts, pie charts, and star charts. These charts provide a quick visual representation of the values of a single variable or several variables. PROC CHART can also display a statistic associated with the values.

CIMPORT procedure
: restores a transport file created by the CPORT procedure to its original form (a SAS library, catalog, or data set) in the format appropriate to the operating environment. Coupled with the CPORT procedure, PROC CIMPORT enables you to move SAS libraries, catalogs, and data sets from one operating environment to another.

COMPARE procedure
: compares the contents of two SAS data sets. You can also use PROC COMPARE to compare the values of different variables within a single data set. PROC COMPARE produces a variety of reports on the comparisons that it performs.

CONTENTS procedure
: prints descriptions of the contents of one or more files in a SAS library.

CONVERT procedure
: converts BMDP system files, OSIRIS system files, and SPSS portable files to SAS data sets. For more information, see the SAS documentation for your operating environment.

COPY procedure
: copies an entire SAS library or specific members of the library. You can limit processing to specific types of library members.

CORR procedure
: computes Pearson product-moment and weighted product-moment correlation coefficients between variables and descriptive statistics for these variables. In addition, PROC CORR can compute three nonparametric measures of association (Spearman's rank-order correlation, Kendall's tau-b, and Hoeffding's measure of dependence, D), partial correlations (Pearson's partial correlation, Spearman's partial rank-order correlation, and Kendall's partial tau-b), and Cronbach's coefficient alpha. For more information, see *Base SAS Procedures Guide: Statistical Procedures*.

CPORT procedure
: writes SAS libraries, data sets, and catalogs in a special format called a transport file. Coupled with the CIMPORT procedure, PROC CPORT enables you to move SAS libraries, data sets, and catalogs from one operating environment to another.

CV2VIEW procedure
: converts SAS/ACCESS view descriptors to PROC SQL views. Starting in SAS 9, conversion of SAS/ACCESS view descriptors to PROC SQL views is recommended because PROC SQL views are platform-independent and enable you to use the LIBNAME statement. For more information, see the *SAS/ACCESS for Relational Databases: Reference*.

DATASETS procedure
: lists, copies, renames, and deletes SAS files and SAS generation groups; manages indexes; and appends SAS data sets in a SAS library. The procedure provides all the capabilities of the APPEND, CONTENTS, and COPY procedures.

You can also modify variables within data sets; manage data set attributes, such as labels and passwords; or Create and Delete integrity constraints.

DELETE procedure
deletes SAS files from the disk or tape on which it is stored.

DISPLAY procedure
executes SAS/AF applications. For information about building SAS/AF applications, see the *Guide to SAS/AF Applications Development*.

DOCUMENT procedure
manipulates procedure output that is stored in ODS documents. PROC DOCUMENT enables a user to browse and edit output objects and hierarchies, and to replay them to any supported ODS output format. For more information, see *SAS Output Delivery System: User's Guide*.

DS2 procedure
enables you to submit DS2 language statements from a Base SAS session.

EXPORT procedure
reads data from a SAS data set and writes it to an external data source.

FCMP procedure
enables you to create, test, and store SAS functions and subroutines before you use them in other SAS procedures. PROC FCMP accepts slight variations of DATA step statements. Most features of the SAS programming language can be used in functions and subroutines that are processed by PROC FCMP.

FEDSQL procedure
enables you to submit FedSQL language statements from a Base SAS session.

FONTREG procedure
adds system fonts to the SAS registry.

FORMAT procedure
creates user-defined informats and formats for character or numeric variables. PROC FORMAT also prints the contents of a format library, creates a control data set to write other informats or formats, and reads a control data set to create informats or formats.

FREQ procedure
produces one-way to *n*-way frequency tables and reports frequency counts. PROC FREQ can compute chi-square tests for one-way to *n*-way tables; for tests and measures of association and of agreement for two-way to *n*-way crosstabulation tables; risks and risk difference for 2×2 tables; trends tests;and Cochran-Mantel-Haenszel statistics. You can also create output data sets. For more information, see *Base SAS Procedures Guide: Statistical Procedures*.

FSLIST procedure
displays the contents of an external file or copies text from an external file to the SAS Text Editor.

GROOVY procedure
enables SAS code to execute Groovy code on the Java Virtual Machine (JVM).

HADOOP procedure
enables SAS to run Apache Hadoop code against Hadoop data.

HDMD procedure
: generate XML-based metadata that describes the contents of files that are stored in HDFS.

HTTP procedure
: issues Hypertext Transfer Protocol (HTTP) requests.

IMPORT procedure
: reads data from an external data source and writes them to a SAS data set.

INFOMAPS procedure
: creates or updates a SAS Information Map. For more information, see the *Base SAS Guide to Information Maps*.

JAVAINFO procedure
: conveys diagnostic information to the user about the Java environment that SAS is using. The diagnostic information can be used to confirm that the SAS Java environment has been configured correctly and can be helpful when reporting problems to SAS technical support.

JSON procedure
: reads data from a SAS data set and writes it to an external file in JSON representation.

MEANS procedure
: computes descriptive statistics for numeric variables across all observations and within groups of observations. You can also create an output data set that contains specific statistics and identifies minimum and maximum values for groups of observations.

METADATA procedure
: sends a method call, in the form of an XML string, to a SAS Metadata Server. For more information, see *SAS Language Interfaces to Metadata*.

METALIB procedure
: updates metadata in a SAS Metadata Repository to match the tables in a library. For more information, see *SAS Language Interfaces to Metadata*.

METAOPERATE procedure
: performs administrative tasks on a metadata server. For more information, see *SAS Language Interfaces to Metadata*.

MIGRATE procedure
: migrates members in a SAS library forward to the most current release of SAS. The migration must occur within the same engine family; for example, V6, V7, or V8 can migrate to V9, but V6TAPE must migrate to V9TAPE.

OPTIONS procedure
: lists the current values of all SAS system options.

OPTLOAD procedure
: reads SAS system option settings from the SAS registry or a SAS data set, and puts them into effect.

OPTSAVE procedure
: saves SAS system option settings to the SAS registry or a SAS data set.

PDS procedure
: lists, deletes, and renames the members of a partitioned data set. For more information, see the *SAS Companion for z/OS*.

PDSCOPY procedure
: copies partitioned data sets from disk to tape, disk to disk, tape to tape, or tape to disk. For more information, see the *SAS Companion for z/OS*.

PLOT procedure
: produces scatter plots that graph one variable against another. The coordinates of each point on the plot correspond to the two variables' values in one or more observations of the input data set.

PMENU procedure
: defines menus that you can use in DATA step windows, macro windows, and SAS/AF windows, or in any SAS application that enables you to specify customized menus.

PRESENV procedure
: preserves all global statements and macro variables in your SAS code from one SAS session to another. When this procedure is invoked at the end of a SAS session, all of the global statements and macro variables are written to a file.

PRINT procedure
: prints the observations in a SAS data set, using all or some of the variables. PROC PRINT can also print totals and subtotals for numeric variables.

PRINTTO procedure
: defines destinations for SAS procedure output and the SAS log.

PROTO procedure
: enables you to register, in batch mode, external functions that are written in the C or C++ programming languages. You can use these functions in SAS as well as in C-language structures and types. After these functions are registered in PROC PROTO, they can be called from any SAS function or subroutine that is declared in the FCMP procedure. After registration, they can also be called from any SAS function, subroutine, or method block that is declared in the COMPILE procedure.

PRTDEF procedure
: creates printer definitions for individual SAS users or all SAS users.

PRTEXP procedure
: exports printer definition attributes to a SAS data set so that they can be easily replicated and modified.

PWENCODE procedure
: encodes passwords for use in SAS programs.

QDEVICE procedure
: produces reports about graphics devices and universal printers.

RANK procedure
: computes ranks for one or more numeric variables across the observations of a SAS data set. The ranks are written to a new SAS data set. Alternatively, PROC RANK produces normal scores or other rank scores.

REGISTRY procedure
: imports registry information into the USER portion of the SAS registry.

RELEASE procedure
: releases unused space at the end of a disk data set in the z/OS environment. For more information, see the *SAS Companion for z/OS*.

REPORT procedure
: combines features of the PRINT, MEANS, and TABULATE procedures with features of the DATA step in a single report-writing tool that can produce both detail and summary reports.

SCAPROC procedure
: implements the SAS Code Analyzer, which captures information about input, output, and the use of macro symbols from a SAS job while it is running.

SCOREACCEL procedure
: provides an interface to the CAS server for DATA step and DS2 model publishing and scoring.

SOAP procedure
: reads XML input from a file that has a fileref and writes XML output to another file that has a fileref.

SORT procedure
: sorts observations in a SAS data set by one or more variables. PROC SORT stores the resulting sorted observations in a new SAS data set or replaces the original data set.

SOURCE procedure
: provides an easy way to back up and process source library data sets. For more information, see the SAS documentation for your operating environment.

SQL procedure
: implements a subset of the Structured Query Language (SQL) for use in SAS. SQL is a standardized, widely used language that retrieves and updates data in SAS data sets, SQL views, and DBMS tables, as well as views based on those tables. PROC SQL can also create tables and views, summaries, statistics, and reports and perform utility functions such as sorting and concatenating. For more information, see *SAS SQL Procedure User's Guide*.

SQOOP procedure
: allows access to Apache Sqoop using options to allow data transfer between a database and HDFS.

STANDARD procedure
: standardizes some or all of the variables in a SAS data set to a given mean and standard deviation and produces a new SAS data set that contains the standardized values.

STREAM procedure
: enables you to process an input stream that consists of arbitrary text that can contain SAS macro specifications. It can expand macro code and store it in a file.

SUMMARY procedure
: computes descriptive statistics for the variables in a SAS data set across all observations and within groups of observations, and writes the results to a new SAS data set.

TABULATE procedure
: displays descriptive statistics in tabular form. The value in each table cell is calculated from the variables and statistics that define the pages, rows, and columns of the table. The statistic associated with each cell is calculated on values from all observations in that category. You can write the results to a SAS data set.

TAPECOPY procedure
: copies an entire tape volume or files from one or more tape volumes to one output tape volume. For more information, see the *SAS Companion for z/OS*.

TAPELABEL procedure
: lists the label information of an IBM standard-labeled tape volume under the z/OS environment. For more information, see the *SAS Companion for z/OS*.

TEMPLATE procedure
: customizes ODS output for an entire SAS job or a single ODS output object. For more information, see *SAS Output Delivery System: User's Guide*.

TIMEPLOT procedure
: produces plots of one or more variables over time intervals.

TRANSPOSE procedure
: transposes a data set that changes observations into variables and vice versa.

TRANTAB procedure
: creates, edits, and displays customized translation tables. For more information, see *SAS National Language Support (NLS): Reference Guide*.

UNIVARIATE procedure
: computes descriptive statistics (including quantiles), confidence intervals, and robust estimates for numeric variables. Provides detail on the distribution of numeric variables, which include tests for normality, plots to illustrate the distribution, frequency tables, and tests of location. For more information, see *Base SAS Procedures Guide: Statistical Procedures*.

XSL procedure
: transforms an XML document into another format, such as HTML, text, or another XML document type.

2

Fundamental Concepts for Using Base SAS Procedures

Language Concepts

Temporary and Permanent SAS Data Sets

Naming SAS Data Sets

SAS data sets can have a one-level name or a two-level name. Typically, names of temporary SAS data sets have only one level and are stored in the WORK library. The WORK library is defined automatically at the beginning of the SAS session and is deleted automatically at the end of the SAS session. Procedures assume that SAS data sets that are specified with a one-level name are to be read from or written to the WORK library. To indicate otherwise, you specify a USER library. For more information, see "USER Library" on page 22. For example, the following PROC PRINT steps are equivalent. The second PROC PRINT step assumes that the DEBATE data set is in the WORK library.

```
proc print data=work.debate;
run;

proc print data=debate;
run;
```

The SAS system options WORK=, WORKINIT, and WORKTERM affect how you work with temporary and permanent libraries. For more information, see *SAS System Options: Reference*.

Typically, two-level names represent permanent SAS data sets. A two-level name takes the form *libref.SAS-data-set*. The *libref* is a name that is temporarily associated with a SAS library. A SAS library is an external storage location that stores SAS data sets in your operating environment. A LIBNAME statement associates the libref with the SAS library. In the following PROC PRINT step, PROCLIB is the libref and EMP is the SAS data set within the library:

```
libname proclib 'SAS-library';
proc print data=proclib.emp;
run;
```

USER Library

You can use one-level names for permanent SAS data sets by specifying a USER library. You can assign a USER library with a LIBNAME statement or with the SAS system option USER=. After you specify a USER library, the procedure assumes

that data sets with one-level names are in the USER library instead of the WORK library. For example, the following PROC PRINT step assumes that DEBATE is in the USER library:

```
options user='SAS-library';
proc print data=debate;
run;
```

Note: If you have a USER library defined, then you can still use the WORK library by specifying WORK.*SAS-data-set*.

SAS System Options

Some SAS system option settings affect procedure output. The SAS system options listed below are the options that you are most likely to use with SAS procedures:

- BYLINE | NOBYLINE
- DATE | NODATE
- DETAILS | NODETAILS
- FMTERR | NOFMTERR
- FORMCHAR=
- FORMDLIM=
- LABEL | NOLABEL
- LINESIZE=
- NUMBER | NONUMBER
- PAGENO=
- PAGESIZE=
- REPLACE | NOREPLACE
- SOURCE | NOSOURCE

For a complete description of SAS system options, see the *SAS System Options: Reference*.

Data Set Options

Most of the procedures that read data sets or create output data sets accept data set options. SAS data set options appear in parentheses after the data set specification. Here is an example:

```
proc print data=stocks(obs=25 pw=green);
```

The individual procedure chapters contain reminders that you can use data set options where it is appropriate.

SAS data set options are as follows:

ALTER=	OBS=
BUFNO=	OBSBUF=
BUFSIZE=	OUTREP=
CNTLLEV=	POINTOBS=
COMPRESS=	PW=
DLDMGACTION=	PWREQ=
DROP=	READ=
ENCODING=	RENAME=
ENCRYPT=	REPEMPTY=
FILECLOSE=	REPLACE=
FIRSTOBS=	REUSE=
GENMAX=	SORTEDBY=
GENNUM=	SPILL=
IDXNAME=	TOBSNO=
IDXWHERE=	TYPE=
IN=	WHERE=
INDEX=	WHEREUP=
KEEP=	WRITE=
LABEL=	

For a complete description of SAS data set options, see the *SAS Data Set Options: Reference*.

Global Statements

You can use these global statements anywhere in SAS programs except after a DATALINES, CARDS, or PARMCARDS statement:

comment	ODS
DM	OPTIONS
ENDSAS	PAGE
FILENAME	RUN
FOOTNOTE	%RUN
%INCLUDE	SASFILE
LIBNAME	SKIP
%LIST	TITLE
LOCK	X

For information about all the above statements except for the ODS statement, see the *SAS DATA Step Statements: Reference*. For information about the ODS statement, see "Output Delivery System" on page 72 and *SAS Output Delivery System: User's Guide*.

AES Encryption

Prior to the SAS 9.4M5 release, SAS supported only one Advanced Encryption Standard (AES) encryption algorithm that was specified with the ENCRYPT=AES data set option. Beginning with the SAS 9.4M5 release, SAS supports a stronger AES key generation algorithm specified with the ENCRYPT=AES2 data set option. This stronger algorithm meets newer standards requested by some SAS customers. The same key value passphrase specified by the ENCRYPTKEY= data set option can be used with either algorithm. A data set that is encrypted with the AES2 algorithm cannot be accessed by any SAS release prior to SAS 9.4M5.

To access a data set that is created with AES encryption, you have to supply the encryption key value with the ENCRYPTKEY= option. If you omit the ENCRYPTKEY= key value when accessing an AES secured data set, a dialog box appears and prompts you to add the ENCRYPTKEY= key value. For more

information, see "AES Encryption" in *SAS Programmer's Guide: Essentials* and "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*.

Procedure Concepts

Input Data Sets

Many Base SAS procedures require an input SAS data set. You specify the input SAS data set by using the DATA= option in the procedure statement, as in this example:

```
proc print data=emp;
```

If you omit the DATA= option, the procedure uses the value of the SAS system option _LAST_=. The default of _LAST_= is the most recently created SAS data set in the current SAS job or session. _LAST_= is described in detail in the *SAS Data Set Options: Reference*.

Threaded Processing for Base SAS Procedures

Threaded processing enables multiple pieces of executable code to run simultaneously. Many SAS procedures, including several SAS/STAT and High-Performance Analytics (HPA) procedures, support threaded processing. However, not all SAS procedures support threaded processing. See the documentation for the procedures that you are using to determine whether they support threaded processing.

Calculated statistics can vary slightly, depending on the order in which observations are processed. Such variations are due to numerical errors that are introduced by floating–point arithmetic, the results of which should be considered approximate and not exact. The order of observation processing can be affected by nondeterministic effects of multithreaded or parallel processing. The order of processing can also be affected by inconsistent or nondeterministic ordering of observations that are produced by a data source, such as a DBMS that delivers query results through an ACCESS engine. For more information, see "Numerical Accuracy in SAS Software" in *SAS Language Reference: Concepts* and "Threading in Base SAS" in *SAS Language Reference: Concepts*.

The following Base SAS procedures support threaded processing:

- Chapter 40, "MEANS Procedure," on page 1463
- Chapter 58, "REPORT Procedure," on page 2047
- Chapter 64, "SORT Procedure," on page 2355

- Chapter 69, "SUMMARY Procedure," on page 2455
- Chapter 70, "TABULATE Procedure," on page 2459
- "SQL Procedure" in *SAS SQL Procedure User's Guide*

See Also

System Options

- "CPUCOUNT= System Option" in *SAS System Options: Reference*
- "THREADS System Option" in *SAS System Options: Reference*

Other Documentation

- "Support for Parallel Processing" in *SAS Language Reference: Concepts*
- *SAS Scalable Performance Data Server: User's Guide*

Controlling the Order of Data Values

Ordering of Data Values

Procedures apply an ordering scheme for data values and certain conditions affect how procedures order data:

- operating-environment-specific collating sequences
- the BY statement
- a single classification variable
- multiple classification variables
- formats
- the ORDER= option
- supplemental ordering options

Examples for ordering data use the Sasuser.Houses data set.

```
data sasuser.houses;
input style $ 1-9 sqfeet 10-13 bedrooms 15 baths 17-19 street $ 21-36 price 38-44;
datalines;
RANCH     1250 2 1.0 Sheppart Avenue    64000
SPLIT     1190 1 1.0 Rand Street        65850
CONDO     1400 2 1.5 Market Street      80050
TWOSTORY  1810 4 3.0 Garris Street     107250
RANCH     1500 3 3.0 Kemble Avenue      86650
SPLIT     1615 4 3.0 West Drive         94450
SPLIT     1305 3 1.5 Graham Avenue      73650
```

```
CONDO     1390 3 2.5 Hampshire Avenue   79650
TWOSTORY  1040 2 1.0 Sanders Road       55850
CONDO     2105 4 2.5 Jeans Avenue      127150
RANCH     1535 3 3.0 State Highway      89100
TWOSTORY  1240 2 1.0 Fairbanks Circle   69250
RANCH      720 1 1.0 Nicholson Drive    34550
TWOSTORY  1745 4 2.5 Highland Road     102950
CONDO     1860 2 2.0 Arcata Avenue     110700
run;

proc datasets lib=sasuser memtype=data;
   modify houses;
   attrib price format=dollar8.;
run;

proc print data=sasuser.houses;
run;
```

Figure 2.1 *The Sasuser.Houses Data Set*

The SAS System

Obs	style	sqfeet	bedrooms	baths	street	price
1	RANCH	1250	2	1.0	Sheppard Avenue	$64,000
2	SPLIT	1190	1	1.0	Rand Street	$65,850
3	CONDO	1400	2	1.5	Market Street	$80,050
4	TWOSTORY	1810	4	3.0	Garris Street	$107,250
5	RANCH	1500	3	3.0	Kemble Avenue	$86,650
6	SPLIT	1615	4	3.0	West Drive	$94,450
7	SPLIT	1305	3	1.5	Graham Avenue	$73,650
8	CONDO	1390	3	2.5	Hampshire Avenue	$79,350
9	TWOSTORY	1040	2	1.0	Sanders Road	$55,850
10	CONDO	2105	4	2.5	Jeans Avenue	$127,150
11	RANCH	1535	3	3.0	State Highway	$89,100
12	TWOSTORY	1240	2	1.0	Fairbanks Circle	$69,250
13	RANCH	720	1	1.0	Nicholson Drive	$34,550
14	TWOSTORY	1745	4	2.5	Highland Road	$102,950
15	CONDO	1860	2	2.0	Arcata Avenue	$110,700

Data Ordered by the Operating Environment

Operating environments use either the ASCII or EBCIDIC collating sequences to order data:

- Windows and UNIX use the ASCII collating sequence.
- z/OS uses the EBCIDIC collating sequence.

This example code was run on Windows and z/OS, changing the title for each system:

```
data order;
   input x $1.;
   datalines;
1
a
A
z
Z
\
;

proc print;
run;
```

The following table shows the difference in the PRINT procedure output between ASCII and EBCIDIC:

ASCII Collating Sequence	EBCDIC Collating Sequence
1	a
A	z
Z	A
\	\
a	Z
z	1

For more information, see "Collating Sequence" in *SAS National Language Support (NLS): Reference Guide*.

Order Data Using the BY Statement

To order data by one or more variables, you must first use the SORT procedure. After the data is sorted, you use the same variables in a procedure BY statement to indicate how the data is sorted. The procedure subsets the data into BY groups based on the BY variables.

```
proc sort data=sasuser.houses out=houses;
   by style;
run;
proc freq data=houses;
  by style;
  tables bedrooms /nopercent;
run;
```

Here are the first two BY groups ordered by the Style variable for the house styles:

Figure 2.2 *The First of Two BY Groups in Ascending Order*

The FREQ Procedure

style=CONDO

bedrooms	Frequency	Cumulative Frequency
2	2	2
3	1	3
4	1	4

Figure 2.3 *The Second of Two BY Groups in Ascending Order*

The FREQ Procedure

style=RANCH

bedrooms	Frequency	Cumulative Frequency
1	1	1
2	1	2
3	2	4

By default, the SORT procedure orders BY groups in ascending order. To reverse the order, you use the DESCENDING option in the BY statement in PROC SORT and in subsequent procedures that process the data set.

```
proc sort data=sasuser.houses out=houses;
   by descending style;
run;
proc freq data=houses;
  by descending style;
  tables bedrooms /nopercent;
  run;
```

Figure 2.4 *First of Two BY Groups in Descending Order*

The FREQ Procedure

style=TWOSTORY

bedrooms	Frequency	Cumulative Frequency
2	2	2
4	2	4

Figure 2.5 *Second of Two BY Groups in Descending Order*

The FREQ Procedure

style=SPLIT

bedrooms	Frequency	Cumulative Frequency
1	1	1
3	1	2
4	1	3

The BY statement has another option, NOTSORTED. The NOTSORTED option is useful when you want to list a variable in a BY statement whose values are grouped together, but are not sorted in either ascending or descending order.

Order Data Using a Single Classification Variable

Classification variables organize data into groups that are meaningful for analysis. The values are grouped and ordered after all of the data values in a data set or BY group have been read by the procedure.

The following table lists some of the procedures and their statements that define classification variables:

Procedure	Statement
FREQ	TABLES
MEANS	CLASS
REPORT	DEFINE use options GROUP, ORDER, or ACROSS
SUMMARY	CLASS
TABULATE	CLASS

For most procedures, the default ordering scheme is ascending for single classification variables with no formats or ordering options:

```
proc means data=sasuser.houses nway mean;
   class style;
   var sqfeet;
run;
```

Figure 2.6 *The Default Ascending Order for a Single Classification Variable*

The MEANS Procedure

Analysis Variable : sqfeet Square footage		
Style of homes	N Obs	Mean
CONDO	4	1688.75
RANCH	4	1251.25
SPLIT	3	1370.00
TWOSTORY	4	1458.75

For information about the default data ordering behavior for PROC REPORT, see "Order Data Using the ORDER= Option" on page 44.

Order Data Using Multiple Classification Variables

Only one variable can be considered the higher-order grouping variable when you use multiple classification variables to create subgroups of data. All other variables are used to create subgroups of the immediate preceding higher-order variable.

Here is a list of statements, by procedure, that specifies the higher-order variable. The first variable in the procedure statement is the higher-order variable. In all examples in the table, A is the higher-order variable.

Procedure	Statement That Specifies the Higher-Order Variable	Example

FREQ	TABLES	`proc freq;`
		`  tables A * B * C * D;`
		`run;`

MEANS	CLASS	`proc means;`
		`  class A B C D;`
		`run;`

REPORT	COLUMN	`proc report;`
		`  column A B C D;`
		`  define C / group;`
		`  define A / group;`
		`  define B / group;`
		`  define D / group;`
		
		`run;`

SUMMARY	CLASS	`proc summary;`
		`  class A B C D;`
		`run;`

TABULATE	TABLE	`proc tabulate;`
		`  class D C B A;`
		`  table A, B, C * D;`
		`run;`

The ordering scheme is determined first by developing a master order for each class variable, for the entire data set or BY group. The master order is then applied to each subgroup of the hierarchy. The order does not change from one class subgroup to the next.

Consider this example:

```
proc tabulate data=sasuser.houses format=3. noseps;
   class style bedrooms;
   table style*bedrooms, n / rts=23;
run;
```

The master order for Style and Bedrooms is determined separately. Style is the higher-order class variable. Bedrooms forms subgroups of each value of Style. The order for Bedrooms is not determined again for each value of Style. Instead, the order is taken from the master order that is determined before generating subgroups.

When no ORDER= option is specified in the CLASS statement, the data is ordered by using unformatted values, which results in the same order as the SORT procedure. The master order for Style is ascending alphabetically, and the master order for Bedrooms is ascending numerically:

Figure 2.7 Master Order Using No ORDER= Option

The SAS System

		N
style	bedrooms	
CONDO	2	2
	3	1
	4	1
RANCH	1	1
	2	1
	3	2
SPLIT	1	1
	3	1
	4	1
TWOSTORY	2	2
	4	2

Consider this example where the order also considers frequency counts:

```
proc tabulate data=sasuser.houses format=3. noseps order=freq;
   class style bedrooms;
   table style*bedrooms, n / rts=23;
run;
```

For PROC TABULATE, if the frequency count is the same for multiple variables, then the master order uses the order in which the data was read by the procedure. When PROC TABULATE reads the data set, the frequency count for Ranch is 4, Split is 3, Condo is 4, and TwoStory is 4. Therefore, the master order of the higher-order variable, Style, is Ranch, Condo, TwoStory, and Split.

The master order for bedrooms is then determined. Two bedrooms has a count of 5, four bedrooms has a count of 4, three bedrooms has a count of 4, and one bedroom has a count of 2. The master order for bedrooms is 2, 4, 3, 1. Here is the output:

Figure 2.8 *The Order of Values Using the Master Order*

The SAS System

		N
Style of homes	Number of bedrooms	
RANCH	2	1
	3	2
	1	1
CONDO	2	2
	4	1
	3	1
TWOSTORY	2	2
	4	2
SPLIT	4	1
	3	1
	1	1

The order becomes obvious when you add the PRINTMISS option to the TABLE statement to show the frequency count:

Figure 2.9 *The Master Order with Frequency Counts*

The SAS System

		N
Style of homes	Number of bedrooms	
RANCH	2	1
	4	.
	3	2
	1	1
CONDO	2	2
	4	1
	3	1
	1	.
TWOSTORY	2	2
	4	2
	3	.
	1	.
SPLIT	2	.
	4	1
	3	1
	1	1

Order Data Using Formats: Procedure Default Behavior

The FREQ, MEANS, SUMMARY, and TABULATE procedures default to order class variable values in ascending order by the actual value in the SAS data set and not their formatted values.

The REPORT procedure default order is ascending order based on the formatted values of the order, group, or across variable.

The following table summarizes the default ordering schemes for procedures when formats are applied to classification variables:

Procedure	Variable Type	Format Specified	Ordered By
FREQ	Numeric or Character	Yes or No	Actual value
MEANS	Numeric or Character	Yes or No	Actual value
REPORT	Numeric	Yes or No	Formatted value [1]
	Character	Yes No	Formatted value Actual value
SUMMARY	Numeric or Character	Yes or No	Actual value
TABULATE	Numeric or Character	Yes or No	Actual value

1 BEST*w.d* is the default format if no format is assigned.

Order Data Using Formats: Using the Lowest Actual Value

When you format multiple values of a class variable and use ORDER=INTERNAL, the ordering of data uses the actual values from the data set and not formatted values. The value that applies to a particular class level is the lowest actual value that was encountered in the data set for the format range. This occurs whether you are producing printed output or an output data set.

In this example, GROUP B appears before GROUP A because the lowest actual value encountered for GROUP B is 1. For GROUP A, the lowest actual value is 3. The lowest possible actual value that could be in GROUP A is 0, but 0 does not exist in the data.

```
proc format;
   value numf 0,3,4='GROUP A'
              1,2='GROUP B';

proc report data=sasuser.houses;
   column bedrooms;
   define bedrooms / group format=numf. order=internal;
run;
```

Figure 2.10 Ordering by the Lowest Value in a Format Range

The SAS System

bedrooms
GROUP B
GROUP A

Another situation that uses the lowest actual value occurs when a format contains groups or ranges that are independent from one another.

In this example, for DEPT=PET, the value OTHER appears last in the sequence. It appears first for DEPT=PLANT. This is because the master ordering sequence for ID is determined before subgroups are created. ID=199 and ID=299 have the same format, OTHER. Because only the formatted value OTHER was established in the master ordering for ID, OTHER is ordered first for DEPT=PLANT.

```
data sample;

   length dept $ 5;
   input dept id;
   datalines;
PET   100
PET   110
PET   120
PET   199
PLANT 200
PLANT 210
PLANT 220
PLANT 299
;

proc format;
   value idfmt
         100='CAT'
         110='DOG'
         120='FISH'
         199='OTHER'
         200='CACTUS'
         210='IVY'
         220='FERN'
         299='OTHER';

proc tabulate data=sample noseps;
   class dept id;
   table dept*id, n;
   format id idfmt.;
run;
```

Figure 2.11 *Ordering by the Lowest Actual Value*

The SAS System

		N
dept	id	
PET	CAT	1
	DOG	1
	FISH	1
	OTHER	1
PLANT	OTHER	1
	CACTUS	1
	IVY	1
	FERN	1

Order Data Using Formats: Missing Values

If missing values exist in the data and in a format range, they can have one of two possible effects on the output, depending on the procedure and options that you specify:

1. The entire format group is treated as invalid.
2. The entire format range has the lowest internal value, possibly resulting in the format range appearing first in an ordering scheme.

Most procedures that use class variables provide the MISSING option, which enables you to specify whether missing values are to be considered valid class levels. PROC FREQ has the option MISSPRINT, which displays missing class levels but does not use them in calculating statistics.

The MEANS, REPORT, SUMMARY, and TABULATE procedures classify missing values as valid or invalid before formats are applied. If you do not specify the MISSING option, and you use a format range that groups nonmissing class levels with missing class levels, then the nonmissing class levels are treated as valid, whereas the missing class levels are not valid.

PROC FREQ applies formats before classifying missing values as valid or invalid. If MISSING or MISSPRINT is not used and a format range groups nonmissing class levels with missing class levels, then both the nonmissing and missing class levels are considered invalid. The following example demonstrates the difference in effect between PROC FREQ and PROC REPORT:

```
proc format;
   value bedfmt 1='ONE' 2='TWO' other='OTHER';
```

```
data houses;
   set sasuser.houses end=last;
   output;
   if last then do;
      bedrooms=.;
      output;
   end;
   format bedrooms bedfmt.;
run;

proc print data=houses;
   title "PROC PRINT";
   title2 "WORK.HOUSES";
   var bedrooms;
   format bedrooms;
run;

proc freq data=houses;
   title1 "PROC FREQ";
   title2 "Without MISSING Specified";
   tables bedrooms / nocum nopercent;
run;

proc report data=houses;
   title1 "PROC REPORT";
   title2 "Without MISSING Specified";
   column beddrooms n;
   define bedrooms /group width=8;
run;
```

Output 2.1 *Order of Data Compared in PROC FREQ and PROC REPORT*

PROC PRINT
WORK.HOUSES

Obs	bedrooms
1	2
2	1
3	2
4	4
5	3
6	4
7	3
8	3
9	2
10	4
11	3
12	2
13	1
14	4
15	2
16	.

PROC FREQ
Without MISSING Specified

The FREQ Procedure

Number of bedrooms	
bedrooms	Frequency
ONE	2
TWO	5
Frequency Missing = 9	

PROC REPORT
Without MISSING Specified

Number of bedrooms	n
ONE	2
OTHER	8
TWO	5

PROC FREQ does not include the formatted class level OTHER, where PROC REPORT does. This is because PROC FREQ applied the BEDFMT. format to the Bedrooms variable before classifying missing values as invalid. PROC REPORT classifies missing values as invalid before applying the format. This allows the nonmissing class levels that would normally be grouped with the missing class levels to be treated as valid.

You can verify this by observing the frequency counts. A total of 16 observations reside in the Work.Houses data set. PROC FREQ reports nine invalid class levels. PROC REPORT treats only one class level as invalid. If the lowest internal value in a format group is a missing value, then the entire group is treated as missing. Because missing values are considered the lowest possible internal value for either numeric or character variables, missing values cause an entire format group to have the lowest internal value. Missing values rank first when ordering by internal values. The following code demonstrates this by adding the MISSING option to the previous example:

```
proc freq data=houses;
   title1 "PROC FREQ";
   title2 "With MISSING Specified";
   tables bedrooms / nocum nopercent missing ;
run;

proc report data=houses missing;
   title1 "PROC REPORT";
   title2 "With MISSING Specified";
   column bedrooms n;
   define bedrooms / group width=8;
run;
```

Output 2.2 *PROC FREQ and PROC REPORT with MISSING Specified*

PROC FREQ
With MISSING Specified

The FREQ Procedure

bedrooms	Frequency
OTHER	9
ONE	2
TWO	5

PROC REPORT
With MISSING Specified

bedrooms	n
ONE	2
OTHER	9
TWO	5

In the results for PROC FREQ, the group OTHER is ordered first in the sequence. In the results for PROC REPORT, OTHER is ordered second. By default, PROC FREQ orders by internal values and PROC REPORT orders by formatted values. Note that the frequency count is the same for both procedures. In PROC FREQ, OTHER corresponds to the missing frequency in the Work.Houses data set. For PROC REPORT, the frequency increases by one to account for the single missing value that was not included in Work.Houses.

Order Data Using Formats: BY Variables

If a format is applied to a variable in a BY statement, then the values of the BY variable are grouped unless the internal values are not sequenced in the format range:

```
proc sort data=sasuser.houses out=houses;
   by bedrooms;
run;

proc format;
   value numf 3='GROUP A' 1,2,4='GROUP B';
run;

proc report data=houses;
   by bedrooms;
```

```
   format bedrooms numf.;
   column price;
run;
```

Output 2.3 *Ordering with a Formatted BY Variable*

Order Data Using the ORDER= Option

The ORDER= option enables you to choose the ordering scheme that the procedure uses. The ORDER= option can have the values INTERNAL or UNFORMATTED, FORMATTED, DATA, and FREQ.

Note: The MEANS, REPORT, SUMMARY, and TABULATE procedures accept both the INTERNAL and UNFORMATTED as a value for the ORDER= option to order unformatted data.

You can use the option with these procedures:

Procedure	SAS Product	Default Value
CATMOD	SAS/STAT	INTERNAL
FREQ	Base SAS	INTERNAL

Procedure	SAS Product	Default Value
GLM	SAS/STAT	FORMATTED
LIFEREG	SAS/STAT	FORMATTED
LOGISTIC	SAS/STAT	FORMATTED
MEANS	Base SAS	UNFORMATTED
PROBIT	SAS/STAT	FORMATTED
REPORT	Base SAS	FORMATTED
SUMMARY	Base SAS	UNFORMATTED
TABULATE	Base SAS	UNFORMATTED

The following topics explain each value of ORDER=.

Order Data Using the ORDER= INTERNAL Option

When you specify ORDER=INTERNAL with no other ordering options specified, it causes class variable values to be listed in ascending order by their actual, unformatted values:

```
proc format;
   value numf 1='ONE' 2='TWO' 3='THREE' 4='FOUR';
run;
proc report data=sasuser.houses;
   column bedrooms;
   define bedrooms /group format=numf8. order=internal;
run;
```

Output 2.4 *Output When ORDER=INTERNAL*

The SAS System

Number of bedrooms
ONE
TWO
THREE
FOUR

The values for bedroom are ONE, TWO, THREE, and FOUR, which correspond to the numbers 1, 2, 3, 4. If you do not specify ORDER=INTERNAL, the values are listed in alphabetical order by the formatted value: FOUR, ONE, THREE, TWO.

Order Data Using the ORDER= FORMATTED Option

When you specify ORDER=FORMATTED with no other ordering options specified causes class variable values to be listed in alphabetical order by their formatted values:

```
proc format;
   value numf 1='ONE' 2='TWO' 3='THREE' 4='FOUR';
run;
proc freq data=sasuser.houses order=formatted;
   tables bedrooms / nopercent;
   format bedrooms numf8. ;
run;
```

Output 2.5 *Output When ORDER=FORMATTED*

The SAS System

The FREQ Procedure

Number of bedrooms		
bedrooms	Frequency	Cumulative Frequency
FOUR	4	4
ONE	2	6
THREE	4	10
TWO	5	15

If ORDER=FORMATTED is specified and a class variable does not have a format associated with it, then the output is listed by its internal, or unformatted values.

In a special case, as the default behavior for PROC REPORT is ORDER=FORMATTED, this setting might cause problems because PROC REPORT uses BEST*w*. as the default format for numeric values. Here is an example:

```
proc report data=sasuser.houses;
   title1 "ORDER=FORMATTED";
   title2 "(default)";
   title4 "FORMAT=BEST9.";
   title5 "(default)";
   column baths;
   define baths / group;
run;
```

Here, BEST9. is the default format because a format is not specified. Since the default setting for PROC REPORT is ORDER=FORMATTED, the values are sorted using the formatted values. This can be complicated by character comparisons that sometimes give misleading results. The values that are being compared are " 1", " 2", " 3", "1.5", and "2.5". The single-digit values have leading blanks. Since a blank character sorts before a number or a period (.), the values "1", "2", and "3" sort before the values 1.5 or 2.5.

Output 2.6 *PROC REPORT Default Formatting When Values Have Leading Blanks*

ORDER=FORMATTED
(default)

FORMAT=BEST9.
(default)

Number of bathrooms
1
2
3
1.5
2.5

This problem is corrected in the next output by using the 3.1 format, causing no leading blanks to appear in the comparison:

```
proc report data=sasuser.houses;
   title1 "ORDER=FORMATTED";
   title2 "(default)";
   title4 "FORMAT=3.1";
   title5 "(specified)";
   column baths;
   define baths / group format=3.1;
run;
```

Output 2.7 *PROC REPORT Formatted When Values Have No Leading Blanks*

ORDER=FORMATTED (default)

FORMAT=3.1 (specified)

Number of bathrooms
1.0
1.5
2.0
2.5
3.0

The problem is also corrected in the following output because the internal values and not the formatted values are used to determine the order:

```
proc report data=sasuser.houses nowd;
   title1 "ORDER =INTERNAL";
   title2 "(specified)";
   title4 "FORMAT=BEST9.";
   title5 "(default)";
   column baths;
   define baths / group order=internal;
run;
```

Output 2.8 *PROC FORMAT Output Based on Internal Values*

ORDER =INTERNAL (specified)

FORMAT=BEST9. (default)

Number of bathrooms
1
1.5
2
2.5
3

Order Data Using the ORDER= DATA Option

ORDER=DATA specifies that the order is set according to how the data is initially read by the procedure. ORDER=DATA can be complicated depending on the use of BY statements or multiple classification variables. Here is a simple case:

```
proc tabulate data=sasuser.houses order=data format=3. noseps;
   class style;
   table style, n;
run;
```

Output 2.9 *PROC TABULATE with ORDER=DATA*

	N
Style of homes	
RANCH	4
SPLIT	3
CONDO	4
TWOSTORY	4

The output order for Style is neither ascending nor descending. RANCH appears first because it is the first value that is encountered in the input data set. SPLIT appears second because it is encountered second, and so on. If you use a BY statement, then the order is reset at the beginning of each new BY group, as if a new data set were being processed.

When you use multiple classification variables, the order is determined independently for each classification variable across the entire data set or BY group. The ordering scheme is developed first using the master order of the highest order variable and then the next highest, and so on. Here is an example:

```
proc tabulate data=sasuser.houses order=data format=3. noseps;
   class style bedrooms;
   table style*bedrooms, n;
run;
```

Output 2.10 *PROC TABULATE Using Two Classification Variables*

		N
Style of homes	Number of bedrooms	
RANCH	2	1
	1	1
	3	2
SPLIT	1	1
	4	1
	3	1
CONDO	2	2
	4	1
	3	1
TWOSTORY	2	2
	4	2

To compare, the order for Style is RANCH, SPLIT, CONDO, TWOSTORY. The order for Bedrooms is 2, 1, 4, 3. This is not clearly apparent in the output because no value of STYLE has all four values of Bedrooms. The order of values is established independently for each variable and not according to the subgroups. You can verify this by adding the PRINTMISS option to the TABLE statement or by comparing the order of Style and Bedrooms in the Sasuser.Houses data set. See "Order Data Using Multiple Classification Variables" on page 32.

Order Data Using the ORDER= FREQ Option

ORDER=FREQ specifies that classification variables are to be ordered by the frequencies of each of their values. With the exception of PROC FREQ, missing class levels are ordered by their frequency counts just as nonmissing class levels are. PROC FREQ always lists missing class levels first, regardless of their frequency counts. All Base SAS procedures, except for PROC REPORT, list the frequencies in descending order. PROC REPORT, by default, lists the frequencies in ascending order. If you use the PROC REPORT option DESCENDING in conjunction with ORDER=FREQ, then the class levels are ordered by their descending frequency counts.

If two class levels have the same frequency, a secondary ordering algorithm is used. All Base SAS procedures, except for PROC FREQ, use ORDER=DATA as a secondary ordering method.

If duplicate frequency counts occur with PROC FREQ and ORDER=FREQ has been specified, then PROC FREQ uses ORDER=FORMATTED as a secondary ordering method. If in PROC FREQ a format has not been applied, then the tie is broken

using the ORDER=INTERNAL method. If you use PROC REPORT with ORDER=FREQ and the DESCENDING option, and a tie occurs, then the ORDER=DATA method is used, but the levels are listed in reverse order of occurrence in the data.

The following table summarizes the behavior across the Base SAS procedures that use the ORDER= option:

Procedure	Order Direction	Format	Order Value In a Tie
FREQ	Descending	No	ORDER=INTERNAL
		Yes	ORDER=FORMATTED
MEANS	Descending	Yes or No	ORDER=DATA
REPORT	Ascending	Yes or No	ORDER=DATA
	Descending	Yes or No	ORDER=DATA [1]
SUMMARY	Descending	Yes or No	ORDER=DATA
TABULATE	Descending	Yes or No	ORDER=DATA

1 If you specify the DESCENDING option, then both the primary method, ORDER=FREQ, and the secondary method, ORDER=DATA, list levels in descending order.

Here are some examples when ORDER=FREQ is specified with the TABULATE, FREQ, and REPORT procedures. First we have PROC TABULATE and PROC FREQ output without a format specified:

```
proc format;
   value bedfmt 1='ONE' 2='TWO' 3='THREE' 4='FOUR';

proc tabulate data=sasuser.houses order=freq noseps format=3.;
   title1 "PROC TABULATE";
   title2 "Without Format";
   class bedrooms;
   table bedrooms, n;
run;

proc freq data=sasuser.houses order=freq;
   title1 "PROC FREQ";
   title2 "Without Format";
   tables bedrooms / nocum nopercent;
run;
```

Both outputs list data values in descending order of the frequency counts.

Output 2.11 *ORDER=FREQ Examples*

PROC TABULATE
Without Format

	N
Number of bedrooms	
2	5
4	4
3	4
1	2

PROC FREQ
Without Format

The FREQ Procedure

Number of bedrooms	
bedrooms	Frequency
2	5
3	4
4	4
1	2

PROC REPORT, when no format is specified, lists the output in ascending order:

```
proc report data=sasuser.houses;
   title1 "PROC REPORT";
   title2 "Without Format";
   title3 "Without DESCENDING";
   column bedrooms n;
   define bedrooms / group order=freq;
run;
```

Output 2.12 *PROC REPORT with No Format Specified*

PROC REPORT
Without Format
Without DESCENDING

Number of bedrooms	n
1	2
4	4
3	4
2	5

For PROC REPORT to list output in descending order, you must specify DESCENDING in the DEFINE statement:

```
proc report data=sasuser.houses;
   title1 "PROC REPORT";
   title2 "Without Format";
   title3 "With DESCENDING";
   column bedrooms n;
   define bedrooms / group order=freq descending;
run;
```

PROC REPORT
Without Format
With DESCENDING

Number of bedrooms	n
2	5
4	4
3	4
1	2

PROC TABULATE and PROC REPORT use the ORDER=DATA method to handle values that are the same.

```
proc tabulate data=sasuser.houses order=freq noseps format=3.;
   title1 "PROC TABULATE";
   title2 "With Format";
   class bedrooms;
   table bedrooms, n;
   format bedrooms bedfmt.;
run;
proc report data=sasuser.houses;
   title1 "PROC REPORT";
   title2 "With Format";
   title3 "Without DESCENDING";
```

```
   column bedrooms n;
   define bedrooms / group order=freq format=bedfmt8.;
run;
```

Output 2.13 *Descending Output Examples*

PROC TABULATE With Format

	N
Number of bedrooms	
TWO	5
FOUR	4
THREE	4
ONE	2

PROC REPORT With Format Without DESCENDING

Number of bedrooms	n
ONE	2
FOUR	4
THREE	4
TWO	5

PROC FREQ uses ORDER=FORMATTED when a format is specified and values are the same.

```
proc freq data=sasuser.houses order=freq;
   title1 "PROC FREQ";
   title2 "With Format";
   tables bedrooms / nocum nopercent;
   format bedrooms bedfmt.;
run;
```

Output 2.14 *Descending Output Using PROC FREQ with a Format*

PROC FREQ
With Format

The FREQ Procedure

Number of bedrooms	
bedrooms	Frequency
TWO	5
FOUR	4
THREE	4
ONE	2

If you do not specify a format, PROC FREQ uses ORDER=INTERNAL.

In PROC REPORT when DESCENDING is applied, data values are listed in descending order of frequency counts and the data values that had the same frequency are listed in reverse order of occurrence. In other words, ORDER=DATA is used to handle values that are the same, and the data values are listed in reverse order.

Output 2.15 *Output Using PROC REPORT with a Format and the DESCENDING Option*

PROC REPORT
With Format
With DESCENDING

Number of bedrooms	n
TWO	5
FOUR	4
THREE	4
ONE	2

As with ORDER=DATA, when you add a BY statement, the order for classification variables is established as if each BY group were a separate data set. When you use multiple classification variables with ORDER=FREQ, the order is determined independently for each classification variable. The overall ordering scheme is then applied first by using the order of the highest order variable and then the next-highest order variable, and so on.

In this example, consider the frequencies for Baths:

```
proc tabulate data=sasuser.houses order=freq format=3. noseps;
```

```
   class baths;
   table baths, n;
run;
```

Output 2.16 *The Frequency of Baths Using PROC TABULATE*

	N
Number of bathrooms	
1	5
3	4
2.5	3
1.5	2
2	1

If you make Bedrooms the highest order variable and Baths the next-highest order variable, you expect the rows to be ordered by the descending frequency of values first in Bedrooms, then in Baths.

```
proc tabulate data=sasuser.houses order=freq format=3. noseps;
   class baths bedrooms;
   table bedrooms*baths, n;
run;
```

The N statistic does not list the frequencies of the combinations in descending order. Instead, the order is set first by the descending frequencies of BEDROOMS and then by BATHS. You can verify this by comparing the order of each variable against the orders used in Output 2.11 on page 52. The master ordering sequence for BEDROOMS is 2, 4, 3, 1. The master ordering sequence for BATHS is 1, 3, 2.5, 1.5, 2.

Output 2.17 *PROC TABULATE with Bedrooms as the High Order Variable*

		N
Number of bedrooms	Number of bathrooms	
2	1	3
	1.5	1
	2	1
4	3	2
	2.5	2
3	3	2
	2.5	1
	1.5	1
1	1	2

RUN-Group Processing

RUN-group processing enables you to submit a PROC step with a RUN statement without ending the procedure. You can continue to use the procedure without issuing another PROC statement. To end the procedure, use a RUN CANCEL or a QUIT statement. Several Base SAS procedures support RUN-group processing:

CATALOG	DS2	PLOT	TRANTAB
DATASETS	FEDSQL	PMENU	

See the section on the individual procedure for more information.

Note: PROC SQL executes each query automatically. Neither the RUN nor RUN CANCEL statement has any effect.

Creating Titles That Contain BY-Group Information

BY-Group Processing

BY-group processing uses a BY statement to process observations that are ordered, grouped, or indexed according to the values of one or more variables. By default, when you use BY-group processing in a procedure step, a BY line identifies each group. This section explains how to create titles that serve as customized BY lines.

Suppressing the Default BY Line

When you insert BY-group processing information into a title, you usually want to suppress the default BY line. To suppress it, use the SAS system option NOBYLINE.

Note: You must use the NOBYLINE option if you insert BY-group information into titles for the following procedures:

- MEANS
- PRINT
- STANDARD
- SUMMARY

If you use the BY statement with the NOBYLINE option, then these procedures always start a new page for each BY group. This behavior prevents multiple BY

groups from appearing on a single page and ensures that the information in the titles matches the report on the pages.

Inserting BY-Group Information into a Title

The general form for inserting BY-group information into a title is as follows:

#BY-specification<.suffix>

BY-specification is one of the following specifications:

BYVAL*n* | BYVAL(*BY-variable*)
places the value of the specified BY variable in the title. You specify the BY variable with one of the following options:

n
is the *n*th BY variable in the BY statement.

BY-variable
is the name of the BY variable whose value you want to insert in the title.

BYVAR*n* | BYVAR(*BY-variable*)
places the label or the name (if no label exists) of the specified BY variable in the title. You designate the BY variable with one of the following options:

n
is the *n*th BY variable in the BY statement.

BY-variable
is the name of the BY variable whose value you want to insert in the title.

BYLINE
inserts the complete default BY line into the title.

suffix supplies text to place immediately after the BY-group information that you insert in the title. No space appears between the BY-group information and the suffix.

Example: Inserting a Value from Each BY Variable into the Title

This example demonstrates these actions:

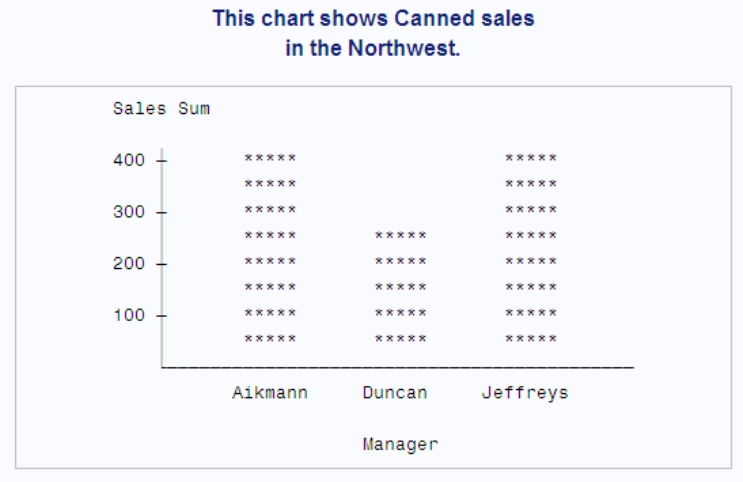
1. creates a data set, GROC, that contains data for stores from four regions. Each store has four departments. See "GROC" on page 2792 for the DATA step that creates the data set.
2. sorts the data by Region and Department.
3. uses the SAS system option NOBYLINE to suppress the BY line that normally appears in output that is produced with BY-group processing.

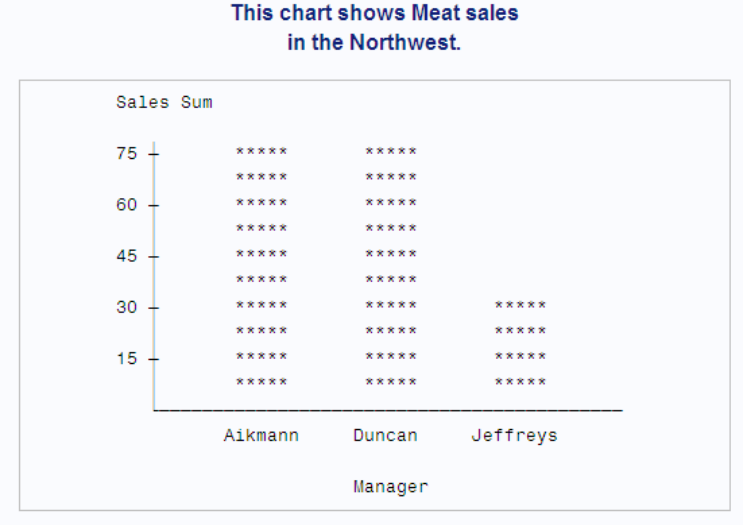
4 uses PROC CHART to chart sales by Region and Department. In the first TITLE statement, #BYVAL2 inserts the value of the second BY variable, Department, into the title. In the second TITLE statement, #BYVAL(Region) inserts the value of Region into the title. The first period after Region indicates that a suffix follows. The second period is the suffix.

5 uses the SAS system option BYLINE to return to the creation of the default BY line with BY-group processing.

```
data groc;                                                    1
   input Region $9. Manager $ Department $ Sales;
   datalines;
Southeast    Hayes       Paper       250
Southeast    Hayes       Produce     100
Southeast    Hayes       Canned      120
Southeast    Hayes       Meat         80
...more lines of data...
Northeast    Fuller      Paper       200
Northeast    Fuller      Produce     300
Northeast    Fuller      Canned      420
Northeast    Fuller      Meat        125
;
proc sort data=groc;                                          2
   by region department;
run;
options nobyline nodate pageno=1
        linesize=64 pagesize=20;                              3
proc chart data=groc;                                         4
   by region department;
   vbar manager / type=sum sumvar=sales;
   title1 'This chart shows #byval2 sales';
   title2 'in the #byval(region)..';
run;
options byline;                                               5
```

This partial output shows two BY groups with customized BY lines:





Example: Inserting the Name of a BY Variable into a Title

This example inserts the name of a BY variable and the value of a BY variable into the title. The program does these actions.

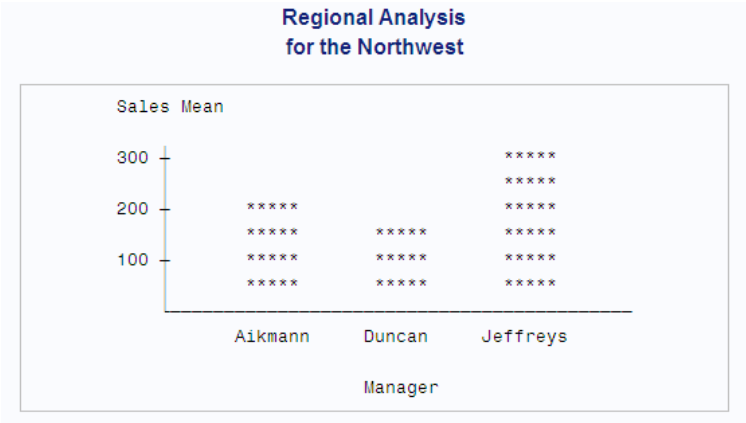
1 uses the SAS system option NOBYLINE to suppress the BY line that normally appears in output that is produced with BY-group processing.

2 uses PROC CHART to chart sales by Region. In the first TITLE statement, #BYVAR(Region) inserts the name of the variable Region into the title. (If Region had a label, #BYVAR would use the label instead of the name.) The suffix `al` is appended to the label. In the second TITLE statement, #BYVAL1 inserts the value of the first BY variable, Region, into the title.

3 uses the SAS system option BYLINE to return to the creation of the default BY line with BY-group processing.

```
options nobyline nodate pageno=1
        linesize=64 pagesize=20;          1
proc chart data=groc;                     2
   by region;
   vbar manager / type=mean sumvar=sales;
   title1 '#byvar(region).al Analysis';
   title2 'for the #byval1';
run;
options byline;                           3
```

This partial output shows one BY group with a customized BY line:



Example: Inserting the Complete BY Line into a Title

This example inserts the complete BY line into the title. The program does these actions:

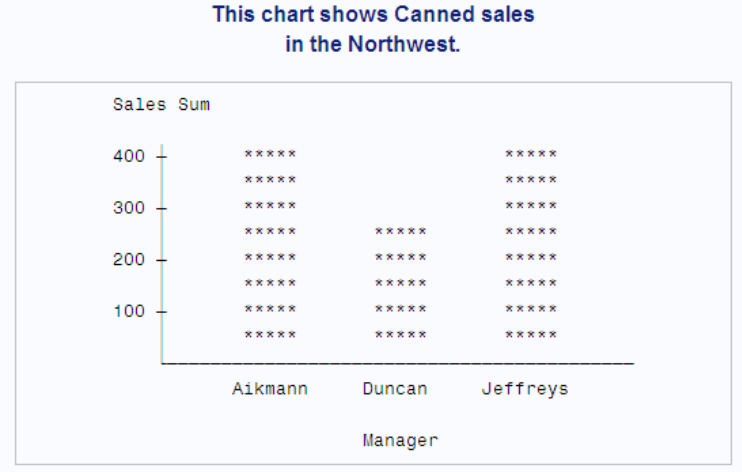
1 uses the SAS system option NOBYLINE to suppress the BY line that normally appears in output that is produced with BY-group processing.

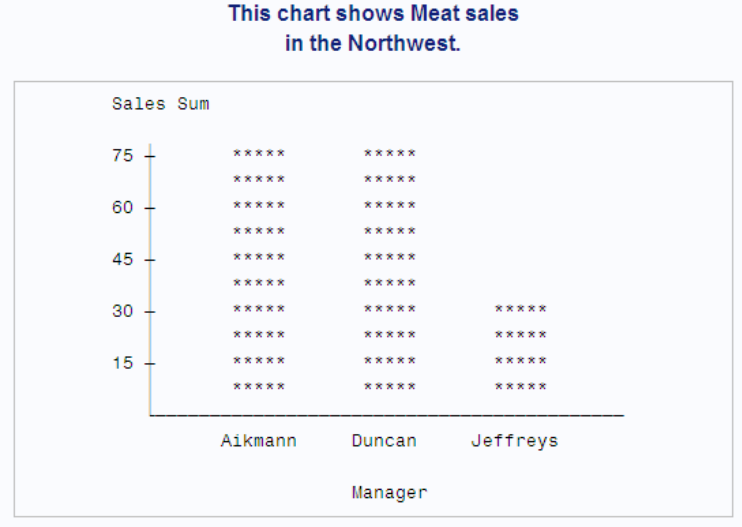
2 uses PROC CHART to chart sales by Region and Department. In the TITLE statement, #BYLINE inserts the complete BY line into the title.

3 uses the SAS system option BYLINE to return to the creation of the default BY line with BY-group processing.

```
options nobyline nodate pageno=1
        linesize=64 pagesize=20;          1
proc chart data=groc;                     2
   by region department;
   vbar manager / type=sum sumvar=sales;
   title 'Information for #byline';
run;
options byline;                           3
```

This partial output shows two BY groups with customized BY lines:





Error Processing of BY-Group Specifications

SAS does not issue error or warning messages for incorrect #BYVAL, #BYVAR, or #BYLINE specifications. Instead, the text of the item becomes part of the title.

Shortcuts for Specifying Lists of Variable Names

Several statements in procedures allow multiple variable names. You can use these shortcut notations instead of specifying each variable name:

Notation	Meaning
`x1-xn`	Specifies variables X1 through X*n*. The numbers must be consecutive.

Notation	Meaning
`x:`	Specifies all variables that begin with the letter X.
`x--a`	Specifies all variables between X and A, inclusive. This notation uses the position of the variables in the data set.
`x-numeric-a`	Specifies all numeric variables between X and A, inclusive. This notation uses the position of the variables in the data set.
`x-character-a`	Specifies all character variables between X and A, inclusive. This notation uses the position of the variables in the data set.
`_numeric_`	Specifies all numeric variables.
`_character_`	Specifies all character variables.
`_all_`	Specifies all variables.

Note: You cannot use shortcuts to list variable names in the INDEX CREATE statement in PROC DATASETS.

For more information, see the *SAS Language Reference: Concepts*.

Formatted Values

Using Formatted Values

Typically, when you print or group variable values, Base SAS procedures use the formatted values. This section contains examples of how Base SAS procedures use formatted values.

Example: Printing the Formatted Values for a Data Set

The following example prints the formatted values of the data set PROCLIB.PAYROLL. (For details about the DATA step that creates this data set, see "PROCLIB.PAYROLL" on page 2801.) In PROCLIB.PAYROLL, the variable

Jobcode indicates the job and level of the employee. For example, **TA1** indicates that the employee is at the beginning level for a ticket agent.

```
options nodate pageno=1
        linesize=64 pagesize=40;
proc print data=proclib.payroll(obs=10)
           noobs;
   title  'PROCLIB.PAYROLL';
   title2 'First 10 Observations Only';
run;
```

The following example is a partial printing of PROCLIB.PAYROLL:

PROCLIB.PAYROLL
First 10 Observations Only

IdNumber	Gender	Jobcode	Salary	Birth	Hired
1919	M	TA2	34376	12SEP60	04JUN87
1653	F	ME2	35108	15OCT64	09AUG90
1400	M	ME1	29769	05NOV67	16OCT90
1350	F	FA3	32886	31AUG65	29JUL90
1401	M	TA3	38822	13DEC50	17NOV85
1499	M	ME3	43025	26APR54	07JUN80
1101	M	SCP	18723	06JUN62	01OCT90
1333	M	PT2	88606	30MAR61	10FEB81
1402	M	TA2	32615	17JAN63	02DEC90
1479	F	TA3	38785	22DEC68	05OCT89

The following PROC FORMAT step creates the format $JOBFMT., which assigns descriptive names for each job:

```
proc format;
    value $jobfmt
          'FA1'='Flight Attendant Trainee'
          'FA2'='Junior Flight Attendant'
          'FA3'='Senior Flight Attendant'
          'ME1'='Mechanic Trainee'
          'ME2'='Junior Mechanic'
          'ME3'='Senior Mechanic'
          'PT1'='Pilot Trainee'
          'PT2'='Junior Pilot'
          'PT3'='Senior Pilot'
          'TA1'='Ticket Agent Trainee'
          'TA2'='Junior Ticket Agent'
          'TA3'='Senior Ticket Agent'
          'NA1'='Junior Navigator'
          'NA2'='Senior Navigator'
          'BCK'='Baggage Checker'
          'SCP'='Skycap';
run;
```

The FORMAT statement in this PROC MEANS step temporarily associates the $JOBFMT. format with the variable Jobcode:

```
options nodate pageno=1
        linesize=64 pagesize=60;
proc means data=proclib.payroll mean max;
   class jobcode;
   var salary;
   format jobcode $jobfmt.;
   title 'Summary Statistics for';
   title2 'Each Job Code';
run;
```

PROC MEANS produces this output, which uses the $JOBFMT. format:

Summary Statistics for Each Job Code

The MEANS Procedure

Analysis Variable : Salary			
Jobcode	**N Obs**	**Mean**	**Maximum**
Baggage Checker	9	25794.22	26896.00
Flight Attendant Trainee	11	23039.36	23979.00
Junior Flight Attendant	16	27986.88	28978.00
Senior Flight Attendant	7	32933.86	33419.00
Mechanic Trainee	8	28500.25	29769.00
Junior Mechanic	14	35576.86	36925.00
Senior Mechanic	7	42410.71	43900.00
Junior Navigator	5	42032.20	43433.00
Senior Navigator	3	52383.00	53798.00
Pilot Trainee	8	67908.00	71349.00
Junior Pilot	10	87925.20	91908.00
Senior Pilot	2	10504.50	11379.00
Skycap	7	18308.86	18833.00
Ticket Agent Trainee	9	27721.33	28880.00
Junior Ticket Agent	20	33574.95	34803.00
Senior Ticket Agent	12	39679.58	40899.00

Note: Because formats are character strings, formats for numeric variables are ignored when the values of the numeric variables are needed for mathematical calculations.

Example: Grouping or Classifying Formatted Data

If you use a formatted variable to group or classify data, then the procedure uses the formatted values. The following example creates and assigns a format, $CODEFMT., that groups the levels of each job code into one category. PROC MEANS calculates statistics based on the groupings of the $CODEFMT. format.

```
proc format;
    value $codefmt
          'FA1','FA2','FA3'='Flight Attendant'
          'ME1','ME2','ME3'='Mechanic'
          'PT1','PT2','PT3'='Pilot'
          'TA1','TA2','TA3'='Ticket Agent'
                'NA1','NA2'='Navigator'
                      'BCK'='Baggage Checker'
                      'SCP'='Skycap';
run;

options nodate pageno=1
        linesize=64 pagesize=40;
proc means data=proclib.payroll mean max;
   class jobcode;
   var salary;
   format jobcode $codefmt.;
   title 'Summary Statistics for Job Codes';
   title2 '(Using a Format that Groups the Job Codes)';
run;
```

PROC MEANS produces this output:

Summary Statistics for Job Codes
(Using a Format that Groups the Job Codes)

The MEANS Procedure

Analysis Variable : Salary			
Jobcode	N Obs	Mean	Maximum
Baggage Checker	9	25794.22	26896.00
Flight Attendant	34	27404.71	33419.00
Mechanic	29	35274.24	43900.00
Navigator	8	45913.75	53798.00
Pilot	20	72176.25	91908.00
Skycap	7	18308.86	18833.00
Ticket Agent	41	34076.73	40899.00

Example: Temporarily Associating a Format with a Variable

If you want to associate a format with a variable temporarily, then you can use the FORMAT statement. For example, the following PROC PRINT step associates the DOLLAR8. format with the variable Salary for the duration of this PROC PRINT step only:

```
options nodate pageno=1
        linesize=64 pagesize=40;
proc print data=proclib.payroll(obs=10)
           noobs;
   format salary dollar8.;
   title 'Temporarily Associating a Format';
   title2 'with the Variable Salary';
run;
```

PROC PRINT produces this output:

Temporarily Associating a Format with the Variable Salary

IdNumber	Gender	Jobcode	Salary	Birth	Hired
1919	M	TA2	$34,376	12SEP60	04JUN87
1653	F	ME2	$35,108	15OCT64	09AUG90
1400	M	ME1	$29,769	05NOV67	16OCT90
1350	F	FA3	$32,886	31AUG65	29JUL90
1401	M	TA3	$38,822	13DEC50	17NOV85
1499	M	ME3	$43,025	26APR54	07JUN80
1101	M	SCP	$18,723	06JUN62	01OCT90
1333	M	PT2	$88,606	30MAR61	10FEB81
1402	M	TA2	$32,615	17JAN63	02DEC90
1479	F	TA3	$38,785	22DEC68	05OCT89

Example: Temporarily Dissociating a Format from a Variable

If a variable has a permanent format that you do not want a procedure to use, then temporarily dissociate the format from the variable by using a FORMAT statement.

In this example, the FORMAT statement in the DATA step permanently associates the $YRFMT. variable with the variable Year. Thus, when you use the variable in a PROC step, the procedure uses the formatted values. The PROC MEANS step,

however, contains a FORMAT statement that dissociates the $YRFMT. format from Year for this PROC MEANS step only. PROC MEANS uses the stored value for Year in the output.

```
proc format;
   value $yrfmt  '1'='Freshman'
                 '2'='Sophomore'
                 '3'='Junior'
                 '4'='Senior';
run;
data debate;
    input Name $ Gender $  Year $  GPA  @@;
    format year $yrfmt.;
    datalines;
Capiccio m 1 3.598 Tucker   m 1 3.901
Bagwell  f 2 3.722 Berry    m 2 3.198
Metcalf  m 2 3.342 Gold     f 3 3.609
Gray     f 3 3.177 Syme     f 3 3.883
Baglione f 4 4.000 Carr     m 4 3.750
Hall     m 4 3.574 Lewis    m 4 3.421
;

options nodate pageno=1
        linesize=64 pagesize=40;
proc means data=debate mean maxdec=2;
   class year;
   format year;
   title 'Average GPA';
run;
```

PROC MEANS produces this output, which does not use the YRFMT. format:

Average GPA

The MEANS Procedure

Analysis Variable : GPA		
Year	N Obs	Mean
1	2	3.75
2	3	3.42
3	3	3.56
4	4	3.69

Formats and BY-Group Processing

When a procedure processes a data set, it checks to determine whether a format is assigned to the BY variable. If it is, then the procedure adds observations to the current BY groups until the formatted value changes. If *nonconsecutive* internal values of the BY variables have the same formatted value, then the values are grouped into different BY groups. Therefore, two BY groups are created with the same formatted value. Also, if different and *consecutive* internal values of the BY variables have the same formatted value, then they are included in the same BY group.

Formats and Error Checking

If SAS cannot find a format, then it stops processing and prints an error message in the SAS log. You can suppress this behavior with the SAS system option NOFMTERR. If you use NOFMTERR, and SAS cannot find the format, then SAS uses a default format and continues processing. Typically, for the default, SAS uses the BEST *w*. format for numeric variables and the $*w*. format for character variables.

Note: To ensure that SAS can find user-written formats, use the SAS system option FMTSEARCH=. How to store formats is described in "Storing Informats and Formats " on page 1080.

Processing All the Data Sets in a Library

You can use the SAS Macro Facility to run the same procedure on every data set in a library. The macro facility is part of the Base SAS software.

"Example 10: Printing All the Data Sets in a SAS Library" on page 1851 shows how to print all the data sets in a library. You can use the same macro definition to perform any procedure on all the data sets in a library. Simply replace the PROC PRINT piece of the program with the appropriate procedure code.

Operating Environment-Specific Procedures

Several Base SAS procedures are specific to one operating environment or one release. Appendix 2, "Operating Environment-Specific Procedures," on page 2743 contains a table with additional information. These procedures are described in more detail in the SAS documentation for operating environments.

Statistic Descriptions

The following table identifies common descriptive statistics that are available in several Base SAS procedures. For more detailed information about available statistics and theoretical information, see "Keywords and Formulas" on page 2700.

Table 2.1 *Common Descriptive Statistics That Base SAS Procedures Calculate*

Statistic	Description	Procedures
Confidence intervals		FREQ, MEANS or SUMMARY, TABULATE, UNIVARIATE
CSS	Corrected sum of squares	CORR, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
CV	Coefficient of variation	MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
Goodness-of-fit tests		FREQ, UNIVARIATE
KURTOSIS	Kurtosis	MEANS or SUMMARY, TABULATE, UNIVARIATE
MAX	Largest (maximum) value	CORR, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
MEAN	Mean	CORR, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
MEDIAN	Median (50^{th} percentile)	CORR (for nonparametric correlation measures), MEANS or SUMMARY, TABULATE, UNIVARIATE
MIN	Smallest (minimum) value	CORR, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
MODE	Most frequent value (if not unique, the smallest mode is used)	UNIVARIATE
N	Number of observations on which calculations are based	CORR, FREQ, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE

Statistic	Description	Procedures
NMISS	Number of missing values	FREQ, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
NOBS	Number of observations	MEANS or SUMMARY, UNIVARIATE
PCTN	Percentage of a cell or row frequency to a total frequency	REPORT, TABULATE
PCTSUM	Percentage of a cell or row sum to a total sum	REPORT, TABULATE
Pearson correlation		CORR
Percentiles		FREQ, MEANS or SUMMARY, REPORT, TABULATE, UNIVARIATE
RANGE	Range	CORR, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
Robust statistics	Trimmed means, Winsorized means	UNIVARIATE
SKEWNESS	Skewness	MEANS or SUMMARY, TABULATE, UNIVARIATE
Spearman correlation		CORR
STD	Standard deviation	CORR, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
STDERR	Standard error of the mean	MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
SUM	sum	CORR, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
SUMWGT	Sum of weights	CORR, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE
Tests of location		UNIVARIATE
USS	Uncorrected sum of squares	CORR, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE

Statistic	Description	Procedures
VAR	Variance	CORR, MEANS or SUMMARY, REPORT, SQL, TABULATE, UNIVARIATE

Computational Requirements for Statistics

The following computational requirements are for the statistics that are listed in Table 2.1 on page 70. They do not describe recommended sample sizes.

- N and NMISS do not require any nonmissing observations.
- SUM, MEAN, MAX, MIN, RANGE, USS, and CSS require at least one nonmissing observation.
- VAR, STD, STDERR, and CV require at least two observations.
- CV requires that MEAN is not equal to zero.

Statistics are reported as missing if they cannot be computed.

Output Delivery System

The Output Delivery System (ODS) gives you greater flexibility in generating, storing, and reproducing SAS procedure and DATA step output, with a wide range of formatting options. ODS provides formatting functionality that is not available from individual procedures or from the DATA step alone. ODS overcomes these limitations and enables you to format your output more easily.

Prior to Version 7, most SAS procedures generated output that was designed for a traditional line-printer. This type of output has limitations that prevent you from getting the most value from your results:

- Traditional SAS output is limited to monospace fonts. With today's desktop document editors and publishing systems, you need more versatility in printed output.
- Some commonly used procedures do not produce output data sets. Before ODS, if you wanted to use output from one of these procedures as input to another procedure, then you relied on PROC PRINTTO and the DATA step to retrieve results.

For more information about the Output Delivery System, see the *SAS Output Delivery System: User's Guide*.

3

Statements with the Same Function in Multiple Procedures

Statements with the Same Function in Multiple Procedures

Overview

Several Base SAS statements have the same function in a number of Base SAS procedures. Some of the statements are fully documented in the *SAS DATA Step Statements: Reference*, and others are documented in this section.

Note: For procedure steps that create output, these statements apply only to the INPUT data set.

The following list shows you where to find more information about each statement:

ATTRIB
: affects the procedure output and the output data set. The ATTRIB statement does not permanently alter the variables in the input data set. The LENGTH=

option has no effect. For the complete documentation, see the *SAS DATA Step Statements: Reference*.

BY
orders the output according to the BY groups. See "BY" on page 74.

FORMAT
affects the procedure output and the output data set. The FORMAT statement does not permanently alter the variables in the input data set. The DEFAULT= option is not valid. For the complete documentation, see the *SAS DATA Step Statements: Reference*.

FREQ
treats observations as if they appear multiple times in the input data set. See "FREQ" on page 79.

INFORMAT
applies a pattern to or executes instructions for a data value to be read as input. The DEFAULT= option is not valid. For the complete documentation, see the *SAS DATA Step Statements: Reference*.

LABEL
affects the procedure output and the output data set. The LABEL statement does not permanently alter the variables in the input data set except when it is used with the MODIFY statement in PROC DATASETS. For complete documentation, see the *SAS DATA Step Statements: Reference*.

QUIT
executes any statements that have not executed and ends the procedure. See "QUIT" on page 81.

WEIGHT
specifies weights for analysis variables in the statistical calculations. See "WEIGHT" on page 82.

WHERE
subsets the input data set by specifying certain conditions that each observation must meet before it is available for processing. See "WHERE" on page 88.

Statements

BY

Overview of the BY Statement

Orders the output according to the BY groups.

For more information, see "Creating Titles That Contain BY-Group Information " on page 57.

BY <DESCENDING> *variable-1*

<... <DESCENDING> *variable-n*>

<NOTSORTED>;

Required Arguments

variable

specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, then either the observations in the data set must be sorted by all the variables that you specify, or they must be indexed appropriately. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING

specifies that the observations are sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED

specifies that observations are not necessarily sorted in alphabetic or numeric order. The observations are grouped in another way (for example, chronological order).

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

You cannot use the NOTSORTED option in a PROC SORT step.

Note: You cannot use the GROUPFORMAT option, which is available in the BY statement in a DATA step, in a BY statement in any PROC step.

BY-Group Processing

Procedures create output for each BY group. For example, the elementary statistics procedures and the scoring procedures perform separate analyses for each BY group. The reporting procedures produce a report for each BY group.

Note: All Base SAS procedures except PROC PRINT process BY groups independently. PROC PRINT can report the number of observations in each BY group as well as the number of observations in all BY groups. Similarly, PROC PRINT can sum numeric variables in each BY group and across all BY groups.

You can use only one BY statement in each PROC step. When you use a BY statement, the procedure expects an input data set that is sorted by the order of the BY variables or one that has an appropriate index. If your input data set does not meet these criteria, then an error occurs. Either sort it with the SORT procedure or create an appropriate index on the BY variables.

Depending on the order of your data, you might need to use the NOTSORTED or DESCENDING option in the BY statement in the PROC step.

- For more information about the BY statement, see *SAS DATA Step Statements: Reference*.
- For more information about PROC SORT, see Chapter 64, "SORT Procedure," on page 2355.
- For more information about creating indexes, see "INDEX CREATE Statement" on page 638.

Formatting BY-Variable Values

When a procedure is submitted with a BY statement, the following actions are taken with respect to processing of BY groups:

1. The procedure determines whether the data is sorted by the internal (unformatted) values of the BY variable(s).
2. The procedure determines whether a format has been applied to the BY variable(s). If the BY variable is numeric and has no user-applied format, then the BEST12. format is applied for the purpose of BY-group processing.
3. The procedure continues adding observations to the current BY group until both the internal and formatted values of the BY variable or variables change.

This process can have unexpected results if, for example, nonconsecutive internal BY values share the same formatted value. In this case, the formatted value is represented in different BY groups. Alternatively, if different consecutive internal BY values share the same formatted value, then these observations are grouped into the same BY group.

BY Variables That Have Different Lengths in Two Data Sets

When a procedure has a BY statement and two input data sets, one of the input data sets is called the primary data set and the other is called the secondary data

set. The primary data set is usually, but not always, the DATA= data set. A BY statement always applies to the primary data set. The variables in the BY statement must appear in the primary data set.

Each procedure determines whether a BY statement applies to a secondary data set, and performs one of the following actions:

- The procedure might always apply the BY statement to the secondary data set. In this case, one or more variables in the BY statement must appear in the secondary data set.
- The procedure might never apply the BY statement to the secondary data set. In this case, the variables in the BY statement are not required in the secondary data set.
- The procedure might check whether the BY variables are in the secondary data set. If none of the BY variables are in the secondary data set, then BY processing does not occur for the secondary data set. If one or more of the BY variables are in the secondary data set, and they match the BY variables in the primary data set, then BY processing is done for the secondary data set. If some but not all BY variables are in the secondary data set, then the procedure might issue an error message and quit. Or, it might take some other action described in the documentation for that particular procedure.

If the BY statement is applied to the secondary data set, then each BY variable that exists on both the data sets must have the same type, character or numeric, in both data sets. The BY variables are required to have either the same formatted value or the same unformatted value. Formatted values match only if both the formatted lengths and the formatted values are the same. Unformatted values are not required to have the same length in order to match. The unformatted character values match if the unformatted values are the same after stripping the trailing blanks. The unformatted doubles match if they have the same value.

A secondary data set does not need to have all of the BY variables that are in the primary data set. A procedure can define a subset of the BY variables for the secondary data set. For example, if the primary data set has the BY variables A,B,C,D, then the procedure can define the following BY variables on the secondary data set:

- A
- A,B
- A,B,C
- A,B,C,D

If both the primary and secondary data sets have the same number of BY variables, and all the BY variables have the same byte lengths and format lengths, then either the unformatted values or the formatted values in the BY buffer (for all of the BY variables) have to match. If they do not match, then each variable is compared. The formatted values of each variable are compared first. The formatted lengths have to match, and the formatted values have to match. If the formatted lengths and values do not match, then the unformatted values are compared even if the byte lengths are different.

If corresponding character variable lengths differ, then the longer character variable can contain only trailing blanks for the extra characters. If the lengths of the

character variables are different, then the values match as long as they are the same after stripping the trailing blanks. For example, 'ABCD' in the primary data set matches 'ABCD ' in the secondary data set. If the secondary data set contained 'ABCDEF', then they would not match.

Base SAS Procedures That Support the BY Statement

CALENDAR	REPORT (nonwindowing environment only)
CHART	SORT (required)
COMPARE	STANDARD
CORR	SUMMARY
FREQ	TABULATE
MEANS	TIMEPLOT
PLOT	TRANSPOSE
PRINT	UNIVARIATE
RANK	

Note: In the SORT procedure, the BY statement specifies how to sort the data. In the other procedures, the BY statement specifies how the data is currently sorted.

Example

This example uses a BY statement in a PROC PRINT step. There is output for each value of the BY variable Year. The DEBATE data set is created in "Example: Temporarily Dissociating a Format from a Variable" on page 67.

```
options nodate pageno=1 linesize=64
        pagesize=40;
proc print data=debate noobs;
   by year;
   title 'Printing of Team Members';
   title2 'by Year';
run;
```

Printing of Team Members by Year

Year=Freshman

Name	Gender	GPA
Capiccio	m	3.598
Tucker	m	3.901

Year=Sophomore

Name	Gender	GPA
Bagwell	f	3.722
Berry	m	3.198
Metcalf	m	3.342

Year=Junior

Name	Gender	GPA
Gold	f	3.609
Gray	f	3.177
Syme	f	3.883

Year=Senior

Name	Gender	GPA
Baglione	f	4.000
Carr	m	3.750
Hall	m	3.574
Lewis	m	3.421

FREQ

Overview of the FREQ Statement

Treats observations as if they appear multiple times in the input data set.

You can use a WEIGHT statement and a FREQ statement in the same step of any procedure that supports both statements.

FREQ *variable*;

Required Arguments

variable
specifies a numeric variable whose value represents the frequency of the observation. If you use the FREQ statement, then the procedure assumes that each observation represents *n* observations, where *n* is the value of *variable*. If *variable* is not an integer, then SAS truncates it. If *variable* is less than 1 or is missing, then the procedure does not use that observation to calculate statistics. If a FREQ statement does not appear, then each observation has a default frequency of 1.

The sum of the frequency variable represents the total number of observations.

Procedures That Support the FREQ Statement

- CORR
- MEANS or SUMMARY
- REPORT
- STANDARD
- TABULATE
- UNIVARIATE

Example

The data in this example represents a ship's course and speed (in nautical miles per hour), recorded every hour. The frequency variable Hours represents the number of hours that the ship maintained the same course and speed. Each of the following PROC MEANS steps calculates average course and speed. The different results demonstrate the effect of using Hours as a frequency variable.

The following PROC MEANS step does not use a frequency variable:

```
options nodate pageno=1 linesize=64 pagesize=40;

data track;
   input Course Speed Hours @@;
   datalines;
30  4  8 50 7 20
75 10 30 30 8 10
80  9 22 20 8 25
```

```
83 11  6 20 6 20
;

proc means data=track maxdec=2 n mean;
   var course speed;
   title 'Average Course and Speed';
run;
```

Without a frequency variable, each observation has a frequency of 1, and the total number of observations is 8.

Average Course and Speed

The MEANS Procedure

Variable	N	Mean
Course	8	48.50
Speed	8	7.88

The second PROC MEANS step uses Hours as a frequency variable:

```
proc means data=track maxdec=2 n mean;
   var course speed;
   freq hours;
   title 'Average Course and Speed';
run;
```

When you use Hours as a frequency variable, the frequency of each observation is the value of Hours. The total number of observations is 141 (the sum of the values of the frequency variable).

Average Course and Speed

The MEANS Procedure

Variable	N	Mean
Course	141	49.28
Speed	141	8.06

QUIT

Overview of the QUIT Statement

Executes any statements that have not executed and ends the procedure.

QUIT;

Procedures That Support the QUIT Statement

- CATALOG
- DATASETS
- PLOT
- PMENU
- SQL

WEIGHT

Overview of the WEIGHT Statement

Specifies weights for analysis variables in the statistical calculations.

You can use a WEIGHT statement and a FREQ statement in the same step of any procedure that supports both statements.

WEIGHT *variable*;

Required Arguments

variable
specifies a numeric variable whose values weight the values of the analysis variables. The values of the variable do not have to be integers.

Different behavior for nonpositive values is discussed in the WEIGHT statement syntax under the individual procedure.

Prior to Version 7 of SAS, no Base SAS procedure excluded the observations with missing weights from the analysis. Most SAS/STAT procedures, such as PROC GLM, have always excluded not only missing weights but also negative and zero weights from the analysis. You can achieve this same behavior in a Base SAS procedure that supports the WEIGHT statement by using the EXCLNPWGT option in the PROC statement.

Weight value	Procedure
0	Counts the observation in the total number of observations

Less than 0	Converts the weight value to zero and counts the observation in the total number of observations
Missing	Excludes the observation from the analysis

The procedure substitutes the value of the WEIGHT variable for w_i, which appears in "Keywords and Formulas" on page 2700.

Procedures That Support the WEIGHT Statement

- CORR
- FREQ
- MEANS or SUMMARY
- REPORT
- STANDARD
- TABULATE
- UNIVARIATE

Note: In PROC FREQ, the value of the variable in the WEIGHT statement represents the frequency of occurrence for each observation. For more information, see the information about PROC FREQ in the *Base SAS(R) 9.3 Procedures Guide: Statistical Procedures*.

Calculating Weighted Statistics

The procedures that support the WEIGHT statement also support the VARDEF= option, which lets you specify a divisor to use in the calculation of the variance and standard deviation.

By using a WEIGHT statement to compute moments, you assume that the *i*th observation has a variance that is equal to σ^2/w_i. When you specify VARDEF=DF (the default), the computed variance is a weighted least squares estimate of σ^2. Similarly, the computed standard deviation is an estimate of σ. Note that the computed variance is not an estimate of the variance of the *i*th observation, because this variance involves the observation's weight, which varies from observation to observation.

If the values of your variable are counts that represent the number of occurrences of each observation, then use this variable in the FREQ statement rather than in the WEIGHT statement. In this case, because the values are counts, they should be integers. (The FREQ statement truncates any noninteger values.) The variance that

is computed with a FREQ variable is an estimate of the common variance σ^2 of the observations.

Note: If your data comes from a stratified sample where the weights w_i represent the strata weights, then neither the WEIGHT statement nor the FREQ statement provides appropriate stratified estimates of the mean, variance, or variance of the mean. To perform the appropriate analysis, consider using PROC SURVEYMEANS, which is a SAS/STAT procedure that is documented in the *Base SAS(R) 9.3 Procedures Guide: Statistical Procedures*.

Weighted Statistics Example

As an example of the WEIGHT statement, suppose 20 people are asked to estimate the size of an object 30 cm wide. Each person is placed at a different distance from the object. As the distance from the object increases, the estimates should become less precise.

The SAS data set SIZE contains the estimate (ObjectSize) in centimeters at each distance (Distance) in meters and the precision (Precision) for each estimate. Notice that the largest deviation (an overestimate by 20 cm) came at the greatest distance (7.5 meters from the object). As a measure of precision, 1/Distance, gives more weight to estimates that were made closer to the object and less weight to estimates that were made at greater distances.

The following statements create the data set SIZE:

```
options nodate pageno=1 linesize=64 pagesize=60;

data size;
   input Distance ObjectSize @@;
   Precision=1/distance;
   datalines;
1.5 30 1.5 20 1.5 30 1.5 25
3   43 3   33 3   25 3   30
4.5 25 4.5 36 4.5 48 4.5 33
6   43 6   36 6   23 6   48
7.5 30 7.5 25 7.5 50 7.5 38
;
```

The following PROC MEANS step computes the average estimate of the object size while ignoring the weights. Without a WEIGHT variable, PROC MEANS uses the default weight of 1 for every observation. Thus, the estimates of object size at all distances are given equal weight. The average estimate of the object size exceeds the actual size by 3.55 cm.

```
proc means data=size maxdec=3 n mean var stddev;
   var objectsize;
   title1 'Unweighted Analysis of the SIZE Data Set';
run;
```

Unweighted Analysis of the SIZE Data Set

The MEANS Procedure

Analysis Variable : ObjectSize			
N	Mean	Variance	Std Dev
20	33.550	80.892	8.994

The next two PROC MEANS steps use the precision measure (Precision) in the WEIGHT statement and show the effect of using different values of the VARDEF= option. The first PROC step creates an output data set that contains the variance and standard deviation. If you reduce the weighting of the estimates that are made at greater distances, the weighted average estimate of the object size is closer to the actual size.

```
proc means data=size maxdec=3 n mean var stddev;
   weight precision;
   var objectsize;
   output out=wtstats var=Est_SigmaSq std=Est_Sigma;
   title1 'Weighted Analysis Using Default VARDEF=DF';
run;

proc means data=size maxdec=3 n mean var std
                     vardef=weight;
   weight precision;
   var objectsize;
   title1 'Weighted Analysis Using VARDEF=WEIGHT';
run;
```

The variance of the *i*th observation is assumed to be $var(x_i) = \sigma^2/w_i$ and w_i is the weight for the *i*th observation. In the first PROC MEANS step, the computed variance is an estimate of σ^2. In the second PROC MEANS step, the computed variance is an estimate of $(n - 1/n)\,\sigma^2/\overline{w}$, where $\overline{w}$ is the average weight. For large n, this value is an approximate estimate of the variance of an observation with average weight.

Weighted Analysis Using Default VARDEF=DF

The MEANS Procedure

Analysis Variable : ObjectSize			
N	Mean	Variance	Std Dev
20	31.088	20.678	4.547

Weighted Analysis Using VARDEF=WEIGHT

The MEANS Procedure

Analysis Variable : ObjectSize			
N	Mean	Variance	Std Dev
20	31.088	64.525	8.033

The following statements create and print a data set with the weighted variance and weighted standard deviation of each observation. The DATA step combines the output data set that contains the variance and the standard deviation from the weighted analysis with the original data set. The variance of each observation is computed by dividing Est_SigmaSq (the estimate of σ^2 from the weighted analysis when VARDEF=DF) by each observation's weight (Precision). The standard deviation of each observation is computed by dividing Est_Sigma (the estimate of σ from the weighted analysis when VARDEF=DF) by the square root of each observation's weight (Precision).

```
data wtsize(drop=_freq_ _type_);
   set size;
   if _n_=1 then set wtstats;
   Est_VarObs=est_sigmasq/precision;
   Est_StdObs=est_sigma/sqrt(precision);

proc print data=wtsize noobs;
   title 'Weighted Statistics';
   by distance;
   format est_varobs est_stdobs
          est_sigmasq est_sigma precision 6.3;
run;
```

Weighted Statistics

Distance=1.5

ObjectSize	Precision	Est_SigmaSq	Est_Sigma	Est_VarObs	Est_StdObs
30	0.667	20.678	4.547	31.017	5.569
20	0.667	20.678	4.547	31.017	5.569
30	0.667	20.678	4.547	31.017	5.569
25	0.667	20.678	4.547	31.017	5.569

Distance=3

ObjectSize	Precision	Est_SigmaSq	Est_Sigma	Est_VarObs	Est_StdObs
43	0.333	20.678	4.547	62.035	7.876
33	0.333	20.678	4.547	62.035	7.876
25	0.333	20.678	4.547	62.035	7.876
30	0.333	20.678	4.547	62.035	7.876

Distance=4.5

ObjectSize	Precision	Est_SigmaSq	Est_Sigma	Est_VarObs	Est_StdObs
25	0.222	20.678	4.547	93.052	9.646
36	0.222	20.678	4.547	93.052	9.646
48	0.222	20.678	4.547	93.052	9.646
33	0.222	20.678	4.547	93.052	9.646

Distance=6

ObjectSize	Precision	Est_SigmaSq	Est_Sigma	Est_VarObs	Est_StdObs
43	0.167	20.678	4.547	124.07	11.139
36	0.167	20.678	4.547	124.07	11.139
23	0.167	20.678	4.547	124.07	11.139
48	0.167	20.678	4.547	124.07	11.139

Distance=7.5

ObjectSize	Precision	Est_SigmaSq	Est_Sigma	Est_VarObs	Est_StdObs
30	0.133	20.678	4.547	155.09	12.453
25	0.133	20.678	4.547	155.09	12.453
50	0.133	20.678	4.547	155.09	12.453
38	0.133	20.678	4.547	155.09	12.453

WHERE

Overview of the WHERE Statement

Subsets the input data set by specifying certain conditions that each observation must meet before it is available for processing.

WHERE *where-expression*;

Required Arguments

where-expression
is a valid arithmetic or logical expression that generally consists of a sequence of operands and operators. For more information about where processing, see *SAS DATA Step Statements: Reference*.

Procedures That Support the WHERE Statement

You can use the WHERE statement with any of the following Base SAS procedures that read a SAS data set:

CALENDAR	RANK
CHART	REPORT
COMPARE	SORT
CORR	SQL
DATASETS (APPEND statement)	STANDARD
FREQ	TABULATE
MEANS or SUMMARY	TIMEPLOT
PLOT	TRANSPOSE
PRINT	UNIVARIATE

Details

- The CALENDAR and COMPARE procedures and the APPEND statement in PROC DATASETS accept more than one input data set. For more information, see the documentation for the specific procedure.
- To subset the output data set, use the WHERE= data set option:

```
proc report data=debate nowd
            out=onlyfr(where=(year='1'));
run;
```

  For more information about WHERE=, see *SAS DATA Step Statements: Reference*.

Example

In this example, PROC PRINT prints only those observations that meet the condition of the WHERE expression. The DEBATE data set is created in "Example: Temporarily Dissociating a Format from a Variable" on page 67.

```
options nodate pageno=1 linesize=64
        pagesize=40;

proc print data=debate noobs;
   where gpa>3.5;
   title 'Team Members with a GPA';
   title2 'Greater than 3.5';
run;
```

Team Members with a GPA Greater than 3.5

Name	Gender	Year	GPA
Capiccio	m	Freshman	3.598
Tucker	m	Freshman	3.901
Bagwell	f	Sophomore	3.722
Gold	f	Junior	3.609
Syme	f	Junior	3.883
Baglione	f	Senior	4.000
Carr	m	Senior	3.750
Hall	m	Senior	3.574

4

In-Database Processing of Base Procedures

Base Procedures That Are Enhanced for In-Database Processing

In-database processing has several advantages over processing within SAS. These advantages include increased security, reduced network traffic, and the potential for faster processing. Increased security is possible because sensitive data does not have to be extracted from the data source. Faster processing is possible for the following reasons:

- Data is manipulated locally, on the data source, using high-speed secondary storage devices instead of being transported across a relatively slow network connection.
- The data source might have more processing resources at its disposal.
- The data source might be capable of optimizing a query for execution in a highly parallel and scalable fashion.

Beginning with SAS 9.2M3, Base SAS procedures were enhanced to process data inside the Teradata, DB2, and Oracle data sources. In SAS 9.3, procedures were enhanced to process data inside the Netezza data source. In SAS 9.4, procedures have been enhanced to process data inside the Amazon Redshift, Aster, Google BigQuery, Greenplum, Hadoop, HAWQ, Impala, Microsoft SQL Server, PostgreSQL, SAP HANA, Snowflake, Vertica, and Yellowbrick data sources. The in-database procedures are used to generate more sophisticated queries that allow the aggregations and analytics to be run inside the data source.

All of these in-database procedures generate SQL queries. You use SAS/ACCESS or SQL as the interface to the data source.

The following Base SAS procedures support in-database processing.

Table 4.1 *In-Database Base Procedures*

Procedure	Description
PROC FREQ in *Base SAS Procedures Guide: Statistical Procedures*	Produces one-way to *n*-way tables; reports frequency counts; computes test and measures of association and agreement for two-way to *n*-way crosstabulation tables; can compute exact tests and asymptotic tests; can create output data sets.
PROC MEANS on page 1471	Computes descriptive statistics; can produce printed output and output data sets. By default, PROC MEANS produces printed output.
PROC RANK on page 2006[1]	Computes ranks for one or more numeric variables across the observations of a SAS data set; can produce some rank scores.
PROC REPORT on page 2154	Combines features of the PRINT, MEANS, and TABULATE procedures with features of the DATA step in a single report-writing tool that can produce a variety of reports.
PROC SORT on page 2387[1]	Orders SAS data set observations by the values of one or more character or numeric variables.
PROC SUMMARY on page 2455	Computes descriptive statistics; can produce a printed report and create an output data set. By default, PROC SUMMARY creates an output data set.
PROC TABULATE on page 2537	Displays descriptive statistics in tabular format, using some or all of the variables in a data set.
PROC TRANSPOSE on page 2655 [2]	Creates an output data set by restructuring the values in a SAS data set, transposing selected variables into observations.

1 Supported by Hadoop with Hive .14 and later.

2 Supported only by Hadoop. Additional licensed products and configuration are required.

For more information, see “In-Database Procedures” in *SAS In-Database Products: User’s Guide*.

5

CAS Processing of Base Procedures

About CAS Processing

Beginning with SAS 9.4M5, some Base SAS procedures are enhanced to process data inside SAS Cloud Analytic Services (CAS) with CAS actions. Processing with CAS actions can result in faster processing times. Faster processing is possible for the following reasons:

- The CAS server processes the in-memory tables instead of transferring the data across a relatively slow network connection between the server and the SAS client machine.
- The hardware for a CAS server typically has greater processing resources at its disposal.
- The majority of CAS actions are scalable for multithreaded processing. For large data volumes, distributed servers use multiple hosts to perform massively parallel processing.

Note: SAS 9.4 CAS-enabled procedures are designed to work with CAS in SAS Viya 3.5. In the SAS Viya 4 platform, some CAS-enabled procedures have been further optimized to take advantage of multithreading and the cloud-native platform.

When processing data in the SAS Viya 4 CAS server, SAS recommends that you submit the code from a SAS client on the SAS Viya 4 platform for best results.

The principle is to summarize and analyze large data volumes in the in-memory tables in the CAS server. The smaller, summarized results, are transferred from the server to the SAS client. The procedure then post-processes the summarized results to produce additional statistics, Output Delivery System (ODS) objects, and so on.

The core product of SAS Viya is SAS Visual Analytics. If you install SAS Visual Analytics only, then you have access to a subset of the Base SAS procedures. If you have SAS Viya with any other offering (in addition to SAS Visual Analytics) that is licensed and installed, you also have access to all SAS 9.4 Base procedures. The *Base SAS Procedures Guide* contains complete documentation for all Base procedures.

Some Base SAS procedures execute code on the CAS server. See Chapter 5, "CAS Processing of Base Procedures," on page 93.

Procedures That Use CAS Actions

The following Base SAS procedures can run CAS actions:

Procedure	Description
PROC APPEND on page 109	Adds rows from a CAS table to the end of a SAS data set, and adds rows from a SAS data set to the end of a CAS table.
PROC CONTENTS on page 489	Shows the contents of a CAS table and prints the directory of the caslib.
PROC COPY on page 521	Copies entire SAS libraries or specific members of the library.
PROC DATASETS on page 561	Manages CAS tables.
PROC DELETE on page 785	Deletes SAS data sets and CAS tables.
PROC DS2 [1]	Manipulates data with DS2 language statements.
PROC FCMP on page 873	Enables you to create, test, and store SAS functions, CALL routines, and subroutines before you use them in other SAS procedures or in DATA steps.

Procedure	Description
PROC FEDSQL [2]	Manipulates data and performs reporting with FedSQL language statements.
PROC FORMAT on page 1075	Creates user-defined informats to read data and user-defined formats to display data.
PROC LUA on page 1403	Enables you to run statements from the Lua programming language within SAS code.
PROC MEANS on page 1473	Computes descriptive statistics; can produce printed output and output data sets. By default, PROC MEANS produces printed output.
PROC REPORT on page 2155	Combines features of the PRINT, MEANS, and TABULATE procedures with features of the DATA step in a single report-writing tool that can produce a variety of reports.
PROC SCOREACCEL on page 2305	Provides an interface to the CAS server for DATA step and DS2 model publishing and scoring.
PROC SORT on page 2389	Provides the ability to manage duplicate observations in data sets. The SORT procedure uses the CAS deduplicate action to perform the equivalent functionality of the NODUPKEY or NOUNIKEY options of PROC SORT.
PROC SUMMARY on page 2455	Computes descriptive statistics; can produce a printed report and create an output data set. By default, PROC SUMMARY creates an output data set.
PROC TABULATE on page 2536	Displays descriptive statistics in tabular format, using some or all of the variables in a data set.

Procedure	Description
PROC TRANSPOSE on page 2656	Transforms SAS data sets so that observations become variables and variables become observations.

1 The DS2 procedure does not use the CAS LIBNAME engine to access in-memory tables. Instead, the procedure accesses tables by caslib and name. For information and limitations, see "DS2 in CAS: Concepts" in *SAS DS2 Programmer's Guide*.

2 The FEDSQL procedure does not use the CAS LIBNAME engine to access in-memory tables. Instead, the procedure accesses tables by caslib and name. For information and limitations, see *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*

When CAS Processing Cannot Be Used

The documentation for each procedure identifies the supported aggregations and supported statements and options. When your program includes a statement or option that cannot be processed with a CAS action, the observation-level data for the in-memory table is transferred to the SAS client. The procedure then runs on the transferred data.

By default, the CAS LIBNAME engine limits data transfer to 100 MB. If you reach the limit:

1. You might be able to achieve the result that you want with a SAS Visual Statistics procedure or SAS Visual Data Mining and Machine Learning procedure.
2. You might be able to program with CAS actions so that the summarization is performed by the server.
3. You can increase the limit with the CASDATALIMIT= system option or the DATALIMIT= LIBNAME option or data set option.

BY-Group Processing

For procedures that support a BY statement, the information is passed to the CAS server. This enables two optimizations:

1. The data does not need to be pre-sorted by the specified variables.
2. When the results are transferred by the server to the SAS client, the groups are already formed. These results can be summarized results as with PROC MEANS or they can be observation-level as is the case with PROC PRINT.

If you know in advance that you will perform BY-group processing, especially if you have large in-memory tables, you can partition the in-memory table as a further efficiency. When you partition an in-memory table with the same variables that you use for BY-group processing, you avoid the performance penalty for forming the groups each time you access the table.

Filtering Observations

Procedures that support a WHERE statement, the expression is sent to the server. The server resolves the expression and subsets the data for the analysis. This can greatly reduce processing time and data transfer from the server to the SAS client.

The same is true of the WHERE= data set option when it is used with the CAS LIBNAME engine—the expression is sent to the server to subset the data.

```
cas casauto host="cloud.example.com" port=5570;
libname mycas cas sessref=casauto;

proc casutil;
  load data=sashelp.prdsale;
quit;

/* View informational messages in the SAS log.       */
options msglevel=i;

/* The WHERE statement is processed by the server.   */
proc means data=mycas.prdsale;
  where region eq 'EAST';
run;

/* These results are identical to the preceding use  */
/* of PROC MEANS, but uses a WHERE= data set option. */
proc means data=mycas.prdsale(where=(region eq 'EAST'));
run;
```

Related Documents

- *SAS Cloud Analytic Services: Fundamentals*
- *SAS Cloud Analytic Services: User's Guide*
- *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*
- *SAS DS2 Programmer's Guide*

6

Base SAS Procedures Documented in Other Publications

Base SAS Procedures Documented in Other Publications

Some Base SAS procedures are documented in other SAS publications. The following table lists these procedures and the publications that contain them.

Procedure	Description	Publication
CALLRFC	Executes Remote Function Calls (RFC) or RFC-compatible functions on an SAP System.	*SAS/ACCESS Interface to R/3: User's Guide*
CORR	Computes Pearson correlation coefficients, three nonparametric measures of association, and the probabilities associated with these statistics.	Base SAS Procedures Guide: Statistical Procedures
DOCUMENT	Enables you to rearrange, duplicate, or remove output from the results of a procedure or a database query that are in ODS documents.	*SAS Output Delivery System: User's Guide*

Procedure	Description	Publication
EXPLODE	Produces printed output with oversized text by expanding each letter into a matrix of characters.	The EXPLODE Procedure
FedSQL	Specifies that the subsequent input is FedSQL statements.	*SAS FedSQL Language Reference*
FORMS	Produces labels for envelopes, mailing labels, external tape labels, file cards, and any other printer forms that have a regular pattern.	The FORMS Procedure
FREQ	Produces one-way to n-way frequency and contingency (crosstabulation) tables.	Base SAS Procedures Guide: Statistical Procedures
GCHART	Produces six types of charts: block charts, horizontal and vertical bar charts, pie and donut charts, and star charts.	*SAS/GRAPH: Reference*
GEOCODE	Adds geographic coordinates (latitude and longitude values) and attribute values such as census blocks to an address.	*SAS/GRAPH and Base SAS: Mapping Reference*
GINSIDE	Compares a data set of X and Y coordinates to a map data set containing map polygons. It determines whether the X and Y coordinates for each point fall inside or outside of the map polygons. The resulting output map data set contains the points inside the map polygons. It can be used as input by the GMAP procedure in SAS/GRAPH, or the ODS Graphics SGMAP procedure in Base SAS.	*SAS/GRAPH and Base SAS: Mapping Reference*
GPLOT	Plots the values of two or more variables on a set of coordinate axes (X and Y).	*SAS/GRAPH: Reference*
GPROJECT	Processes map data sets by converting spherical coordinates (longitude and latitude) into Cartesian coordinates for use by the GMAP and SGMAP procedures.	*SAS/GRAPH and Base SAS: Mapping Reference*
GREDUCE	Processes map data sets so that they can draw simpler maps with fewer boundary points. The resulting output map data set with an added DENSITY variable can be used as an input map data set by the GMAP	*SAS/GRAPH and Base SAS: Mapping Reference*

Procedure	Description	Publication
	procedure in SAS/GRAPH, or the ODS Graphics SGMAP procedure in Base SAS.	
GREMOVE	Combines unit areas defined in a map data set into larger unit areas by removing internal borders between the original unit areas. The resulting output map data set can be used as input by the GMAP procedure in SAS/GRAPH, or the ODS Graphics SGMAP procedure in Base SAS.	*SAS/GRAPH and Base SAS: Mapping Reference*
INFOMAPS	Enables you to create information maps programmatically.	*Base SAS Guide to Information Maps*
MAPIMPORT	Enables you to import Esri shapefiles (spatial data formats) and process the SHP files into map data sets that are made available with SAS/GRAPH or through third-party sources.	*SAS/GRAPH and Base SAS: Mapping Reference*
METADATA	Sends an XML string to the SAS Metadata Server.	*SAS Language Interfaces to Metadata*
METALIB	Updates the metadata in the metadata server to match the tables in a library.	*SAS Language Interfaces to Metadata*
METAOPERATE	Enables you to perform administrative tasks in batch mode that are associated with the SAS Metadata Server.	*SAS Language Interfaces to Metadata*
ODSLIST	Stores a report's individual components and then enables you to modify and replay the report.	*SAS Output Delivery System: User's Guide*
ODSTABLE	Creates your tabular output templates.	*SAS Output Delivery System: User's Guide*
ODSTEXT	Creates paragraphs and lists that can be customized and nested an infinite number of times.	*SAS Output Delivery System: User's Guide*
SGDESIGN	Produces a graph from one or more input SAS data sets and a user-defined ODS Graphics Designer (SGD) file.	*SAS ODS Graphics: Procedures Guide*

Procedure	Description	Publication
SGMAP	Identifies the data sets needed for map areas, map response values, and overlay plots.	*SAS ODS Graphics: Procedures Guide*
SGPANEL	Creates a panel of graph cells for the values of one or more classification variables.	*SAS ODS Graphics: Procedures Guide*
SGPIE	Identifies the data set that contains the plot variables. The statement also gives you the option to specify a description, control automatic legends, and specify whether the chart background is opaque or transparent.	*SAS ODS Graphics: Procedures Guide*
SGPLOT	Creates one or more plots and overlays them on a single set of axes.	*SAS ODS Graphics: Procedures Guide*
SGRENDER	Produces graphical output from templates that are created with the Graph Template Language (GTL).	*SAS ODS Graphics: Procedures Guide*
SGSCATTER	Creates a paneled graph of scatter plots for multiple combinations of variables, depending on the plot statement that you use.	*SAS ODS Graphics: Procedures Guide*
SQL	Implements Structured Query Language (SQL) for SAS.	*SAS SQL Procedure User's Guide*
TEMPLATE	Enables you to customize the appearance of your SAS output.	*SAS Output Delivery System: User's Guide*
TRANTAB	Creates, edits, and displays customized translation tables, and enables you to view and modify translation tables that are supplied by SAS.	*SAS National Language Support (NLS): Reference Guide*
UNIVARIATE	Provides a variety of descriptive measures, graphical displays, and statistical methods, which you can use to summarize, visualize, analyze, and model the statistical distributions of numeric variables.	Base SAS Procedures Guide: Statistical Procedures

For information about all SAS procedures, see *SAS Procedures by Name and Product*. The information in *SAS Procedures by Name and Product* is arranged alphabetically by the procedures' names and by their products' names.

PART 2

Procedures

7

APPEND Procedure

Overview: APPEND Procedure

What Does the APPEND Procedure Do?

The APPEND procedure adds the observations from one SAS data set to the end of another SAS data set.

For more information, see Chapter 5, “CAS Processing of Base Procedures,” on page 93.

Generally, the APPEND procedure functions the same as the APPEND statement in the DATASETS procedure. The only difference between the APPEND procedure and the APPEND statement in PROC DATASETS is the default for *libref* in the BASE= and DATA= options. For PROC APPEND, the default is either Work or User. For the APPEND statement, the default is the libref of the procedure input library.

Syntax: APPEND Procedure

Requirement: The BASE= data set must be a member of a SAS library that supports update processing. Because the CAS libname engine does not support update processing, an existing CAS table cannot be specified with the BASE= option.

Notes: NOTE: _LAST_ is the name of the last data set created in your session. When the BASE= data set does not exist and PROC APPEND creates it, PROC APPEND sets _LAST_ to the name of the BASE= data set.

If you use the DROP=, KEEP=, or RENAME= options on the BASE= data set, the options affect ONLY the APPEND processing and does not change the variables in the appended BASE= data set. Variables that are dropped or not kept using the DROP= and KEEP= options still exist in the appended BASE= data set. Variables that are renamed using the RENAME= option remain with their original name in the appended BASE= data set.

Tips: Complete documentation for the APPEND procedure is located within the DATASETS procedure in APPEND Statement on page 586.

You can use the ATTRIB, FORMAT, LABEL, and WHERE statements. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

You can use data set options with the BASE= and DATA= options when using the APPEND procedure.

PROC APPEND BASE=*<libref.>SAS-data-set*

<APPENDVER=V6>
<DATA=*<libref.>SAS-data-set*>
<ENCRYPTKEY=*key-value*>
<FORCE>
<GETSORT>
<NOWARN>;

Statement	Task	Example
APPEND	Add observations from one SAS data set to the end of another SAS data set	Ex. , Ex. 3

Usage: APPEND Procedure

Using the APPEND Procedure

To copy only the table metadata and structure of a data set but not the data, use the following example where Dataset1 is nonexistent:

```
proc append base=dataset1 data=dataset2(obs=0);
run;

proc contents data=dataset1;
run;
quit;
```

Examples: APPEND Procedure

Example 1: Concatenating Two SAS Data Sets

Features:
- PROC APPEND statement options
  - BASE=
  - DATA=
  - FORCE
- OPTIONS statement
- PRINT procedure

Data set: EXP Library

Details

This example demonstrates the following tasks:

- suppresses the printing of a library
- appends two data sets
- prints the new data set after appending

To create the Exp.Results and Exp.Sur data sets and print them out before using this example to concatenate them, see "EXP Library" on page 2789.

Program

```
options pagesize=40 linesize=64 nodate pageno=1;

LIBNAME exp 'SAS-library';

proc append base=exp.results data=exp.sur force;
run;

proc print data=exp.results noobs;
   title 'The Concatenated RESULTS Data Set';
run;
quit;
```

Program Description

This example appends one data set to the end of another data set.

The data set Exp.Sur contains the variable Wt6Mos, but the Exp.Results data set does not.

Set the system options. The NODATE option suppresses the display of the date and time in the output. The PAGENO= option specifies the starting page number. The LINESIZE= option specifies the output line length, and the PAGESIZE= option specifies the number of lines on an output page.

```
options pagesize=40 linesize=64 nodate pageno=1;
```

The LIBNAME statement assigns the library.

```
LIBNAME exp 'SAS-library';
```

Append the data set Exp.Sur to the Exp.Results data set. PROC APPEND appends the data set Exp.Sur to the data set Exp.Results. FORCE causes PROC APPEND to carry out the Append operation even though Exp.Sur has a variable that Exp.Results does not. PROC APPEND does not add the Wt6Mos variable to Exp.Results.

```
proc append base=exp.results data=exp.sur force;
run;
```

Print the data set. See Output 7.20 on page 114.

```
proc print data=exp.results noobs;
   title 'The Concatenated RESULTS Data Set';
run;
quit;
```

Output: Concatenating Two Data Sets

Output 7.1 *The Results Data Set*

The RESULTS Data Set

ID	TREAT	INITWT	WT3MOS	AGE
1	Other	166.28	146.98	35
2	Other	214.42	210.22	54
3	Other	172.46	159.42	33
5	Other	175.41	160.66	37
6	Other	173.13	169.40	20
7	Other	181.25	170.94	30
10	Other	239.83	214.48	48
11	Other	175.32	162.66	51
12	Other	227.01	211.06	29
13	Other	274.82	251.82	31

Output 7.2 *The Sur Data Set*

The EXP.SUR Data Set

ID	treat	initwt	wt3mos	wt6mos	age
14	surgery	203.60	169.78	143.88	38
17	surgery	171.52	150.33	123.18	42
18	surgery	207.46	155.22	.	41

Output 7.3 *Concatenating the Results and the Sur Data Sets*

The RESULTS Data Set

ID	TREAT	INITWT	WT3MOS	AGE
1	Other	166.28	146.98	35
2	Other	214.42	210.22	54
3	Other	172.46	159.42	33
5	Other	175.41	160.66	37
6	Other	173.13	169.40	20
7	Other	181.25	170.94	30
10	Other	239.83	214.48	48
11	Other	175.32	162.66	51
12	Other	227.01	211.06	29
13	Other	274.82	251.82	31
14	surgery	203.60	169.78	38
17	surgery	171.52	150.33	42
18	surgery	207.46	155.22	41

Example 2: Concatenating a CAS Table to a SAS Data Set

Features:

PROC APPEND statement options
- BASE=
- DATA=
- FORCE

OPTIONS statement

CONTENTS procedure

Details

This example demonstrates the following tasks:

- appending a CAS table to a SAS data set
- contents of the table, the data set, and the new data set after appending

Program

```
options pagesize=40 linesize=64 nodate pageno=1;

libname sascas1 cas;

libname saleslib 'directory-name';

proc contents data=saleslib.monthly;
run;

proc contents data=sascas1.lastmonth;
run;

proc append base=saleslib.monthly data=sascas1.lastmonth force;
run;

proc sql outobs=5;
   select store_id, address, city, state, zipcode, totalsales
   format dollar12.
   from saleslib.monthly(obs=4)
   where totalsales gt 2000000;
quit;
```

Program Description

This example appends a CAS table to the end of a SAS data set.

Set the system options. The NODATE option suppresses the display of the date and time in the output. The PAGENO= option specifies the starting page number. The LINESIZE= option specifies the output line length, and the PAGESIZE= option specifies the number of lines on an output page.

```
options pagesize=40 linesize=64 nodate pageno=1;
```

The LIBNAME statements assign the CAS engine and BASE engine libraries.

```
libname sascas1 cas;

libname saleslib 'directory-name';
```

Check the contents of the table and data set. Use PROC CONTENTS to view the data set and table.

```
proc contents data=saleslib.monthly;
run;

proc contents data=sascas1.lastmonth;
run;
```

Append the SasCas1.LastMonth table to the SalesLib.Monthly data set. The data for last month's sales in a CAS table is appended to the accumulated sales data stored in a SAS data set. The CAS table uses VARCHAR to store the city and address values. The SAS data set stores the values in character variables. Since the attribute for the two values differ, the FORCE option is used in PROC APPEND.

```
proc append base=saleslib.monthly data=sascas1.lastmonth force;
run;
```

Retrieve total sales. Use PROC SQL to retrieve five variables and sales that are greater than $2,000,000.

```
proc sql outobs=5;
   select store_id, address, city, state, zipcode, totalsales
   format dollar12.
   from saleslib.monthly(obs=4)
   where totalsales gt 2000000;
quit;
```

Warnings in the Log

Note the warnings that were sent to the log.

```
117        proc append base=saleslib.monthly data=sascas1.lastmonth force;
 118        run;

 NOTE: Appending SASCAS1.LASTMONTH to SALESLIB.MONTHLY.
 WARNING: Variable city has different lengths on BASE and DATA files
         (BASE 100 DATA 21).
 WARNING: Variable address has different lengths on BASE and DATA files
         (BASE 160 DATA 19).
 NOTE: There were 12 observations read from the data set SASCAS1.LASTMONTH.
 NOTE: 12 observations added.
 NOTE: The data set SALESLIB.MONTHLY has 24 observations and 7 variables.
```

Output: Concatenating a CAS Table to a SAS Data Set

Output 7.4 *The CAS Table Contents*

LastMonth Table

The CONTENTS Procedure

Data Set Name	SASCAS1.LASTMONTH	**Observations**	12
Member Type	DATA	**Variables**	7
Engine	CAS	**Indexes**	0
Created	08/16/2017 18:56:09	**Observation Length**	80
Last Modified	08/16/2017 18:56:09	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information	
Data Limit	100MB
Caslib	CASUSER
Scope	Session

Alphabetic List of Variables and Attributes

#	Variable	Type	Len		Max Bytes Used
			Bytes	Chars	
6	address	Varchar	160	40	19
4	city	Varchar	100	25	21
7	month	Char	10		
5	state	Char	2		
1	store_id	Char	3		
2	totalsales	Num	8		
3	zipcode	Char	5		

Output 7.5 *The Monthly Data Set Contents*

Concatenated Data Set

The CONTENTS Procedure

Data Set Name	SALESLIB.MONTHLY	**Observations**	24
Member Type	DATA	**Variables**	7
Engine	V9	**Indexes**	0
Created	08/16/2017 13:56:07	**Observation Length**	288
Last Modified	08/16/2017 13:56:17	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	227
Obs in First Data Page	24
Number of Data Set Repairs	0
Filename	/r/ge
Release Created	9.0401M5
Host Created	Linux
Inode Number	71586336
Access Permission	rw-r--r--
Owner Name	
File Size	128KB
File Size (bytes)	131072

Alphabetic List of Variables and Attributes

#	Variable	Type	Len
6	address	Char	160
4	city	Char	100
7	month	Char	10
5	state	Char	2
1	store_id	Char	3
2	totalsales	Num	8
3	zipcode	Char	5

Output 7.6 *Concatenated Data Set*

Concatenated Data Set

The CONTENTS Procedure

Data Set Name	SALESLIB.MONTHLY	Observations	24
Member Type	DATA	Variables	7
Engine	V9	Indexes	0
Created	08/16/2017 13:56:07	Observation Length	288
Last Modified	08/16/2017 13:56:17	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	227
Obs in First Data Page	24
Number of Data Set Repairs	0
Filename	/r/ge
Release Created	9.0401M5
Host Created	Linux
Inode Number	71586336
Access Permission	rw-r--r--
Owner Name	
File Size	128KB
File Size (bytes)	131072

Output 7.7 *Total Sales*

store_id	address	city	state	zipcode	totalsales
843	318 S Barnes St	What Cheer	IA	50268	$2,218,497
486	2345 Lindeman Ln	Nameless	TX	78641	$2,101,480
814	115 Tuscarora Pike	Shanghai	WV	25427	$2,195,378
842	318 S Lamar St	What Cheer	IA	50268	$2,218,497

Example 3: Getting Sort Indicator Information

Features:

PROC APPEND statement options
    GETSORT

BY statement

CONTENTS procedure

ODS statement

SORT procedure

Details

This example demonstrates the following tasks:

- creates two data sets: one with no observations and one with observations
- sorts a data set in descending order
- creates a sort indicator using the SORTEDBY data set option
- creates a sort indicator using the SORT procedure

Program

```
data mtea;
    length var1 8.;
    stop;
run;

data phull;
    length var1 8.;
    do var1=1 to 100000;
    output;
end;
run;

proc sort data=phull;
    by DESCENDING var1;
run;

proc append base=mtea data=phull getsort;
run;

ods select sortedby;

proc contents data=mtea;
run;

data mysort(sortedby=var1);
    length var1 8.;
    do var1=1 to 10;
    output;
end;
run;

ods select sortedby;

proc contents data=mysort;
run;
quit;

data mysort;
    length var1 8.;
```

```
    do var1=1 to 10;
    output;
end;
run;

proc sort data=mysort;
    by var1;
run;

ods select sortedby;

proc contents data=mysort;
run;
quit;
```

Program Description

The following example shows that a sort indicator can be inherited using the GETSORT option with the APPEND procedure.

Create a "shell" data set that contains no observations.

```
data mtea;
    length var1 8.;
    stop;
run;
```

Create another data set with the same structure, but with many observations. Sort the data set.

```
data phull;
    length var1 8.;
    do var1=1 to 100000;
    output;
end;
run;

proc sort data=phull;
    by DESCENDING var1;
run;

proc append base=mtea data=phull getsort;
run;

ods select sortedby;

proc contents data=mtea;
run;
```

A sort indicator is being created using the SORTEDBY data set option.

```
data mysort(sortedby=var1);
    length var1 8.;
    do var1=1 to 10;
    output;
end;
```

```
run;

ods select sortedby;

proc contents data=mysort;
run;
quit;
```

A sort indicator is being created by PROC SORT.

```
data mysort;
    length var1 8.;
    do var1=1 to 10;
    output;
end;
run;

proc sort data=mysort;
    by var1;
run;

ods select sortedby;

proc contents data=mysort;
run;
quit;
```

Output Examples

Output 7.8 *Descending Sort Information*

The CONTENTS Procedure

Sort Information	
Sortedby	DESCENDING var1
Validated	YES
Character Set	ANSI

Output 7.9 *Sort Indicator Information Using the SORTEDBY= Data Set Option*

The CONTENTS Procedure

Sort Information	
Sortedby	var1
Validated	NO
Character Set	ANSI

Output 7.10 *Sort Indicator Information Using the SORT Procedure*

The CONTENTS Procedure

Sort Information	
Sortedby	var1
Validated	YES
Character Set	ANSI

8

AUTHLIB Procedure

Overview: AUTHLIB Procedure

What Does the AUTHLIB Procedure Do?

The AUTHLIB procedure is a utility procedure that manages metadata-bound libraries. With PROC AUTHLIB, you can do the following:

- create a metadata-bound library by binding a physical library to metadata within a SAS Metadata Repository
- modify password and encryption key values for a metadata-bound library
- purge replaced password and encryption key values that are also known as metadata-bound library credentials
- repair metadata-bound libraries by recovering security information, secured library objects, and secured table objects
- remove the physical security information and metadata objects that protect a metadata-bound library
- report inconsistencies between physical library contents and corresponding metadata objects within a specified metadata-bound library

Users cannot access metadata-bound data sets from any release of SAS prior to 9.3M2.

Note: For a z/OS direct-access bound library that has been bound to metadata, the constraint is slightly broader. Neither the library nor any of its members can be accessed by earlier releases of SAS.

Concepts: AUTHLIB Procedure

Metadata-Bound Library

A metadata-bound library is a physical library that is tied to a corresponding metadata secured table object. Each physical table within a metadata-bound library has information in its header that points to a specific metadata object. The pointer creates a security binding between the physical table and the metadata object. The binding ensures that SAS universally enforces metadata-layer access requirements for the physical table—regardless of how a user requests access from SAS. For more information, see *SAS Guide to Metadata-Bound Libraries*.

Using Metadata-Bound Library Passwords

A metadata-bound library contains a single set of passwords that are stored in the secured library object. This set of passwords is added to all data sets that are created in the metadata-bound library. These passwords are not used to authorize user access to the data. They are used to authorize administrator access to repair the binding of physical data to the secured library or table metadata objects. The passwords are also validated in the process of authorizing a user's access to a data set. They do not determine the permissions that any user is authorized to have.

The metadata-bound library passwords are intended to be known only by the administrators of the metadata-bound library. Knowledge of these passwords is required to restore or re-create secured library and secured table objects in a SAS Metadata Server for data sets in a data library that have lost their previously recorded metadata objects and permissions.

The metadata-bound library passwords also prevent a user from exporting the secured library and secured table objects from a SAS Metadata Server and then importing them to a SAS Metadata Server that an unauthorized user created and controls. This prevents the unauthorized user from using such objects where the user has modified the permissions.

The metadata-bound library passwords are always stored and transmitted in encrypted formats. The encrypted password is not usable to access the data if it is

captured from a transmission and presented to SAS as a password value in the SAS language. Administrators might choose to use the PWENCODE procedure to encode the passwords for use in a PROC AUTHLIB statement. Using an encoded password prevents a casual observer from seeing the clear-text password in the PROC AUTHLIB statements that the administrator types.

There are three passwords in the metadata-bound library set that correspond to the READ=, WRITE=, and ALTER= passwords of SAS data sets. For greater simplicity in administration of metadata-bound libraries, it is recommended that you use the PW= option in PROC AUTHLIB statements to specify a single password value. In the context of metadata-bound libraries, the READ=, WRITE=, and ALTER= options do not Create access distinctions. If you are concerned that a single eight character password does not meet your security requirements, then you can choose to set three different password values (using READ=, WRITE=, and ALTER=). Setting different values for these three options can create a 24-character password. However, you must keep track of all password values that you have assigned to a metadata-bound library. You must specify the passwords to do the following:

- unbind the library
- modify the passwords
- repair any inconsistencies in the binding information between what is recorded in the physical files and the actual metadata objects

For more information, see "Setting and Modifying Metadata-Bound Library Passwords" on page 128.

TIP All password values must be valid SAS names with a maximum length of 8 characters.

CAUTION
If you lose the password (or passwords) for a metadata-bound library, then you cannot unbind the library or change its passwords. Be sure to keep track of passwords that you assign in the CREATE and MODIFY statements.

Setting and Modifying Metadata-Bound Library Passwords

The metadata-bound library passwords are set in the CREATE statement and can be changed with the MODIFY statement. The passwords stored in data sets in the operating system library can be changed by those statements and subordinate TABLES statements. The passwords stored in the data sets can also be changed if the library is unbound from the metadata with a REMOVE statement.

All of the password options in the CREATE, MODIFY, TABLES, and REMOVE statements accept a syntax where two values can be specified separated by a slash (/) (for example, `PW=password-value/new-password-value`). For CREATE and MODIFY statements, a password value to set in the metadata or data sets is obtained from the password value before the slash (/) if no new password value is specified after the slash (/). The same is true for the REMOVE statement with the additional possibility of specifying the slash (/) and no new password value to indicate that the password should be removed from the data sets during the unbind process. However, note that if the CREATE, MODIFY, or REMOVE statement also specifies TABLESONLY=YES, then any new password values on those statements are ignored.

In general, you do not specify a new password value in a TABLES statement following a CREATE or MODIFY statement. The new value is obtained from the metadata to which the data set is bound or being bound. You can specify a new password value in TABLES statements following a REMOVE statement if you want different data sets to have unique passwords. In that case, you follow these steps:

1. Change the password for the data sets using a REMOVE statement with TABLESONLY=YES and an individual TABLES statement for each unique password.
2. Remove the metadata-bound library with a REMOVE statement without TABLESONLY=YES.

See Also

- “Example 1: Binding a Physical Library That Contains Unprotected Data Sets” on page 167
- “Example 2: Binding a Physical Library That Contains Password-Protected Data Sets” on page 169
- “Example 3: Binding a Library When Existing Data Sets Are Protected with the Same Passwords” on page 171
- “Example 4: Binding a Library When Existing Data Sets Are Protected with Different Passwords” on page 173
- “Example 5: Changing Passwords on Data Sets” on page 176
- “Example 6: Changing Metadata-Bound Library Passwords” on page 178

Encrypted Data Set Considerations

Some data sets in metadata-bound libraries might be encrypted either with the SAS Proprietary Encryption or Advanced Encryption Standard (AES) encryptions. SAS Proprietary Encryption is specified as ENCRYPT=YES when the data set is created. AES encryption is specified as ENCRYPT=AES or ENCRYPT=AES2 and as ENCRYPTKEY= key value (passphrase) when the data set is created. Special

considerations apply for these encrypted data sets when processed by the AUTHLIB procedure. The same encrypt passphrase is used for both AES and AES2, but different keys are generated for the actual encryption. AES2 keys meet stricter NIST (National Institute of Standards and Technology) guidelines..

CAUTION

AES encryption is supported only in SAS 9.4 and later releases. Do not use AES encryption if the data sets need to be accessible by SAS 9.3M2. The AES2 key generation algorithm is supported only in SAS 9.4M5 and later. Do not use it if data sets need to be accessible by earlier releases.

SAS Proprietary Encrypted Data Sets

SAS Proprietary Encryption uses the READ password of the data set as part of the encryption key. Since all metadata-bound data sets in the library share the same set of passwords, it is not necessary to specify the READ password when accessing the file. However, when the READ password is modified on the data set in a CREATE, MODIFY, or REMOVE statement, the data must be re-encrypted with the new password value. This process is done automatically for you in the 9.4 release with a copy-in-place operation. For more information about the copy-in-place operation, see "Copy-In-Place Operation" on page 166.

AES-Encrypted Data Sets

There are two ways to access an AES-encrypted data set:

- the user must provide the ENCRYPTKEY= passphrase value to open the data set
- the administrator must have recorded an optional or required encryption key for the metadata-bound library with the ENCRYPTKEY= option in the CREATE or MODIFY statement

Note: The ENCRYPTKEY= value is a passphrase that can be up to 64 characters long from which the actual AES encryption key is later derived, but it is referred to as the encryption key in most SAS documentation.

By recording an optional or required ENCRYPTKEY= key value for the metadata-bound library, the metadata becomes a key store for the encryption key value. Like password values, the key value is always stored and transmitted in encrypted formats. The encrypted key value is not usable to access the data if it is captured from a transmission and presented to SAS as an encryption key value in the SAS language. For more information, see "Setting and Modifying Metadata-Bound Library Encryption Options" on page 132. If there is no recorded encryption key for the library or the data set is encrypted with a different key, then you can specify the encryption key value by specifying the ENCRYPTKEY= option in a TABLES statement. For more information, see "TABLES Statement" on page 161.

Note: If an encryption key is recorded in the metadata with the AUTHLIB procedure, then it is honored by the SAS 9.4 release when creating and replacing SAS data sets, whether SAS 9.4M1 has been applied or not. The SAS 9.4 release of the AUTHLIB procedure cannot be used to administer the metadata-bound library if the REQUIRE_ENCRYPTION=YES attribute has been set.

CAUTION

Even if you record the encryption key in metadata for the library, you should also record the key elsewhere when using ENCRYPT=AES or ENCRYPT=AES2. If you lose the metadata and forget the ENCRYPTKEY= key value, then you lose your data. SAS cannot assist you in recovering the ENCRYPTKEY= key value. The following note is written to the log:

```
NOTE: If you lose or forget the ENCRYPTKEY= value,
there will be no way  to open the file or
recover the data.
```

For more information, see "Setting and Modifying Metadata-Bound Library Encryption Options" on page 132.

CAUTION

If data sets using AES encryption have referential integrity constraints, then the encryption key for all data sets must be available when they are opened for Update access. Normally, SAS requires that all data sets share the same encryption key. With a recorded optional or required encryption key in metadata, related data sets can have different keys. However, issues can arise if you change the encryption key on one library that has data sets related to data sets in a different library.

TIP If a metadata-bound library contains AES-encrypted data sets, then SAS recommends that you record an encryption key and use it for all metadata-bound data sets in the library that are encrypted with AES. The best way to ensure that the encryption key is used for all data sets is to require encryption. For more information, see "Requiring Encryption for Metadata-Bound Data Sets" on page 134.

See Also

- "Example 10: Binding a Library When Existing Data Sets Are SAS Proprietary Encrypted" on page 184
- "Example 11: Binding a Library When Existing Data Sets Are AES-Encrypted" on page 186
- "Example 12: Binding a Library with an Optional Recorded Encryption Key When Existing AES-Encrypted Data Sets Have Different Encryption Keys " on page 189
- "Example 13: Binding a Library with Required AES Encryption When Existing Data Sets Are Encrypted with the Same Encryption Key" on page 192
- "Example 14: Changing the Encryption Key on a Metadata-Bound Library That Requires AES Encryption" on page 196

Setting and Modifying Metadata-Bound Library Encryption Options

There are three options that affect metadata-bound library encryption:

- REQUIRE_ENCRYPTION=
- ENCRYPT=
- ENCRYPTKEY=

The metadata-bound library encryption options are set in the CREATE statement and can be changed with the MODIFY statement. The encryption of data sets in the operating system library can be changed by the CREATE and MODIFY statements and subordinate TABLES statements. The encryption of data sets can also be changed if the library is unbound from the metadata by using a REMOVE statement. However, note that if the CREATE, MODIFY, or REMOVE statement also specifies TABLESONLY=YES, then any new encryption options on those statements are ignored. Also note that when encryption options are changed for a data set, the copy-in-place operation is automatically executed to re-encrypt the data with the new options. For more information about the copy-in-place operation, see “Copy-In-Place Operation” on page 166.

The default for the REQUIRE_ENCRYPTION= option is NO when it is used in the CREATE statement. The REQUIRE_ENCRYPTION= option can be changed in the MODIFY statement to YES or NO.

The ENCRYPT= option specifies the encryption type to use: AES, AES2, YES, or NO. ENCRYPT=NO is not valid if encryption is required. To record or change a metadata-bound library encryption key, ENCRYPT=AES or ENCRYPT=AES2 must be specified. If you want to switch from a required encryption with a recorded AES or AES2 encryption key to a required encryption with the SAS Proprietary algorithm, then specify ENCRYPT=YES in the MODIFY statement. This process also removes the recorded encryption key. To remove the recorded encryption key when encryption is not required, specify ENCRYPT=NO in the MODIFY statement. To change the encryption of data sets when unbinding with the REMOVE statement, perform one of the following tasks:

- specify different encryption options for data sets that are unbound by using TABLESONLY=YES and the encryption options on different TABLES statements
- change to a common encryption for all data sets that are unbound with the ENCRYPT= option if TABLESONLY is not YES

Similar to password options, the ENCRYPTKEY= option on statements accepts a syntax where two values that are separated by a slash (/) can be specified. Here is an example:

```
ENCRYPTKEY=key-value/new-key-value
```

For CREATE and MODIFY statements, the encryption key value to record in the metadata or data sets is obtained from the encryption key value before the slash (/) if

- ENCRYPT=AES or ENCRYPT=AES2
- there is no new key value specified after the slash (/)

If you do not specify ENCRYPT=AES or ENCRYPT=AES2, then the encryption key value is used to open data sets but it is not recorded in metadata. Unlike password options, you do not remove an encryption key value by specifying a slash (/) after it and leaving it blank. Instead, you use ENCRYPT=YES or ENCRYPT=NO, as discussed in the previous paragraph.

If encryption is required, then you do not specify a new key value in a TABLES statement following a CREATE or MODIFY statement. The new value is obtained from the metadata to which the data set is bound or being bound. If encryption is not required or if you are following a REMOVE statement with TABLESONLY=YES, then you can specify ENCRYPT=AES or ENCRYPT=AES2 and a new key value in TABLES statements to have the data set re-encrypted with the new key value.

See Also

- "Example 15: Binding a Library with Existing Data Sets That Are AES-Encrypted with Different Encryption Keys" on page 199
- "Example 16: Changing a Metadata-Bound Library to Require AES Encryption When Existing Data Sets Are Encrypted with Different Encryption Keys" on page 202

Retaining and Purging Metadata-Bound Library Credentials

Passwords and encryption keys for a metadata-bound library are collectively referred to as *metadata-bound library credentials*. Prior to SAS 9.4M3, when any of these credentials were modified, the replaced values were immediately removed from the metadata. Sometimes tables were not processed because another user was accessing the table.

Beginning with SAS 9.4M3, the credentials are retained in metadata and can be used by the system to open data sets that were not modified. This retention enables the user to continue processing tables and the administrator to complete the modification of credentials. The retained credentials are purged if a MODIFY statement that is processing all of the tables in the library determines that all the tables have been successfully changed with the credentials.

An administrator might want to retain the credentials even after all the existing tables have been processed successfully. The following are reasons for retaining the credentials:

- It enables processing of view files that implemented row and column level security on underlying tables by using the old passwords in the view definition.

SAS does not know which view files might contain the passwords and does not have the ability to modify them in the view file. The administrator must redefine the views with the new passwords.

- It enables processing of data sets restored from backups prior to the modification.

An administrator who wants to retain older credentials and not purge them can specify the PURGE=NO option in the MODIFY statement.

Note: The administrator must specify the PURGE=NO option in each MODIFY statement that processes all tables until the administrator is ready for the replaced credentials to be purged.

If a library contains tables that do not follow our best practices, automatic deletion of old credentials might not occur when issuing a MODIFY statement for all tables. For example, a MODIFY statement that changes the stored encryption key for a library with optional encryption would not modify the keys of data sets whose keys do not match the stored key. Because some data sets were not modified, the old encryption key is not removed. In this case, the PURGE statement must be used to remove the old credentials.

Note: Notes are written to the SAS log whenever a metadata-bound table is accessed and the replaced credentials are used to successfully open the data set. The Note identifies the date and time that these credentials were replaced.

For more information, see "PURGE Statement" on page 148.

Requiring Encryption for Metadata-Bound Data Sets

Beginning in SAS 9.4M1, an administrator can require that all data sets in a metadata-bound library be automatically encrypted when created. This is specified by using the REQUIRE_ENCRYPTION=YES option in the CREATE or MODIFY statements. The type of encryption required depends on whether there is a recorded encryption key or not. If there is a recorded encryption key, then all data sets that are bound to the secured library object are automatically encrypted with an encryption key that is generated from the recorded passphrase with the recorded key generation algorithm. If there is no recorded encryption key, then all data sets are automatically encrypted with the SAS Proprietary algorithm.

In order to automatically encrypt the data sets, a copy-in-place operation is used. For an explanation of the copy-in-place operation, see "Copy-In-Place Operation" on page 166. If the data set is currently encrypted with a different key value, then that key value must be either the current recorded encryption key value or specified with the ENCRYPTKEY= option in the TABLES statement.

Note: If the REQUIRE_ENCRYPTION=YES attribute of a metadata-bound library is set in the metadata with the AUTHLIB procedure, then it is honored by SAS 9.4 when creating and replacing SAS data sets whether SAS 9.4M1 has been applied or not. The pre-maintenance version of the AUTHLIB procedure cannot be used to administer the metadata-bound library if the REQUIRE_ENCRYPTION=YES attribute has been set. SAS 9.3M2 does not honor the REQUIRE_ENCRYPTION=YES attribute, and its AUTHLIB procedure should not be used to administer the library if the REQUIRE_ENCRYPTION=YES attribute is set.

See Also

- "Example 15: Binding a Library with Existing Data Sets That Are AES-Encrypted with Different Encryption Keys" on page 199
- "Example 16: Changing a Metadata-Bound Library to Require AES Encryption When Existing Data Sets Are Encrypted with Different Encryption Keys" on page 202

Data Sets in a Metadata-Bound Library That Are Not Bound to Secured Table Objects

It is possible that some data sets in a metadata-bound library do not have the metadata-bound library passwords. These data sets are not considered to be part of the bound library for authorization purposes. This can occur with either of the following scenarios:

- the data sets existed in the library before it was bound and their passwords differed from the metadata library passwords
- the data set is AES-encrypted and the encryption key was not available to open the data set in a CREATE or MODIFY statement

See the following examples:

- "Example 2: Binding a Physical Library That Contains Password-Protected Data Sets" on page 169
- "Example 12: Binding a Library with an Optional Recorded Encryption Key When Existing AES-Encrypted Data Sets Have Different Encryption Keys " on page 189

This can also occur if data sets were to be copied into the library by an operating system copy utility.

If a data set was bound before being copied, then the data set is still protected by the permissions that the users have in the secured table object to which it is bound in the original secured library.

If a data set was not bound before being copied, then it is also not bound in the new library or protected by the metadata permissions. If the data set has passwords, then you must supply the appropriate passwords to access the data.

You can use the MODIFY statement to modify the passwords if necessary and to bind the data set to a secured table object in the secured library object to which the library is bound. For more information, see "Example 5: Changing Passwords on Data Sets" on page 176.

Syntax: AUTHLIB Procedure

Restrictions: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Users cannot access metadata-bound data sets from any release of SAS prior to SAS 9.3M2.

The AUTHLIB procedure is intended for use by SAS administrators. Users who lack sufficient privileges in either the metadata layer or the host layer cannot use this statement.

The AUTHLIB procedure cannot operate on libraries that are assigned for access through a SAS/SHARE server.

The physical library specified cannot be a concatenated library, temporary library, or accessed through a SAS/SHARE server and must be processed by an engine that supports metadata-bound libraries.

This procedure is not supported on the CAS server.

Requirement: The AUTHLIB procedure requires a connection to the target metadata server.

Tip: Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

See: *SAS Guide to Metadata-Bound Libraries*

```
PROC AUTHLIB <options>;
   CREATE
      SECUREDLIBRARY='secured-library-name'
        < SECUREDFOLDER='secured-folder-path' >
        < LIBRARY=libref >
        PW=all-password-value </ new-all-password-value> |
        ALTER=alter-password-value </ new-alter-password-value>
        READ=read-password-value </ new-read-password-value>
        WRITE=write-password-value </ new-write-password-value>
        <REQUIRE_ENCRYPTION=YES | NO>
        <ENCRYPT=YES | NO | AES | AES2>
        <ENCRYPTKEY=key-value < / new-key-value >>;
   MODIFY <LIBRARY=libref>
      PW=all-password < / new-all-password > |
        ALTER=alter-password < / new-alter-password >
        READ=read-password < / new-read-password >
```

WRITE=*write-password* < / *new-write-password* >
<TABLESONLY=YES | NO>
<REQUIRE_ENCRYPTION=YES | NO>
<ENCRYPT=YES | NO | AES | AES2>
<ENCRYPTKEY=*key-value* < / *new-key-value* >>
<PURGE=YES | | NO>;

PURGE CREDENTIALS | CREDS <LIBRARY=*libref*>

PW=*all-password* |
ALTER=*alter-password*
READ=*read-password*
WRITE=*write-password*
BEFORE=*datetime*;

REMOVE<LIBRARY=*libref*>

PW=*all-password* < / <*new-all-password*> > |
ALTER=*alter-password* < / <*new-alter-password*> >
READ=*read-password* < / <*new-read-password*> >
WRITE=*write-password* < / <*new-write-password*> >
<TABLESONLY=YES | NO>
<ENCRYPT=YES | NO | AES | AES2>
<ENCRYPTKEY=*key-value* < / *new-key-value* >>;

REPAIR ADD | UPDATE | DELETE

LOCATION | METADATA
SECUREDLIBRARY='*secured-library-name*'
SECUREDFOLDER='*secured-folder-path*'
< LIBRARY=*libref* >
PW=*all-password* |

ALTER=*alter-password*
READ=*read-password*
WRITE=*write-password*

<TABLESONLY=YES | NO>
<ENCRYPTKEY=*key-value*>;

REPORT <LIBRARY=*libref*>

<ENCRYPTKEY=*key-value*>;

TABLES *SAS-dataset(s)* | _ALL_ | _NONE_

< / >
< PW=*all-password* > < / <*new-all-password*> > |
< ALTER=*alter-password* > < / <*new-alter-password*> >
< READ=*read-password* > < / <*new-read-password*> >
< WRITE=*write-password* > < / <*new-write-password*> >;
< MEMTYPE= DATA | VIEW >
< ENCRYPT=YES | NO | AES | AES2 >
<ENCRYPTKEY=*key-value*< / *new-key-value* >>;

Statement	Task	Example
PROC AUTHLIB	Create and manage metadata-bound libraries	
CREATE	Create the secured library object in the SAS Metadata Server and record the physical	Ex. 1, Ex. 2, Ex. 3, Ex. 4,

Statement	Task	Example
	security information in the directory or bound files	Ex. 11, Ex. 10, Ex. 12, Ex. 13, Ex. 15
MODIFY	Modify password values and encryption key values for a metadata-bound library	Ex. 5, Ex. 6, Ex. 16
PURGE	Removes any retained metadata-bound library credentials older than a given date of replacement.	
REMOVE	Remove the physical security information and metadata objects that protect a metadata-bound library	Ex. 7
REPAIR	Recover security information (in physical data) or secured library and table objects (in metadata)	
REPORT	For a specified metadata-bound library, compare physical library contents with corresponding metadata objects (in order to identify any inconsistencies)	Ex. 8
TABLES	Specify which tables within a specified metadata-bound library are affected by certain AUTHLIB statements	Ex. 4, Ex. 9, Ex. 11, Ex. 10, Ex. 12, Ex. 15, Ex. 16

PROC AUTHLIB Statement

Manages metadata-bound libraries.

Note: Data set names and variable names that end with large numeric values that are larger than a long integer cannot be used in numbered-range lists. For more information, see "Restriction for Numbered Range Lists" in *SAS Language Reference: Concepts*.

Syntax

PROC AUTHLIB <*options*>;

Summary of Optional Arguments

LIBRARY=*libref*
: is the name of the physical library for which the secured library object is created and the security information is stored.

NOWARN
: suppresses error processing.

PWREQ=YES | NO
: controls the pop up of a dialog box.

Optional Arguments

LIBRARY=*libref*
is the name of the physical library for which the secured library object is created and the security information is stored.

If the LIBRARY= option is not specified, then the LIBRARY=*libref* (physical library) from the CREATE, MODIFY, REMOVE, REPORT, or REPAIR statement is used.

Aliases
: LIB=

  DDNAME=

  DD=

Restriction
: The physical library specified cannot be a concatenated library, temporary library, or accessed through a SAS/SHARE server and must be processed by an engine that supports metadata-bound libraries.

NOWARN
suppresses the **`file not found`** error message when a data set in a TABLES statement does not exist.

PWREQ=YES | NO
controls the pop up of a dialog box for a data set password in interactive mode.

YES
: specifies that a dialog box appear if a missing or invalid password is entered when required.

NO
: prevents a dialog box from appearing. If a missing or invalid password is entered, then the data set is not opened, and an error message is written to the SAS log.

Default
: NO

CREATE Statement

Binds a physical library and data sets in the library to metadata by generating corresponding metadata objects in the SAS Metadata Repository and creating a record of the metadata objects in the physical directory and data sets.

Requirement: The AUTHLIB CREATE statement requires a connection to the target metadata server. For more requirements, see "Requirements for Using the AUTHLIB Statements" on page 165.

Tip: Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

Syntax

CREATE

SECUREDLIBRARY='*secured-library-name*'
<SECUREDFOLDER='*secured-folder-path*'>
<LIBRARY=*libref*>
PW=*all-password-value* </ *new-all-password-value*> |
ALTER=*alter-password-value* </ *new-alter-password-value*>
READ=*read-password-value* </ *new-read-password-value*>
WRITE=*write-password-value* </ *new-write-password-value*>
<REQUIRE_ENCRYPTION=YES | NO>
<ENCRYPT=YES | NO | AES | AES2>
<ENCRYPTKEY=*key-value* </ *new-key-value*>>;

Required Arguments

SECUREDLIBRARY='*secured-library-name*'
names the secured library object in the SAS Metadata Server.

Alias SECLIB=

Restriction The total length of the secured library object pathname including the fully qualified secured folder path cannot exceed 256 characters.

PW=*all-password-value* <*/ new-all-password-value*>
sets a single password for a metadata-bound library.

ALTER=*alter-password-value* <*/ new-alter-password-value*>
sets one of a maximum of three password values for a metadata-bound library.

READ=*read-password-value* <*/ new-read-password-value*>
sets one of a maximum of three password values for a metadata-bound library.

WRITE=*write-password-value* <*/ new-write-password-value* >
sets one of a maximum of three password values for a metadata-bound library.

> **TIP** All password values must be valid SAS names with a maximum length of 8 characters.

Optional Arguments

SECUREDFOLDER='*secured-folder-path*'
is the name of the metadata folder within the **`/System/Secured Libraries`** folder tree where the secured library object is created.

If the SECUREDFOLDER= option is not specified, then the metadata-bound library is created directly in the **`/System/Secured Libraries`** folder of the Foundation repository. If the SECUREDFOLDER= option does not begin with a slash (/), then it is a relative path and the value is appended to **`/System/Secured Libraries/`** to find the folder. If the SECUREDFOLDER= option begins with a slash (/), then it is an absolute path and the value must begin with **`/System/Secured Libraries`** or **`/<repository_name>/System/Secured Libraries`**.

Alias SECFLDR=

Restriction The total length of the secured library object pathname including the fully qualified secured folder path cannot exceed 256 characters.

ENCRYPT=YES | NO | AES | AES2
specifies the encryption type.

YES	specifies the SAS Proprietary algorithm.
NO	specifies no encryption.
AES | AES2	specifies Advanced Encryption Standard (AES) encryption and to record the key in metadata.

Restriction ENCRYPTKEY= option is required if the library has AES encryption.

See "Encrypted Data Set Considerations" on page 129

ENCRYPTKEY=*key-value* </ *key-value*>
specifies a key value for AES encryption.

Requirement ENCRYPTKEY= option is required if the library or a data file has AES or AES2 encryption.

Note The encryption key value for all the data sets in a library can be stored in a metadata-bound library so that an authorized user does not have to supply the encryption key value every time a data set is opened. For more information, see "Considerations for Data File Encryption" in the *SAS Guide to Metadata-Bound Libraries*.

Tip The ENCRYPTKEY= value is a passphrase that can be up to 64 characters long from which the actual AES or AES2 encryption key is later derived, but it is referred to as the encryption key in most SAS documentation.

See "Encrypted Data Set Considerations" on page 129

"ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*

LIBRARY=*libref*

name of the physical library for which the secured library object is created and the security information is stored.

If the LIBRARY= option is not specified, then the physical library from the AUTHLIB procedure is used.

Aliases LIB=

DDNAME=

DD=

Restriction The physical library specified cannot be a concatenated library, temporary library, or accessed through a SAS/SHARE server and must be processed by an engine that supports metadata-bound libraries.

REQUIRE_ENCRYPTION=YES | NO

YES specifies that all data sets in a metadata-bound library are automatically encrypted.

NO specifies that data sets in a metadata-bound library are not automatically encrypted.

See "Requiring Encryption for Metadata-Bound Data Sets" on page 134

Details

Specifying Passwords

If your physical library does not contain password-protected data sets, then you need to specify the new metadata-bound library password(s) with either the PW= option or READ=,WRITE=, and ALTER= options in the CREATE statement. This is the most common case. For an example, see "Example 1: Binding a Physical Library That Contains Unprotected Data Sets" on page 167.

If your physical library contains some password-protected data sets that all share the same current set of passwords, then you can specify the most restrictive password on the data sets before a slash (/) in the CREATE statement password option(s) and the new password(s) after the slash (/). For an example, see "Example 3: Binding a Library When Existing Data Sets Are Protected with the Same Passwords" on page 171.

If your physical library contains password-protected data sets with different sets of passwords, then you can specify the data sets with each set of passwords on separate TABLES statements (see "Example 4: Binding a Library When Existing

Data Sets Are Protected with Different Passwords" on page 173) or you can subsequently use MODIFY and TABLES statements to change the passwords after the library has been bound with the CREATE statement (see "Example 5: Changing Passwords on Data Sets" on page 176).

Specifying Encryption Keys

To create or access a metadata-bound library that is protected using AES or AES2 encryption requires an encryption key value. You must use ENCRYPT=AES or ENCRYPT=AES2 and ENCRYPTKEY=*key-value* data set options.

If your physical library contains some AES-encrypted data sets that all share the same AES or AES2 encryption key, then you can specify the key value following ENCRYPTKEY= in the CREATE statement. If you want to record the key in metadata, then specify ENCRYPT=AES or ENCRYPT=AES2. For an example, see "Example 13: Binding a Library with Required AES Encryption When Existing Data Sets Are Encrypted with the Same Encryption Key" on page 192.

If your physical library contains AES or AES2-encrypted data sets with different encryption keys, then you can specify the data sets with each encryption key on separate TABLES statements. For an example, see "Example 15: Binding a Library with Existing Data Sets That Are AES-Encrypted with Different Encryption Keys" on page 199.

> **TIP** For more information, see "Considerations for Data File Encryption" in the *SAS Guide to Metadata-Bound Libraries*.

For more information, see "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference* and "ENCRYPT= Data Set Option" in *SAS Data Set Options: Reference*.

CAUTION
If data sets using AES encryption have referential integrity constraints, then the encryption key for all data sets must be available when they are opened for Update access. Normally, SAS requires that all data sets share the same encryption key. With a recorded optional or required encryption key in metadata, related data sets can have different keys. However, issues can arise if you change the encryption key on one library that has data sets related to data sets in a different library.

CAUTION
For AES-encrypted data sets that are referentially related to one another, follow these best practices to ensure that the data does not become inaccessible: Store the encryption key in the library's metadata. You can modify the stored key, but do not remove the key from metadata and do not unbind the library.

CAUTION
Even if you record the encryption key in metadata for the library, then you should also record the key elsewhere when using ENCRYPT=AES or ENCRYPT=AES2. If you lose the metadata and forget the ENCRYPTKEY= key value,

then you lose your data. SAS cannot assist you in recovering the ENCRYPTKEY= key value. The following note is written to the log:

```
NOTE: If you lose or forget the ENCRYPTKEY= value,
there will be no way  to open the file or
recover the data.
```

MODIFY Statement

Modifies password and encryption key values for a metadata-bound library.

Requirement: The AUTHLIB MODIFY statement requires a connection to the target metadata server. For more requirements, see "Requirements for Using the AUTHLIB Statements" on page 165.

Tip: Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

Syntax

MODIFY

<LIBRARY=*libref*>
PW=*all-password </ new-all-password>* |
ALTER=*alter-password </ new-alter-password>*
READ=*read-password </ new-read-password>*
WRITE=*write-password </ new-write-password>*
<TABLESONLY=YES | NO>
<REQUIRE_ENCRYPTION=YES | NO>
<ENCRYPT=YES | NO | AES | AES2>
<ENCRYPTKEY=*key-value </ new-key-value*>>
<PURGE=YES | NO>;

Required Arguments

PW=*all-password </ new-all-password >*
modifies a single password for a metadata-bound library.

ALTER=*alter-password </ new-alter-password>*
modifies one of a maximum of three password values for a metadata-bound library.

READ=*read-password </ new-read-password>*
modifies one of a maximum of three password values for a metadata-bound library.

WRITE=*write-password </ new-write-password>*
modifies one of a maximum of three password values for a metadata-bound library.

> **TIP** All password values must be valid SAS names with a maximum length of 8 characters.

Optional Arguments

ENCRYPT=YES | NO | AES | AES2
specifies the encryption type.

YES
specifies the SAS Proprietary algorithm.

NO
specifies no encryption.

AES
AES2
specifies Advanced Encryption Standard (AES) encryption and to record the key in metadata.

Requirement ENCRYPTKEY= option is required if the library has AES encryption.

See "Encrypted Data Set Considerations" on page 129

ENCRYPTKEY=*key-value </ key-value>*
specifies a key value for AES encryption.

Requirement ENCRYPTKEY= option is required if the library or a data file has AES encryption.

Note The encryption key value for all the data sets in a library can be stored in a metadata-bound library so that an authorized user does not have to supply the encryption key value every time a data set is opened. For more information, see "Considerations for Data File Encryption" in the *SAS Guide to Metadata-Bound Libraries*.

Tip The ENCRYPTKEY= value is a passphrase that can be up to 64 characters long from which the actual AES or AES2 encryption key is later derived, but it is referred to as the encryption key in most SAS documentation.

See "Encrypted Data Set Considerations" on page 129

"ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*

LIBRARY=*libref*
name of the physical library that is metadata-bound.

If the LIBRARY= option is not specified, then the physical library from the AUTHLIB procedure is used.

Alias LIB=, DDNAME=, DD=

Restriction The physical library specified cannot be a concatenated library, temporary library, or accessed through a SAS/SHARE server and must be processed by an engine that supports metadata-bound libraries.

PURGE=YES | NO

YES
removes all retained metadata-bound library credentials if all tables in the library are successfully modified to the newer credentials.

Default YES

NO
does not remove replaced metadata-bound library credentials even if all tables in the library were successfully modified.

See "Retaining and Purging Metadata-Bound Library Credentials" on page 133

REQUIRE_ENCRYPTION=YES | NO

YES
specifies that all data sets in a metadata-bound library are automatically encrypted.

NO
specifies that data sets in a metadata-bound library are not automatically encrypted.

See "Requiring Encryption for Metadata-Bound Data Sets" on page 134

TABLESONLY=YES | NO
specifies whether the MODIFY statement action is applied at the library level or just to the tables. If TABLESONLY=NO, then the action is applied to the library and data sets. If TABLESONLY=YES, then the action is applied only to the data sets.

Default NO

Tip If you specify TABLESONLY=YES and a new password or encryption key value in the CREATE, MODIFY, or REMOVE statement, then the new password value or encryption key value is ignored. The current password or encryption key value is still required if the library is metadata-bound.

Details

Using the MODIFY Statement

The MODIFY statement can modify the value of the required metadata-bound library passwords and encryption options. This statement can also modify passwords on data sets (tables) that do not have the required metadata-bound library password values. The TABLES statement follows the MODIFY statement to specify current passwords and encryption keys in the data sets.

If your physical library is currently bound to a metadata library with one set of passwords and you want to change the metadata-bound library passwords to another set, then specify the current and new values for the metadata-bound library passwords separated by a / in the MODIFY statement. For an example, see "Example 6: Changing Metadata-Bound Library Passwords" on page 178.

If your physical library contains password-protected data sets with different sets of passwords from the metadata-bound library passwords, then you can modify the data set passwords to match the metadata-bound library required passwords using the MODIFY and TABLES statements. Specify the metadata-bound library passwords in the MODIFY statement. Specify the data sets with each set of passwords in separate TABLES statements. For more information, see "Example 5: Changing Passwords on Data Sets" on page 176.

If you want to change encryption options for the library, then specify the new options in the MODIFY statement. If your physical library contains AES-encrypted data sets, then you must specify the ENCRYPTKEY= key value in the MODIFY or TABLES statements or have a recorded encryption key for the library to make any modifications to the encrypted data sets. For and example, see "Example 16: Changing a Metadata-Bound Library to Require AES Encryption When Existing Data Sets Are Encrypted with Different Encryption Keys" on page 202.

For more information, see "TABLES Statement" on page 161.

CAUTION

For AES-encrypted data sets that are referentially related to one another, follow these best practices to ensure that the data does not become inaccessible: Store the encryption key in the library's metadata. You can modify the stored key, but do not remove the key from metadata and do not unbind the library.

CAUTION

Even if you record the encryption key in metadata for the library, you should also record the key elsewhere when using ENCRYPT=AES or ENCRYPT=AES2. If you lose the metadata and forget the ENCRYPTKEY= key value, then you lose your data. SAS cannot assist you in recovering the ENCRYPTKEY= key value.

You might have a need to import a SecuredLibrary object from a backup package for one of the following reasons:

- the SecuredLibrary object was inadvertently deleted
- you are promoting the metadata-bound library to a new metadata server

Password values and encryption key values are not exported with the SecuredLibrary object. This prevents them from being imported to a rogue Metadata Server. In this case, the passwords and any recorded encryption key values need to be reset in the imported SecuredLibrary object. Until you do this, libname assignments that refers to the imported SecuredLibrary object will fail with the following messages:

```
ERROR: The secured library object information for library library-name
could not be obtained from the metadata server or has invalid data.
ERROR: Association not found.
ERROR: Error in the LIBNAME statement.
```

For an example, see "Example 18: Resetting Credentials on Imported SecuredLibrary Objects" on page 208.

Using the LIBRARY= Option

If you want to override the default library from the AUTHLIB procedure, then use LIBRARY=.

```
MODIFY <LIBRARY=library-name>
```

If you want to modify the passwords or encryption options for a secured library object that is no longer bound to a physical library, then specify LIBRARY=_NONE_ with the SECUREDLIBRARY= and SECUREDFOLDER= options to locate the secured library object.

```
MODIFY <LIBRARY=_NONE_ SECUREDLIBRARY=secured-library-name>
                <SECUREDFOLDER=secured-folder-name>
```

CAUTION

Do not use LIB=_none_ when the secured library object is bound to a physical library. LIB=_none_ causes the action to operate only on the secured library object and has no effect on the physical data.

Using the PURGE Option

Passwords and encryption keys for a metadata-bound library are collectively referred to as *metadata-bound library credentials*. For information about retaining and purging credentials, see "Retaining and Purging Metadata-Bound Library Credentials" on page 133.

PURGE Statement

Removes any retained metadata-bound library credentials older than a given date of replacement.

Requirement: The AUTHLIB PURGE statement requires a connection to the target metadata server. For more requirements, see "Requirements for Using the AUTHLIB Statements" on page 165.

Tip: Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

Syntax

PURGE CREDENTIALS | CREDS <LIBRARY=*libref*>

PW=*all-password* |
ALTER=*alter-password*
READ=*read-password*
WRITE=*write-password*
BEFORE=*datetime*;

Required Arguments

PW=*all-password*
specifies a single password for a metadata-bound library.

ALTER=*alter-password*
specifies one of a maximum of three password values for a metadata-bound library.

READ=*read-password*
specifies one of a maximum of three password values for a metadata-bound library.

WRITE=*write-password*
specifies one of a maximum of three password values for a metadata-bound library.

> **TIP** All password values must be valid SAS names with a maximum length of 8 characters.

BEFORE=*datetime*
specifies a datetime constant before any replaced, but retained, credentials are removed.

Optional Argument

LIBRARY=*libref*
name of the physical library for which the metadata-bound library is created and the security information is stored.

If the LIBRARY= option is not specified, then the physical library from the AUTHLIB procedure is used.

Alias LIB=, DDNAME=, DD=

Restriction The physical library specified cannot be a concatenated library, temporary library, or accessed through a SAS/SHARE server and

must be processed by an engine that supports metadata-bound libraries.

Details

Using the PURGE Statement

Passwords and encryption keys for a metadata-bound library are collectively referred to as *metadata-bound library credentials*. For more information about purging metadata-bound library credentials, see "Retaining and Purging Metadata-Bound Library Credentials" on page 133.

Using the LIBRARY= Option

If you want to override the default library from the AUTHLIB procedure, then use LIBRARY= option.

```
PURGE CREDENTIALS <LIBRARY=library-name>
```

If you want to purge the credentials for a secured library object that is no longer bound to a physical library, then specify LIBRARY=_NONE_ with the SECUREDLIBRARY= and SECUREDFOLDER= options to locate the secured library object.

```
PURGE CREDENTIALS <LIBRARY=_NONE_ SECUREDLIBRARY=secured-library-name>
<SECUREDFOLDER=secured-folder-name>
```

REMOVE Statement

Removes the physical security information and metadata objects that protect a metadata-bound library so that it is no longer a metadata-bound library.

Requirement: The AUTHLIB REMOVE statement requires a connection to the target metadata server. For more requirements, see "Requirements for Using the AUTHLIB Statements" on page 165.

Note: If any data set uses SAS Proprietary Encryption, then you cannot remove passwords unless you also specify ENCRYPT=NO to remove encryption.

Tips: Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

If you do not want the non-secured data sets altered, then move all non-secured data sets from the physical library before performing a REMOVE statement.

Before you use the REMOVE statement, consider running the REPORT statement. The output from the REPORT statement identifies any physical tables that do not have corresponding secured table objects in metadata. In the unusual circumstance that such physical tables exist, their security location information is unaffected by the REMOVE statement unless you specify AUTHADMIN=YES in the LIBNAME

statement. You should use the AUTHADMIN=YES option in the LIBNAME statement in this circumstance.

Examples: "Example 7: Using the REMOVE Statement" on page 180

"Example 17: Using the REMOVE Statement on a Metadata-Bound Library with Required AES Encryption" on page 205

Syntax

REMOVE<LIBRARY=*libref*>

PW=*all-password* </ <*new-all-password*>> |
ALTER=*alter-password* </ <*new-alter-password*>>
READ=*read-password* </ <*new-read-password*>>
WRITE=*write-password* </ <*new-write-password*>>
<TABLESONLY=YES | NO>
<ENCRYPT=YES | NO | AES | AES2>
<ENCRYPTKEY=*key-value* </ *new-key-value*>>;

Required Arguments

PW=*all-password* </ <*new-all-password*>>
specifies a single password for a metadata-bound library.

ALTER=*alter-password* </ <*new-alter-password*>>
specifies one of a maximum of three password values for a metadata-bound library.

READ=*read-password* </ <*new-read-password*>>
specifies one of a maximum of three password values for a metadata-bound library.

WRITE=*write-password* </ <*new-write-password*>>
specifies one of a maximum of three password values for a metadata-bound library.

Optional Arguments

ENCRYPT=YES | NO | AES | AES2
specifies the encryption type.

YES	specifies the SAS Proprietary algorithm.
NO	specifies no encryption.
AES | AES2	specifies Advanced Encryption Standard (AES) encryption and is required if specifying that data sets be encrypted with a new key value.

See "Encrypted Data Set Considerations" on page 129

ENCRYPTKEY=*key-value* </ *key-value*>
specifies a key value for AES encryption.

Tip The ENCRYPTKEY= value is a passphrase that can be up to 64 characters long from which the actual AES or AES2 encryption key is later derived, but it is referred to as the encryption key in most SAS documentation.

See "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*

LIBRARY=*libref*
name of the physical library that is metadata-bound.

If the LIBRARY= option is not specified, then the physical library from the PROC AUTHLIB statement is used.

Alias LIB=, DDNAME=, DD=

Restriction The physical library specified cannot be a concatenated library, temporary library, or accessed through a SAS/SHARE server and must be processed by an engine that supports metadata-bound libraries.

TABLESONLY=YES | NO
specifies whether the REMOVE statement action is applied at the library level or just to the tables. If TABLESONLY=NO, then the action is applied to the library and data sets. If TABLESONLY=YES, then the action is applied only to the individual data sets listed.

Default NO

Tip If you specify TABLESONLY=YES and a new password or encryption options, then the new password or encryption options are ignored. The current password is still required if the library is metadata-bound.

Details

The REMOVE statement is used to unbind the metadata-bound library feature from a SAS library and the data sets within it. This statement also removes the secured library and secured table objects from the SAS Metadata Server. The data sets remain in the physical library protected by the metadata-bound library passwords unless the administrator specifies password modifications in the REMOVE statement. Since the metadata-bound library feature is being removed and there is no longer a requirement that the data set passwords match the metadata-bound library passwords, the data set passwords can be removed by using a slash (/) after the current password but not specifying a new password. If you choose to do this, then you are warned in the SAS log that the data sets no longer have any SAS protection. You can also modify the encryption key of data sets by specifying the new key following a slash (/) in ENCRYPTKEY= and specifying ENCRYPT=AES or ENCRYPT=AES2. You can change to SAS Proprietary Encryption by specifying ENCRYPT=YES. You can remove all encryption by specifying ENCRYPT=NO.

The REMOVE statement removes the location information from any data set if the passwords specified match the metadata-bound library passwords stored in the data set. Note also that if the data set is AES or AES2-encrypted, the encryption

key must either be recorded in metadata or specified in the REMOVE or TABLES statements. However, it does not delete the referenced secured table object unless that secured table object is under the secured library object to which the operating system library is bound. If a data set has been copied into the bound library by a utility not written in SAS from another metadata-bound library, then this process prevents a REMOVE from deleting the secured table object that belongs to the other metadata-bound library.

Note: Ensure that all physical tables that are protected by a particular metadata-bound library remain within that library (directory). This best practice maximizes clarity and is essential in order for REMOVE statements to be fully effective. Special circumstances (for example, a table that is host copied to another directory) can prevent a REMOVE statement from unbinding the relocated data set.

CAUTION

If you have to unbind a library that contains AES-encrypted data sets that are referentially related to other data sets, then either make sure that all related data sets are no longer AES-encrypted or make sure that all related data sets share the same encryption key. If you preserve AES encryption, the data will be available only to those users who supply the key and have host-layer access.

REPAIR Statement

Recovers security information (in physical data) or secured library and table objects (in metadata).

Requirement: The AUTHLIB REPAIR statement requires a connection to the target metadata server. For more requirements, see "Requirements for Using the AUTHLIB Statements" on page 165.

Tip: Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

Syntax

REPAIR ADD | UPDATE | DELETE

LOCATION | METADATA
SECUREDLIBRARY='*secured-library-name*'
SECUREDFOLDER='*secured-folder-path*'
<LIBRARY=*libref*>
PW=*all-password* |
ALTER=*alter-password*
READ=*read-password*
WRITE=*write-password*
<TABLESONLY=YES | NO>
<ENCRYPT=YES | NO | AES | AES2>

<ENCRYPTKEY=*key-value*>;

Required Arguments

ADD | UPDATE | DELETE
one of these actions must be specified.

LOCATION | METADATA
clarifies whether the action is to apply to the physical security information in the file system, to the metadata objects in the SAS Metadata Server, or to both.

PW=*all-password*
specifies a single password for a metadata-bound library.

ALTER=*alter-password*
assigns, changes, or removes an Alter password from the secured library object and from the data sets in the physical library.

READ=*read-password*
assigns, changes, or removes a Read password from the secured library object and from the data sets in the physical library.

WRITE=*write-password*
assigns, changes, or removes a Write password from the secured library object and from the data sets in the physical library.

TABLESONLY= YES | NO
specifies whether the REPAIR statement action is applied at the library level or just to the tables. If TABLESONLY=NO, then the action is applied to the library and the tables. If TABLESONLY=YES, then the action is applied only to the tables. This is especially important for REPAIR because it gives the administrator a way to delete specific secured table objects without deleting the secured library and all secured tables.

Optional Arguments

/
is required if any options are included, such as passwords or MEMTYPE=. Here is an example:

```
tables table-name / pw=password;
```

ENCRYPT=YES | NO | AES | AES2
specifies the encryption type.

YES	specifies the SAS Proprietary algorithm.
NO	specifies no encryption.
/	is required if any options are included, such as passwords or MEMTYPE.
AES | AES2	specifies Advanced Encryption Standard (AES) encryption and is required if changing and encrypting with a new key value and TABLESONLY=YES in the action statement.

Requirement A / is reuired when using TABLES.

```
tables table-name / pw=password;
```

See "Encrypted Data Set Considerations" on page 129

ENCRYPTKEY=*key-value*
specifies a key value for AES encryption.

Requirement ENCRYPTKEY= data set option is required if the library or a data file has AES encryption and if the key is not recorded in the library metadata.

Note The encryption key value for all the data sets in a library can be stored in a metadata-bound library so that an authorized user does not have to supply the encryption key value every time a data set is opened. For more information, see "Considerations for Data File Encryption" in the *SAS Guide to Metadata-Bound Libraries*.

Tip The ENCRYPTKEY= value is a passphrase that can be up to 64 characters long from which the actual AES encryption key is later derived, but it is referred to as the encryption key in most SAS documentation.

See "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*

LIBRARY=*libref*
name of the physical library where the security information is stored.

If the LIBRARY= option is not specified, then the physical library from the PROC AUTHLIB statement is used.

Alias LIB=, DDNAME=, DD=

Restriction The physical library specified cannot be a concatenated library, temporary library, or accessed through a SAS/SHARE server and must be processed by an engine that supports metadata-bound libraries.

SECUREDLIBRARY='*secured-library-name*'
names the secured library object in the SAS Metadata Server.

Alias SECLIB=

Restriction The total length of the secured library object pathname including the fully qualified secured folder path cannot exceed 256 characters.

SECUREDFOLDER='*secured-folder-path*'
name of the metadata folder within a **`/System/Secured Libraries`** folder tree where the secured library is repaired or re-created.

Alias SECFLDR=

Restriction The total length of the secured library object pathname including the fully qualified secured folder path cannot exceed 256 characters.

TABLESONLY=YES | NO

specifies whether the REPAIR statement action is applied at the library level or just to the tables. If TABLESONLY=NO, then the action is applied to the library and the tables. If TABLESONLY=YES, then the action is applied only to the tables. This is especially important for REPAIR because it gives the administrator a way to delete specific secured table objects without deleting the secured library and all secured tables.

Default NO

Details

The REPAIR statement feature that has been fully tested is REPAIR DELETE LOCATION. Use this combination of options when you need to delete the security information in a metadata-bound library and or data sets within the library without deleting the metadata objects.

It is possible for a system administrator to get in situations where a data set still has location information pointing to a secured table object that no longer exists. REPAIR DELETE LOCATION is required to remove that location information before the data set can be accessed in any other way.

When using the REPAIR statement, one of the ADD, UPDATE, or DELETE actions must be specified. LOCATION, METADATA, or both are used to clarify if the action is to apply to the metadata security information in the file system, to the metadata objects in the SAS Metadata Server, or to both. Other than DELETE LOCATION, these other actions have not been fully tested and are considered pre-production implementations. They are documented here but should be used only under advise and direction from Technical Support.

One or more TABLES statements can follow the REPAIR statement to perform the same action on the specified data sets. An implicit TABLES _ALL_ is used if no TABLES statement follows the REPAIR statement.

Inconsistencies between the metadata security information stored in the operating system files and the secured library object in the SAS Metadata Server that need repair can prevent the assignment of a LIBNAME statement to the physical library. The administrator that owns the physical library and knows the metadata-bound library passwords can perform a library assignment and repair the data by adding the AUTHADMIN=YES option to the LIBNAME statement. Best practice is to use the AUTHADMIN=YES option when performing any REPAIR actions.

CAUTION

Repairing a metadata-bound library is an advanced task. Make sure you have a current backup (of both metadata and physical data) before you use this statement.

Use the REPAIR statement to restore metadata-bound library security information or metadata objects that are inadvertently deleted. The administrator can carefully use the REPAIR statement to make some repairs to inconsistencies reported by the REPORT statement. If there are a significant number of groupings in the REPORT listing, then it might be more advisable to do the following:

1. Create a new operating system directory and metadata-bound library, and then use SAS Management Console to set appropriate default library permissions for the new secured library object.
2. Access the current library with the AUTHADMIN=YES, AUTHPW= or AUTHALTER=, AUTHWRITE=, and AUTHREAD= options in the LIBNAME statement.
3. Use the SAS COPY procedure to copy the SAS data sets to the new library. Use CONSTRAINT=YES if any data sets have referential integrity constraints. Use SAS Management Console to set any permissions on the secured table objects that differ from those inherited from the secured library object. The following is an example of using the COPY procedure.

Metadata-bound library ABCDE also has data sets Employees, EmpInfo, and Product. The REPORT statement has shown some inconsistencies between the physical library contents and the corresponding metadata objects. This is an example of a way to resolve these differences.

```
libname klmno "SAS-library-2";

proc authlib lib=klmno;
 create securedfolder="Department XYZZY"
        securedlibrary="KLMNOEmps"
        pw=password;
run;
quit;

libname abcde "SAS-library"
   AUTHADMIN=yes
   AUTHPW=password;

proc copy in=abcde out=klmno ;run;
```

Example Code 8.1 *Using PROC COPY to Resolve Differences*

```
88   proc copy in=abcde out=klmno ;run;

NOTE: Copying ABCDE.EMPINFO to KLMNO.EMPINFO (memtype=DATA).
NOTE: Data set ABCDE.EMPINFO.DATA has secured table object location information, but the
      secured library object location information that it contains:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ABCDEEmps
           SecuredLibraryGUID: 38C24AF4-9CF5-458B-8389-52092307007E
      is different from the registered location for the library ABCDE:
           SecuredFolder:
           SecuredLibrary:
           SecuredLibraryGUID:
      The data set might have been copied to this directory with a host copy utility.
NOTE: Permissions are obtained from the secured table and the secured library objects that are
      referenced in the header of the metadata-bound table.
NOTE: Metadata-bound library permissions are used for KLMNO.EMPINFO.DATA.
NOTE: Successfully added new secured table object "EMPINFO.DATA" to the secured library object
      at path "/System/Secured Libraries/Department XYZZY/KLMNOEmps" for data set
      KLMNO.EMPINFO.DATA.
NOTE: There were 5 observations read from the data set ABCDE.EMPINFO.
NOTE: The data set KLMNO.EMPINFO has 5 observations and 6 variables.
NOTE: Copying ABCDE.EMPLOYEES to KLMNO.EMPLOYEES (memtype=DATA).
NOTE: Data set ABCDE.EMPLOYEES.DATA has secured table object location information, but the
      secured library object location information that it contains:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ABCDEEmps
           SecuredLibraryGUID: 38C24AF4-9CF5-458B-8389-52092307007E
      is different from the registered location for the library ABCDE:
           SecuredFolder:
           SecuredLibrary:
           SecuredLibraryGUID:
      The data set might have been copied to this directory with a host copy utility.
NOTE: Permissions are obtained from the secured table and the secured library objects that are
      referenced in the header of the metadata-bound table.
NOTE: Metadata-bound library permissions are used for KLMNO.EMPLOYEES.DATA.
NOTE: Successfully added new secured table object "EMPLOYEES.DATA" to the secured library
      object at path "/System/Secured Libraries/Department XYZZY/KLMNOEmps" for data set
      KLMNO.EMPLOYEES.DATA.
```

```
NOTE: There were 5 observations read from the data set ABCDE.EMPLOYEES.
NOTE: The data set KLMNO.EMPLOYEES has 5 observations and 6 variables.
NOTE: Copying ABCDE.PRODUCT to KLMNO.PRODUCT (memtype=DATA).
NOTE: Data set ABCDE.PRODUCT.DATA has secured table object location information, but the
      secured library object location information that it contains:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ABCDEEmps
           SecuredLibraryGUID: 38C24AF4-9CF5-458B-8389-52092307007E
      is different from the registered location for the library ABCDE:
           SecuredFolder:
           SecuredLibrary:
           SecuredLibraryGUID:
      The data set might have been copied to this directory with a host copy utility.
NOTE: Permissions are obtained from the secured table and the secured library objects that are
      referenced in the header of the metadata-bound table.
NOTE: Metadata-bound library permissions are used for KLMNO.PRODUCT.DATA.
NOTE: Successfully added new secured table object "PRODUCT.DATA" to the secured library object
      at path "/System/Secured Libraries/Department XYZZY/KLMNOEmps" for data set
      KLMNO.PRODUCT.DATA.
NOTE: There were 5 observations read from the data set ABCDE.PRODUCT.
NOTE: The data set KLMNO.PRODUCT has 5 observations and 2 variables.
NOTE: PROCEDURE COPY used (Total process time):
      real time           0.14 seconds
      cpu time            0.04 seconds
```

The following REPAIR statement combination of options are *preproduction* and have not been fully tested. Preproduction means that this feature is a preliminary release of software that has not completed full development and testing. Because it has not been fully tested, preproduction software should be used with care. After final testing is completed, preproduction software is likely to be offered in a future release as a production-quality component or product.

REPAIR ADD LOCATION
: Use this combination of options when metadata-bound library and secured table security information is missing in the metadata-bound library or data sets within the metadata-bound library. The secured library and secured tables objects must exist in the SAS Metadata Server.

REPAIR UPDATE LOCATION
: Use this combination of options when metadata-bound library and secured table security information exists in the metadata-bound library or data sets within the metadata-bound library but points to incorrect or non-existent metadata objects. The secured library and secured tables objects to which you update the location information must exist in the SAS Metadata Server.

REPAIR ADD METADATA LOCATION
: Use this combination of options when secured library and secured table objects have been deleted from the SAS Metadata Server and their security information is no longer registered in the metadata-bound library and data sets within the metadata-bound library. The metadata objects are created in the SAS Metadata Server, and the security information for these objects are registered in the metadata-bound library and data sets.

REPAIR DELETE METADATA
: Use this combination of options when you need to delete the secured library, the secured table metadata objects, or both without deleting the security information in a metadata-bound library or in the data sets within that library.

REPAIR DELETE METADATA LOCATION
: Use this combination of options when you need to delete the secured library, the secured table metadata objects, or both and the security information in a metadata-bound library or in the data sets within that library.

REPAIR UPDATE LOCATION
: Use this combination of options when you need to update the security information in a metadata-bound library, in the data sets, or both to point to different existing secured library and secured table metadata objects.

Note: The METADATA option is not supported with a REPAIR UPDATE action.

REPORT Statement

For a specified metadata-bound library, compares physical library contents with corresponding metadata objects (in order to identify any inconsistencies).

Requirement: The AUTHLIB REPORT statement requires a connection to the target metadata server. For more requirements, see "Requirements for Using the REPORT Statement" on page 160.

Tip: Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

Example: "Example 8: Using the REPORT Statement" on page 181

Syntax

REPORT

<LIBRARY=*libref*>
<ENCRYPTKEY=*key-value*>;

Optional Arguments

LIBRARY=*libref*
name of the physical library on which to report binding information.

If the LIBRARY= option is not specified, then the physical library from the PROC AUTHLIB statement is used.

Alias: LIB=, DDNAME=, DD=

Restriction: The physical library specified cannot be a concatenated library, temporary library, or accessed through a SAS/SHARE server and must be processed by an engine that supports metadata-bound libraries.

ENCRYPTKEY=*key-value*
specifies a key value for an AES encryption.

Tip: The ENCRYPTKEY= value is a passphrase that can be up to 64 characters long from which the actual AES encryption key is later derived, but it is referred to as the encryption key in most SAS documentation.

See: "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*

Details

Requirements for Using the REPORT Statement

An administrator uses the REPORT statement to identify any inconsistencies between a physical metadata-bound library and its corresponding metadata objects.

In order to use the REPORT statement, you must meet the following criteria:

- The SAS session runs under an account that has host-layer Read access to the target physical library. This is necessary in order to assign the libref.
- The SAS session connects to the metadata server as an identity that has the ReadMetadata permission for the target secured library object and secured table objects.
- If the library has secured library object location information and the secured library object cannot be obtained, then you will need to use the AUTHADMIN=YES option in the LIBNAME= statement in order to assign the library.

Reporting Inconsistencies

The REPORT statement is used to report any inconsistencies between the physical library contents and the corresponding metadata objects.

Inconsistencies between the metadata security information in the physical directory, data sets, the secured library, and secured table objects might occur if the metadata or the operating system files are manipulated using nonstandard SAS processing. For example, an operating system data set copied from one directory into a metadata-bound library directory using an operating system copy utility will not have the appropriate security information for that metadata-bound library. Another example is that an administrator might mistakenly delete a secured library or secured table object using SAS Management Console.

The REPORT statement reports the secured table and metadata-bound library security information for each data set in the operating system directory of the library. This data set information is grouped by the metadata-bound library attributes that all the data sets share. If any data sets in the physical library are correctly registered to the secured library object for the library and have the required passwords, then those data sets and attributes will be listed as the first grouping in the report. Subsequent groupings are for data sets with either passwords that differ from the metadata-bound library passwords or whose metadata-bound library security information does not match the metadata-bound library location registered for the operating system directory.

TABLES Statement

Used after a CREATE, MODIFY, REMOVE, REPAIR, and REPORT statement to specify the tables to process a statement action. Also, you can specify the current passwords or encryption key value of the data sets in the TABLES statement, if different from the metadata-bound library passwords or recorded encryption key.

Default: When no TABLES statement is specified, the TABLES _ALL_ statement is the default behavior.

Requirement: The TABLES statement must be preceded by a CREATE, MODIFY, REMOVE, REPAIR, REPORT, or another TABLES statement.

Tip: Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

Example: "Example 9: Using the TABLES Statement" on page 183

Syntax

TABLES *SAS-dataset(s)* | _ALL_ | _NONE_

</>
<PW=*all-password* > </ *<new-all-password>*> |
<ALTER=*alter-password*> </ *<new-alter-password>*>
<READ=*read-password*> </ *<new-read-password>*>
<WRITE=*write-password*> </ *<new-write-password>*>;
<MEMTYPE= DATA | VIEW>
<ENCRYPT=YES | NO | AES | AES2>
<ENCRYPTKEY=*key-value*< / *new-key-value*>>;

Required Argument

***SAS-dataset(s)* | _ALL_ | _NONE_**

SAS-dataset(s)	name of one or more SAS data sets.
ALL	specifies password options to apply to all data sets.
NONE	limits the action of the previous CREATE, MODIFY, or REPAIR statements to the library level and does not apply the action to any table.

Optional Arguments

/

is required if any options are included, such as passwords or MEMTYPE=. Here is an example:

```
tables table-name / pw=password;
```

ENCRYPT=YES | NO | AES | AES2

specifies the encryption type.

YES	specifies the SAS Proprietary algorithm.
NO	specifies no encryption.
AES | AES2	specifies Advanced Encryption Standard (AES) encryption and is required if changing and encrypting with a new key value and TABLESONLY=YES in the action statement.

See "Encrypted Data Set Considerations" on page 129

ENCRYPTKEY=*key-value* </ *key-value*>

specifies a key value for AES encryption.

Requirement ENCRYPTKEY= data set option is required if the data file has AES encryption and the key is not recorded for the library.

Tip The ENCRYPTKEY= value is a passphrase that can be up to 64 characters long from which the actual AES or AES2 encryption key is later derived, but it is referred to as the encryption key in most SAS documentation.

See "Encrypted Data Set Considerations" on page 129

"ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*

MEMTYPE= DATA | VIEW
restricts processing to a single member type of DATA or VIEW. If not specified, then the default is both types.

DATA specifies SAS data file member type.

VIEW specifies SAS view member type.

Aliases MTYPE=

MT=

Default ALL

PW=*all-password* </ *<new-all-password>*>
specifies the current password of the data set.

ALTER=*alter-password* </ *<new-alter-password>*>
specifies the current ALTER= password of the data set.

READ=*read-password* </ *<new-read-password>*>
specifies the current READ= password of the data set.

WRITE=*write-password* </ *<new-write-password>*>
specifies the current WRITE= password of the data set.

> **TIP** All password values must be valid SAS names with a maximum length of 8 characters.

Details

Using the TABLES Statement

The TABLES statement is primarily used to specify the current password(s) and encryption key(s) on data sets when different from the current metadata-bound library required password(s) or encryption key(s). A TABLES statement usually follows a CREATE or MODIFY statement to make the data set passwords and encryption keys change to the metadata-bound library passwords and encryption keys. For an example, see "Example 4: Binding a Library When Existing Data Sets Are Protected with Different Passwords" on page 173.

TABLES _NONE_ can be used to limit the action of the previous CREATE, MODIFY, or REPAIR statements to the library level and not apply the action to any table. TABLES _ALL_ is the default behavior if no TABLES statement is specified. You might wish to write an explicit TABLES _ALL_ if you want to specify passwords or encryption key values to use when opening all data sets.

Using the TABLES Statement with the CREATE Statement

The CREATE statement can be followed by one or more TABLES statements to specify current passwords or encryption key values for data sets when different from the metadata-bound library passwords and encryption keys. If the TABLES statement is not used, then only two groups of data sets are bound:

- data sets without passwords or encryption keys
- data sets with passwords or encryption key values matching the metadata-bound library

In effect, omitting TABLES statements is equivalent to specifying one TABLES _ALL_ statement. For more information, see "CREATE Statement" on page 140.

Using the TABLES Statement with the MODIFY Statement

The MODIFY statement can be followed by one or more TABLES statements to specify modifications to passwords or an encryption key value in the data sets. If no TABLES statement follows the MODIFY statement, then there is an implicit TABLES _ALL_ statement. A separate TABLES statement is required for sets of data sets (tables) that might have different current passwords or encryption keys. For more information, see "MODIFY Statement" on page 144.

Using the TABLES Statement with the REPAIR Statement

When using the REPAIR statement, one of the ADD, UPDATE, or DELETE actions must be specified. LOCATION, METADATA, or both are used to clarify if the action is to apply to the physical security information in file system, to the metadata objects in the SAS Metadata Server, or to both. The REPAIR statement can be followed by one or more TABLES statements to perform the same action on the specified data sets. However, you cannot specify a new password or encryption key value in a TABLES statement that follows a REPAIR statement. For more information, see "REPAIR Statement" on page 153.

Using the TABLES Statement with the REMOVE Statement

You can use a TABLES statement with TABLESONLY=YES in the REMOVE statement to only remove the location information and secured table objects for specific tables in the metadata-bound library. If you do not use TABLESONLY=YES with a TABLES statement, then the secured library object and all secured table objects are deleted by the REMOVE statement.

When you use the TABLES statement after the REMOVE statement, an ENCRYPT=NO option removes the encryption on the data set as the table is being removed. For more information, see "Encrypted Data Set Considerations" on page 129. This process is necessary only if the administrator is trying to remove the passwords or encryption of a data set.

If you are removing the binding of the physical library to metadata or the physical library is not bound to a secured library, then you might want to modify the data set passwords or encryption to some other value. You are not restricted to changing to a common metadata-bound library password or encryption. You might choose to specify both a current and new password or current and new encryption key separated by a slash (/) in the REMOVE statement. If you want the different data sets to have unique passwords or encryption, then use the following two steps:

1 Change the PW= option for the data sets using a REMOVE statement with TABLESONLY=YES and an individual TABLES statement for each unique password and encryption.

2 Remove the metadata-bound library using a REMOVE statement **without** TABLESONLY=YES.

Using the TABLES Statement with the REPORT Statement

The TABLES statement is syntactically accepted with the REPORT statement but has little use. Specifying TABLES limits the report to the tables listed if used. For more information, see "REPORT Statement" on page 159.

Usage: AUTHLIB Procedure

Requirements for Using the AUTHLIB Statements

Except for the REPORT statement, all statements within the AUTHLIB procedure require that you must meet the following criteria:

- The SAS session runs under an account that has host-layer control of the target physical library. To ensure that only users who have host control can bind a physical library to metadata, the SAS session must run under a privileged host account as follows:
  - On UNIX, the account must be the owner of the directory.
  - On Windows, the account must have full control of the directory.
  - On z/OS, for UNIX file system libraries, the account must be the owner of the directory.
  - On z/OS, for direct-access bound libraries, the account must have RACF ALTER access authority to the library data set.
- The SAS session connects to the SAS Metadata Server as an identity that has ReadMetadata and WriteMemberMetadata permissions to the target secured data folder.

- You must supply the password(s) in CREATE, MODIFY, REPAIR, and REMOVE statements.

The REPORT statement requirements are less restrictive and are documented with that statement.

Copy-In-Place Operation

In the SAS 9.4 release, the copy-in-place operation is used to re-encrypt data sets.

Prior to SAS 9.4M2, metadata-bound data sets in different representations other than the host environment executing the AUTHLIB code fails in CREATE, MODIFY, REPAIR, and REMOVE actions. In SAS 9.4M2, the copy-in-place operation is used to bind or alter bindings of most metadata-bound data files and view files that are accessed through CEDA (Cross-Environment Data Access). However, metadata-bound data sets accessed through CEDA that contain indexes, extended attributes, and integrity constraints are detected and the copy-in-place operation is not attempted as it would still fail.

The following steps are performed in the copy-in-place operation:

1. The data set is renamed to _TEMP_ENCRYPT_FILE_NAME_.
2. The data set is copied back to the original data set name, which re-encrypts the data in the process.
3. The _TEMP_ENCRYPT_FILE_NAME_ file is deleted.

See the following SAS log examples of the copy-in-place operation:

- “Example 12: Binding a Library with an Optional Recorded Encryption Key When Existing AES-Encrypted Data Sets Have Different Encryption Keys ” on page 189
- “Example 16: Changing a Metadata-Bound Library to Require AES Encryption When Existing Data Sets Are Encrypted with Different Encryption Keys” on page 202

Results: AUTHLIB Procedure

Results: AUTHLIB Procedure

The REPORT statement produces the following output.

Output 8.1 *Using the REPORT Statement*

The OS library is properly registered to this SecuredLibrary. These data sets are properly registered to SecuredTables in it.
SecuredLibrary Path: /System/Secured Libraries/Department XYZZY/ABCDEEmps
SecuredLibrary Guid: F25E6004-EF15-4792-B0BD-9A8499435A07
Registered in OS Path: C:\lib1
Password Set: 0

MemberName	MemberType	SecuredTableName	SecuredTableGUID
PRODUCT	DATA	PRODUCT.DATA	5057208E-7EB0-4090-BD6D-57EA856DEA8B

The OS library is properly registered to this SecuredLibrary. These data sets have no registered SecuredTable location information.
SecuredLibrary Path: /System/Secured Libraries/Department XYZZY/ABCDEEmps
SecuredLibrary Guid: F25E6004-EF15-4792-B0BD-9A8499435A07
Registered in OS Path: C:\lib1
Password Set: 1

MemberName	MemberType	SecuredTableName	SecuredTableGUID
EMPINFO	DATA		
EMPLOYEES	DATA		

Examples: AUTHLIB Procedure

Example 1: Binding a Physical Library That Contains Unprotected Data Sets

Features: PROC AUTHLIB statement options
CREATE statement options:
PW=
SECUREDLIBRARY=
SECUREDFOLDER=

Details

This example demonstrates binding a physical library that contains data sets that do not have passwords or AES encryption.

Program

```
proc authlib lib=zyxwvut;

    create securedfolder="Department XYZZY"
        securedlibrary="ZYXWVUTEmps"
        pw=secretpw;
run;
quit;
```

Program Description

Library ZYXWVUT contains three data sets that do not have passwords: Employees, EmpInfo, Product.

```
proc authlib lib=zyxwvut;
```

Using the CREATE statement, enter the name of the metadata folder and name the secured library object in the SAS Metadata Server. Specify metadata-bound library passwords with the PW= option.

```
    create securedfolder="Department XYZZY"
        securedlibrary="ZYXWVUTEmps"
        pw=secretpw;
run;
quit;
```

Results: The library and data sets are bound with the password *secretpw*. The binding is straightforward, as PROC AUTHLIB has unhindered access to the data.

Log Examples

Example Code 8.2 *Unprotected Data Sets*

```
79   proc authlib lib=zyxwvut;
80
81    create securedfolder="Department XYZZY"
82           securedlibrary="ZYXWVUTEmps"
83           pw=XXXXXXXX;
84
85   run;

NOTE: Successfully created a secured library object for the physical library ZYXWVUT and recorded its
      location as:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ZYXWVUTEmps
           SecuredLibraryGUID: 1A323C03-A3D8-4A83-9615-2BC2CB9FAAE2
NOTE: Successfully added new secured table object "EMPINFO.DATA" to the secured library object at
      path "/System/Secured Libraries/Department XYZZY/ZYXWVUTEmps" for data set ZYXWVUT.EMPINFO.DATA.
NOTE: The passwords on ZYXWVUT.EMPINFO.DATA were successfully modified.
NOTE: Successfully added new secured table object "EMPLOYEES.DATA" to the secured library object at
      path "/System/Secured Libraries/Department XYZZY/ZYXWVUTEmps" for data set
      ZYXWVUT.EMPLOYEES.DATA.
NOTE: The passwords on ZYXWVUT.EMPLOYEES.DATA were successfully modified.
NOTE: Successfully added new secured table object "PRODUCT.DATA" to the secured library object at
      path "/System/Secured Libraries/Department XYZZY/ZYXWVUTEmps" for data set ZYXWVUT.PRODUCT.DATA.
NOTE: The passwords on ZYXWVUT.PRODUCT.DATA were successfully modified.
86   quit;
```

Example 2: Binding a Physical Library That Contains Password-Protected Data Sets

Features: PROC AUTHLIB statement options
CREATE statement options:
PW=
SECUREDLIBRARY=
SECUREDFOLDER=

Details

This example demonstrates what happens if you use a similar CREATE statement as Example 1 when the physical library contains two data sets that have the same READ=, WRITE=, and ALTER= passwords and one data set that does not have any passwords. None of the data sets are AES-encrypted.

Program

```
proc authlib lib=abcde;

    create securedfolder="Department XYZZY"
        securedlibrary="ABCDEEmps"
        pw=secretpw;
run;
quit;
```

Program Description

Library ABCDE has Employees, EmpInfo, and Product data sets. However, in library ABCDE, the Employees and EmpInfo data sets are protected with a READ= password `abcd`, WRITE= password `efgh`, and an ALTER= password `ijkl` before the library is secured by the statements. The third data set, Product, is not protected with passwords.

```
proc authlib lib=abcde;
```

Using the CREATE statement, enter the name of the metadata folder and name the secured library object in the SAS Metadata Server. Specify metadata-bound library passwords with the PW= option.

```
    create securedfolder="Department XYZZY"
        securedlibrary="ABCDEEmps"
        pw=secretpw;
run;
quit;
```

Results: The ABCDE library is bound and the unprotected Product data set is bound and the password was set. The protected data sets are not bound and their passwords did not change because their current passwords were not specified.

Log Examples

Example Code 8.3 *Password-Protected Data Sets*

```
179  proc authlib lib=abcde;
180
181   create securedfolder="Department XYZZY"
182          securedlibrary="ABCDEEmps"
183          pw=XXXXXXXX;
184
185  run;

NOTE: Successfully created a secured library object for the physical library ABCDE and recorded its
      location as:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ABCDEEmps
           SecuredLibraryGUID: 4881263D-C346-41F7-AC49-BF9181AF13D2
ERROR: The ALTER password is the most restrictive on ABCDE.EMPINFO.DATA. You must supply its value in
       order to alter or add any passwords.
ERROR: The ALTER password is the most restrictive on ABCDE.EMPLOYEES.DATA. You must supply its value
       in order to alter or add any passwords.
NOTE: Successfully added new secured table object "PRODUCT.DATA" to the secured library object at
      path "/System/Secured Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.PRODUCT.DATA.
NOTE: The passwords on ABCDE.PRODUCT.DATA were successfully modified.
NOTE: Some statement actions not processed because of errors noted above.
186  quit;

NOTE: The SAS System stopped processing this step because of errors.
```

Example 3: Binding a Library When Existing Data Sets Are Protected with the Same Passwords

Features:

PROC AUTHLIB statement options
- CREATE statement options:
- PW=
- SECUREDLIBRARY=
- SECUREDFOLDER=

Details

This example demonstrates how to specify the passwords for the Employees and EmpInfo data sets from the preceding example in the PROC AUTHLIB CREATE statement. None of the data sets are AES-encrypted.

Program

```
proc authlib lib=abcde;

    create securedlibrary="ABCDEEmps"
        securedfolder="Department XYZZY"
        pw=ijkl/secretpw;
run;
quit;
```

Program Description

Library ABCDE also has Employees, EmpInfo, and Product data sets. However, in library ABCDE, the Employees and EmpInfo data sets are protected with a READ= password `abcd`, WRITE= password `efgh`, and ALTER= password `ijkl` before the library is secured by the statements. The third data set, Product, is not protected with any passwords.

```
proc authlib lib=abcde;
```

Using the CREATE statement, enter the name of the metadata folder and name the secured library object in the SAS Metadata Server. Specify the ALTER= password `ijkl` for the data sets in the PW= argument before the new password *secretpw*, separated by a slash (/).

```
    create securedlibrary="ABCDEEmps"
        securedfolder="Department XYZZY"
        pw=ijkl/secretpw;
run;
quit;
```

Results: The library ABCDE is bound. All three data sets are bound with the same password *secretpw*.

Log Examples

Example Code 8.4 *Securing a Library with Data Sets That Are Protected with the Same Passwords*

```
39   proc authlib lib=abcde;
40   create securedlibrary="ABCDEEmps"
41   securedfolder="Department XYZZY"
42   pw=XXXX/XXXXXXXX;
43   run;

NOTE: Successfully created a secured library object for the physical library ABCDE and recorded its
location as:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ABCDEEmps
           SecuredLibraryGUID: 9F746F86-2336-4E2F-A67E-BFB77DEC27F0
NOTE: Successfully added new secured table object "DEPTNAME.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.DEPTNAME.DATA.
NOTE: The passwords on ABCDE.DEPTNAME.DATA were successfully modified.
NOTE: Successfully added new secured table object "EMPINFO.DATA" to the secured library object at path
"/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.EMPINFO.DATA.
NOTE: The passwords on ABCDE.EMPINFO.DATA were successfully modified.
NOTE: Successfully added new secured table object "EMPLOYEE.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.EMPLOYEE.DATA.
NOTE: The passwords on ABCDE.EMPLOYEE.DATA were successfully modified.
44   quit;
```

Example 4: Binding a Library When Existing Data Sets Are Protected with Different Passwords

Features:

PROC AUTHLIB statement options
- CREATE statement options:
- ALTER=
- READ=
- SECUREDLIBRARY=
- SECUREDFOLDER=
- WRITE=
- TABLE statement options:
- ALTER=
- PW=
- READ=
- WRITE=

Details

This example demonstrates how to bind the library KLMNO, which contains three data sets with different passwords. None of the data sets are AES-encrypted. It also demonstrates creating a longer metadata-bound library password by specifying the READ=, WRITE=, and ALTER= password options.

Program

```
proc authlib lib=klmno;

    create securedlibrary="KLMNOEmps"
        securedfolder="Department XYZZY"
        read=abcdefgh
        write=ijklmno
        alter=pqrstuvw;

    tables employees /
        pw=lmno;
    tables empinfo /
        read=abcd
        write=efgh
        alter=ijkl;
    tables product;
run;
quit;
```

Program Description

Library KLMNO has Employees, EmpInfo, and Product data sets. The Employees data set is protected with the PW= password `lmno`. The EmpInfo data set is protected with a READ= password `abcd`, a WRITE= password `efgh`, and an ALTER= password `ijkl`. The Product data set is not protected.

```
proc authlib lib=klmno;
```

Using the CREATE statement, enter the name of the metadata folder and name the secured library object in the SAS Metadata Server. Specify the values for READ= password `abcdefgh`, WRITE= password `ijklmno`, and ALTER= password `pqrstuvw` to create a longer metadata-bound library password.

```
    create securedlibrary="KLMNOEmps"
        securedfolder="Department XYZZY"
        read=abcdefgh
        write=ijklmno
        alter=pqrstuvw;
```

Use the TABLES statement to specify the current password for each data set. When using TABLES statements, a TABLES statement must be specified for all data sets.

```
      tables employees /
          pw=lmno;
      tables empinfo /
          read=abcd
          write=efgh
          alter=ijkl;
      tables product;
run;
quit;
```

Results: The library KLMNO is bound, and all three data sets are bound with the same passwords. The passwords are READ= password `abcdefgh`, WRITE= password `ijklmno`, and ALTER= password `pqrstuvw`.

Log Examples

Example Code 8.5 *Securing a Library with Existing Data Sets That Are Protected with Different Passwords*

```
177  libname klmno "c:\lib2";
NOTE: Libref KLMNO was successfully assigned as follows:
      Engine:        V9
      Physical Name: c:\lib2
178
179  proc authlib lib=klmno;
180  create securedlibrary="KLMNOEmps"
181  securedfolder="Department XYZZY"
182  read=XXXXXXXX
183  write=XXXXXXX
184  alter=XXXXXXXX;
185  tables employees /
186  pw=XXXX;
187  tables empinfo /
188  read=XXXX
189  write=XXXX
190  alter=XXXX;
191  tables product;
192  run;

NOTE: Successfully created a secured library object for the physical library KLMNO and recorded its
location as:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     KLMNOEmps
           SecuredLibraryGUID: BC74E81F-E86B-402E-8C16-F9A94A078F81
NOTE: Successfully added new secured table object "EMPLOYEES.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/KLMNOEmps" for data set KLMNO.EMPLOYEES.DATA.
NOTE: The passwords on KLMNO.EMPLOYEES.DATA were successfully modified.
NOTE: Successfully added new secured table object "EMPINFO.DATA" to the secured library object at path
"/System/Secured
      Libraries/Department XYZZY/KLMNOEmps" for data set KLMNO.EMPINFO.DATA.
NOTE: The passwords on KLMNO.EMPINFO.DATA were successfully modified.
NOTE: Successfully added new secured table object "PRODUCT.DATA" to the secured library object at path
"/System/Secured
      Libraries/Department XYZZY/KLMNOEmps" for data set KLMNO.PRODUCT.DATA.
NOTE: The passwords on KLMNO.PRODUCT.DATA were successfully modified.
193  quit;
```

Example 5: Changing Passwords on Data Sets

Features:

PROC AUTHLIB statement options
- MODIFY statement options:
- PW=
- TABLESONLY=
- TABLES statement options:
- PW=

Details

This example shows a different approach for modifying the passwords of existing data sets to match the metadata-bound library passwords. It uses the MODIFY statement. Here, the MODIFY statement is used to modify the data set passwords of the Employees and EmpInfo data sets from Example 2 on page 169 to match the metadata-bound library password. Neither of these data sets are AES-encrypted.

The MODIFY statement can also be used to modify the data set passwords of data sets that are copied into a metadata-bound library by operating system commands after the library has been bound.

Program

```
proc authlib lib=abcde;

    modify tablesonly=yes
        pw=secretpw;

    tables _all_ /
        pw=ijkl/secretpw;
run;
quit;
```

Program Description

Library ABCDE has Employees, EmpInfo, and Product data sets. The library is bound with metadata-bound library password *secretpw*. However, in library ABCDE, the Employees and EmpInfo data sets are not bound to the library and are protected with an ALTER= password `ijkl`. The third data set, Product, is already bound.

```
proc authlib lib=abcde;
```

The MODIFY statement is used to modify the data set passwords of the Employees and EmpInfo data sets to match the metadata-bound library password. The TABLESONLY= statement specifies to modify table passwords only.

```
    modify tablesonly=yes
        pw=secretpw;
```

A TABLES statement must be specified. The existing data sets' ALTER password is specified in the PW= argument before the metadata-bound password, separated by a slash (/) in the TABLES statement.

```
    tables _all_ /
        pw=ijkl/secretpw;
run;
```

```
quit;
```

Results: All three data sets are now bound with the *secretpw* password.

Log Examples

Example Code 8.6 *Changing Data Set Passwords*

```
76   proc authlib lib=abcde;
77   modify tablesonly=yes
78   pw=XXXXXXXX;
79   tables _all_ /
80   pw=XXXX/XXXXXXXX;
81   run;

NOTE: The passwords on ABCDE.DEPTNAME.DATA do not require modification.
NOTE: The passwords on ABCDE.EMPINFO.DATA do not require modification.
NOTE: The passwords on ABCDE.EMPLOYEE.DATA do not require modification.
82   quit;
```

Example 6: Changing Metadata-Bound Library Passwords

Features:

PROC AUTHLIB statement options
MODIFY statement options:
PW=
SECUREDLIBRARY=
SECUREDFOLDER=

Details

This example demonstrates how to use the MODIFY statement to change the library passwords if you believe that the metadata-bound library passwords have been compromised. The following code changes the library passwords and the data set passwords of all data sets in the library that use the specified passwords or do not have a password. In this example, no data sets are AES-encrypted. See later examples if your library has AES-encrypted data.

Program

```
proc authlib lib=abcde;
```

```
    modify securedlibrary="ABCDEEmps"
        securedfolder="Department XYZZY"
        pw=secretpw/new-password;
run;
quit;
```

Program Description

Library ABCDE requires a password change.

```
proc authlib lib=abcde;
```

Use the MODIFY statement to change the library passwords and the data set passwords. Note that the name of the secured library object and the name of the metadata folder are optional, but can be specified to ensure that the library is bound to that secured library object before making the change. This is used when the SAS Management Console submits the code from the Modify action to ensure that the correct operation system library path was specified.

```
    modify securedlibrary="ABCDEEmps"
        securedfolder="Department XYZZY"
        pw=secretpw/new-password;
run;
quit;
```

Results: The library ABCDE remains bound and the library password is modified to the *new-password*. All three data sets remain bound, and their passwords are modified with *new-password*. An error message would be displayed in the SAS log for any data set that had a password other than *secretpw*.

Log Examples

Example Code 8.7 *Changing Metadata-bound Library Passwords*

```
217  proc authlib lib=abcde;
218    modify securedlibrary="ABCDEEmps"
219        securedfolder="Department XYZZY"
220        pw=XXXXXXXX/XXXXXXXX;
221
222  run;

NOTE: The passwords for the secured library object with path "/System/Secured Libraries/Department
      XYZZY/ABCDEEmps" were successfully modified."
NOTE: The passwords on ABCDE.EMPINFO.DATA were successfully modified.
NOTE: The passwords on ABCDE.EMPLOYEES.DATA were successfully modified.
NOTE: The passwords on ABCDE.PRODUCT.DATA were successfully modified.
223  quit;
```

Example 7: Using the REMOVE Statement

Features: PROC AUTHLIB statement options
REMOVE statement options:
PW=

Details

This example demonstrates how to unbind a metadata-bound library. The code does the following:

- deletes metadata that describes the library and its tables from the SAS Metadata Repository
- removes security bindings from the physical library and data sets
- removes the assigned password from the data sets, leaving them unprotected

The slash (/) after the password is optional and is used to remove or replace the password from the data sets. If a library is bound with READ=, WRITE=, and ALTER= passwords, as in Example 4 on page 173, then you must specify all of the passwords, and they must each have a slash (/). None of the data sets are AES-encrypted.

Program

```
proc authlib lib=abcde;

    remove
        pw=currntpw/;
run;
quit;
```

Program Description

Unbinding the metadata-bound library ABCDE.

```
proc authlib lib=abcde;
```

Use the REMOVE statement to unbind the metadata-bound library. The slash (/) after the password is used to remove the password from the data sets.

```
    remove
        pw=currntpw/;
```

```
run;
quit;
```

Results: The library ABCDE and all the data sets that are bound to it are no longer bound. All passwords are removed from the unbound data sets making them unprotected.

Log Examples

Example Code 8.8 *Unbinding a Metadata-Bound Library*

```
195  proc authlib lib=abcde;
196  remove
197  pw=XXXXXXXX/;
198  run;

WARNING: Some or all the passwords on ABCDE.DEPTNAME.DATA were removed along with the secured library
object location,
         leaving the data set unprotected.
NOTE: The secured table object location for ABCDE.DEPTNAME.DATA was successfully removed.
WARNING: Some or all the passwords on ABCDE.EMPINFO.DATA were removed along with the secured library
object location, leaving
         the data set unprotected.
NOTE: The secured table object location for ABCDE.EMPINFO.DATA was successfully removed.
WARNING: Some or all the passwords on ABCDE.EMPLOYEE.DATA were removed along with the secured library
object location,
         leaving the data set unprotected.
NOTE: The secured table object location for ABCDE.EMPLOYEE.DATA was successfully removed.
NOTE: Successfully deleted the secured library object that was located at:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ABCDEEmps
           SecuredLibraryGUID: 9F746F86-2336-4E2F-A67E-BFB77DEC27F0
NOTE: Successfully deleted the recorded location of the secured library object for the physical
library ABCDE.
199  quit;
```

Example 8: Using the REPORT Statement

Features: PROC AUTHLIB statement options
Report statement

Details

This example demonstrates how to check a library's bindings.

Program

```
proc authlib lib=abcde;

    report;
run;
quit;
```

Program Description

Check the bindings of the metadata-bound library ABCDE.

```
proc authlib lib=abcde;
```

Use the REPORT statement.

```
    report;
run;
quit;
```

Results: For the REPORT statement results, see"Output Example" on page 183.

Log Examples

Example Code 8.9 *Creating a Report*

```
49   proc authlib lib=abcde;
50    report;
51   run;

52   quit;
```

Output Example

Output 8.2 *REPORT Statement Results for the ABCDE Library*

The OS library is properly registered to this SecuredLibrary. These data sets are properly registered to SecuredTables in it.
SecuredLibrary Path: /System/Secured Libraries/Department XYZZY/ABCDEEmps
SecuredLibrary Guid: F25E6004-EF15-4792-B0BD-9A8499435A07
Registered in OS Path: C:\lib1
Password Set: 0

MemberName	MemberType	SecuredTableName	SecuredTableGUID
EMPINFO	DATA	EMPINFO.DATA	C8EA8780-83E8-4F32-9912-14F109FA1D50
EMPLOYEES	DATA	EMPLOYEES.DATA	A0F173F6-9D0B-40A0-B38F-C56433CE22E1
PRODUCT	DATA	PRODUCT.DATA	5057208E-7EB0-4090-BD6D-57EA856DEA8B

Example 9: Using the TABLES Statement

Features:

PROC AUTHLIB statement options
CREATE statement options:
ALTER=
READ=
SECUREDLIBRARY=
SECUREDFOLDER=
WRITE=
TABLE statements options:
ALTER=
PW=
READ=
WRITE=

Details

Example 4 on page 173 demonstrates how to use the TABLES statement.

Example 10: Binding a Library When Existing Data Sets Are SAS Proprietary Encrypted

Features: PROC AUTHLIB statement options
CREATE statement options:
PW=
SECUREDLIBRARY=
SECUREDFOLDER=
TABLES statement options:
PW=
READ=

Details

The following example demonstrates how to bind and change passwords on SAS Proprietary encrypted data sets.

Program

```
proc authlib lib=klmno;

    create securedlibrary="KLMNOEmps"
        securedfolder="Department XYZZY"
        pw=pqrstuvw;

    tables employees /
        pw=lmno;
    tables empinfo /
        read=abcd;
    tables product;
run;
quit;
```

Program Description

Library KLMNO has three data sets: Employees, EmpInfo, and Product. In this library, the Employees data set is protected with the PW= password `lmno`. The EmpInfo data set is protected with a READ= password `abcd`. Both Employees and EmpInfo data sets are SAS Proprietary encrypted. The Product data set is not protected.

```
proc authlib lib=klmno;
```

Using the CREATE statement, enter the name of the metadata folder and name the secured library object in the SAS Metadata Server. Set the library password to `pqrstuvw`.

```
      create securedlibrary="KLMNOEmps"
          securedfolder="Department XYZZY"
          pw=pqrstuvw;
```

Because these data sets have different passwords, a TABLES statement must be specified for all data sets in order to change their passwords.

```
      tables employees /
          pw=lmno;
      tables empinfo /
          read=abcd;
      tables product;
run;
quit;
```

Results: The library KLMNO is bound. All three data sets are bound and use the same PW= password `pqrstuvw`. Data sets Employees and EmpInfo are copied-in-place to encrypt with the password `pqrstuvw`. Data set Product is bound, but not encrypted.

Log Examples

Example Code 8.10 *TABLES Statement for the KLMNO Library Containing a SAS Proprietary Data Set*

```
265  proc authlib lib=klmno;
266  create securedlibrary="KLMNOEmps"
267  securedfolder="Department XYZZY"
268  pw=XXXXXXXX;
269  tables employees /
270  pw=XXXX;
271  tables empinfo /
272  read=XXXX;
273  tables product;
274  run;

NOTE: Successfully created a secured library object for the physical library KLMNO and recorded its
location as:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     KLMNOEmps
           SecuredLibraryGUID: E71881CD-8C54-4E21-A8B5-FD7D4FBDAA7D
NOTE: Copying data set KLMNO.EMPLOYEES in place to encrypt with the new secured library passwords or
encryption options.
NOTE: Renaming the data set KLMNO.EMPLOYEES to KLMNO.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set KLMNO.__TEMP_ENCRYPT_FILE_NAME__ to KLMNO.EMPLOYEES.
NOTE: Metadata-bound library permissions are used for KLMNO.EMPLOYEES.DATA.
NOTE: Successfully added new secured table object "EMPLOYEES.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/KLMNOEmps" for data set KLMNO.EMPLOYEES.DATA.
NOTE: There were 5 observations read from the data set KLMNO.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set KLMNO.EMPLOYEES has 5 observations and 6 variables.
NOTE: Deleting the data set KLMNO.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on KLMNO.EMPLOYEES.DATA were successfully modified.
NOTE: Copying data set KLMNO.EMPINFO in place to encrypt with the new secured library passwords or
encryption options.
NOTE: Renaming the data set KLMNO.EMPINFO to KLMNO.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set KLMNO.__TEMP_ENCRYPT_FILE_NAME__ to KLMNO.EMPINFO.
NOTE: Metadata-bound library permissions are used for KLMNO.EMPINFO.DATA.
NOTE: Successfully added new secured table object "EMPINFO.DATA" to the secured library object at path
"/System/Secured
      Libraries/Department XYZZY/KLMNOEmps" for data set KLMNO.EMPINFO.DATA.
NOTE: There were 5 observations read from the data set KLMNO.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set KLMNO.EMPINFO has 5 observations and 6 variables.
NOTE: Deleting the data set KLMNO.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on KLMNO.EMPINFO.DATA were successfully modified.
NOTE: The passwords on KLMNO.PRODUCT.DATA do not require modification.
NOTE: Successfully added new secured table object "PRODUCT.DATA" to the secured library object at path
"/System/Secured
      Libraries/Department XYZZY/KLMNOEmps" for data set KLMNO.PRODUCT.DATA.
275  quit;
```

Example 11: Binding a Library When Existing Data Sets Are AES-Encrypted

Features: PROC AUTHLIB statement options
CREATE statement options:
PW=

SECUREDLIBRARY=
SECUREDFOLDER=
TABLES statement option:
ENCRYPTKEY=

Details

This example demonstrates how to bind data sets that are AES-encrypted. None of the data sets have passwords.

CAUTION
SAS strongly recommends that you not have AES-encrypted data sets with different encryption keys in metadata-bound libraries, like this example creates. Instead, SAS recommends that you record a default encryption key in metadata and convert all AES-encrypted data sets to use that key. Doing this, your users, and programs do not have to specify the key when opening the data sets. The examples following this example show you how to do this process.

Program

```
proc authlib lib=klmno;

    create securedlibrary="KLMNOEmps"
        securedfolder="Department XYZZY"
        pw=pqrstuvw;

    tables employees /
        encryptkey=lmno;
    tables empinfo /
        encryptkey=abcd;
    tables product;
run;
quit;
```

Program Description

Library KLMNO has three data sets: Employees, EmpInfo, and Product. In this library, the Employees data set is AES-encrypted and has the ENCRYPTKEY= value `lmno`. The EmpInfo data set is AES-encrypted and has the ENCRYPTKEY= value `abcd`. The Product data set is not protected.

```
proc authlib lib=klmno;
```

Using the CREATE statement, enter the name of the metadata folder and name the secured library object in the SAS Metadata Server. Set the library password to pqrstuvw.

```
      create securedlibrary="KLMNOEmps"
          securedfolder="Department XYZZY"
          pw=pqrstuvw;
```

Using the TABLES statements, specify the encrypt key for each data set. A TABLES statement must be specified for all data sets.

```
      tables employees /
          encryptkey=lmno;
      tables empinfo /
          encryptkey=abcd;
      tables product;
  run;
  quit;
```

Results: The library KLMNO is bound. All three data sets are bound. The Employees and EmpInfo data sets remain AES-encrypted. The Product data set is not encrypted. The encrypt key values for the Employees and Empinfo data sets are different. SAS strongly recommends that you not have AES-encrypted data sets with different encryption keys in metadata-bound libraries, like this example created.

Log Examples

Example Code 8.11 *TABLES Statement for the KLMNO Library Containing AES-Encrypted Data Sets*

```
351  proc authlib lib=klmno;
352  create securedlibrary="KLMNOEmps"
353  securedfolder="Department XYZZY"
354  pw=XXXXXXXX;
355  tables employees /
356  encryptkey=XXXX;
357  tables empinfo /
358  encryptkey=XXXX;
359  tables product;
360  run;

NOTE: Successfully created a secured library object for the physical library KLMNO and recorded its
location as:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     KLMNOEmps
           SecuredLibraryGUID: 48E2C4C7-ADE1-49D2-BBFE-14E5EAAB8961
NOTE: Successfully added new secured table object "EMPLOYEES.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/KLMNOEmps" for data set KLMNO.EMPLOYEES.DATA.
NOTE: The passwords on KLMNO.EMPLOYEES.DATA were successfully modified.
NOTE: Successfully added new secured table object "EMPINFO.DATA" to the secured library object at path
"/System/Secured
      Libraries/Department XYZZY/KLMNOEmps" for data set KLMNO.EMPINFO.DATA.
NOTE: The passwords on KLMNO.EMPINFO.DATA were successfully modified.
NOTE: Successfully added new secured table object "PRODUCT.DATA" to the secured library object at path
"/System/Secured
      Libraries/Department XYZZY/KLMNOEmps" for data set KLMNO.PRODUCT.DATA.
NOTE: The passwords on KLMNO.PRODUCT.DATA were successfully modified.
361  quit;
```

Example 12: Binding a Library with an Optional Recorded Encryption Key When Existing AES-Encrypted Data Sets Have Different Encryption Keys

Features:

PROC AUTHLIB statement options
- CREATE statement options:
- ENCRYPT=
- ENCRYPTKEY=
- PW=
- SECUREDLIBRARY=
- SECUREDFOLDER=
- TABLES statement options:
- ENCRYPT=
- ENCRYPTKEY=

Details

This example demonstrates how to bind a library with an optional recorded encryption key. None of the data sets have passwords.

Since some SAS code existed that created and references the EmpInfo data set with ENCRYPTKEY=DEF and since the recorded library key is not required, the specification of the ENCRYPTKEY=DEF should be removed from the code. Any code that re-creates the data must keep the ENCRYPT=AES or ENCRYPT=AES2 option so that the optional recorded key is used when the data set is re-created.

Program

```
proc authlib lib=abcde;

    create securedlibrary="ABCDEEmps"
        securedfolder="Department XYZZY"
        pw=secret
        encrypt=aes
        encryptkey=optionalkey;


    tables employee;
    tables empinfo /
        encryptkey=def/optionalkey
        encrypt=aes;
    tables deptname;
run;
quit;
```

Program Description

Library ABCDE has Employees, EmpInfo, and DeptName data sets. In this library, the EmpInfo data set is AES-encrypted and has the ENCRYPTKEY= value `def`.

```
proc authlib lib=abcde;
```

Using the CREATE statement, enter the name of the metadata folder and name the secured library object in the SAS Metadata Server. The optional encrypt key is specified for the metadata-bound library.

```
    create securedlibrary="ABCDEEmps"
        securedfolder="Department XYZZY"
        pw=secret
        encrypt=aes
        encryptkey=optionalkey;
```

A TABLES statement is required for each data set.

```
      tables employee;
      tables empinfo /
          encryptkey=def/optionalkey
          encrypt=aes;
      tables deptname;
run;
quit;
```

Results: The ABCDE library is bound and the optional encrypt key is stored. When the statements are executed, the following happens to the three data sets. The Employee data set is updated with the new metadata-bound library password but is not encrypted. The DeptName data set is updated with the metadata-bound library password but is not encrypted. The EmpInfo data set is copied to re-encrypt with the optional recorded key and gets the new metadata-bound library password. Note that it is necessary to supply both the current and new optional key in the TABLES statement for EmpInfo in the following program. Without the new key specification, the data set would remain encrypted with the `def` key.

Log Examples

Example Code 8.12 *Changing an Encryption Key Value to the Recorded Encryption Key*

```
467  libname abcde "c:\lib1";
NOTE: Libref ABCDE was successfully assigned as follows:
      Engine:        V9
      Physical Name: c:\lib1
468
469  proc authlib lib=abcde;
470  create securedlibrary="ABCDEEmps"
471  securedfolder="Department XYZZY"
472  pw=XXXXXX
473  encrypt=aes
474  encryptkey=XXXXXXXXXXX;
475  tables employee;
476  tables empinfo /
477  encryptkey=XXX/XXXXXXXXXX
478  encrypt=aes;
479  tables deptname;
480  run;

NOTE: Successfully created a secured library object for the physical library ABCDE and recorded its
location as:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ABCDEEmps
           SecuredLibraryGUID: 8E683650-B306-4871-A92D-16D481EC6456
NOTE: Successfully added new secured table object "EMPLOYEE.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.EMPLOYEE.DATA.
NOTE: The passwords on ABCDE.EMPLOYEE.DATA were successfully modified.
NOTE: Copying data set ABCDE.EMPINFO in place to encrypt with the new secured library passwords or
encryption options.
NOTE: Renaming the data set ABCDE.EMPINFO to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPINFO.
NOTE: Metadata-bound library permissions are used for ABCDE.EMPINFO.DATA.
NOTE: Successfully added new secured table object "EMPINFO.DATA" to the secured library object at path
"/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.EMPINFO.DATA.
NOTE: There were 5 observations read from the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPINFO has 5 observations and 6 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on ABCDE.EMPINFO.DATA were successfully modified.
NOTE: Successfully added new secured table object "DEPTNAME.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.DEPTNAME.DATA.
NOTE: The passwords on ABCDE.DEPTNAME.DATA were successfully modified.
480  quit;
```

Example 13: Binding a Library with Required AES Encryption When Existing Data Sets Are Encrypted with the Same Encryption Key

Features: PROC AUTHLIB statement options
CREATE statement options:

ENCRYPT=
ENCRYPTKEY=
PW=
REQUIRE_ENCRYPTION
SECUREDLIBRARY=
SECUREDFOLDER=

Details

This example demonstrates how to bind a library with requiring that all of the data sets in this metadata-bound library have AES encryption and have the same encryption key.

Program

```
proc authlib lib=abcde;

    create  seclib="ABCDEEmps"
        securedfolder="Department XYZZY"
        pw=secret
        require_encryption=yes
        encrypt=aes
        encryptkey=abc ;
run;
quit;
```

Program Description

Library ABCDE has three data sets: Employees, EmpInfo, and DeptName. Data set EmpInfo has encryption key value of `abc`. The other two data sets are not AES-encrypted. None of the data sets have passwords.

```
proc authlib lib=abcde;
```

Using the CREATE statement, enter the name of the metadata folder and name the secured library object in the SAS Metadata Server.
REQUIRE_ENCRYPTION=YES specifies that all data sets in the metadata-bound library are automatically AES-encrypted and use the AES key generation algorithm. Note that with required encryption and an encryption key, the specific key generation algorithm specified with ENCRYPT= is always used. With optional encryption, whichever key generation algorithm is specified in code with ENCRYPT= is used with the recorded key.

```
    create  seclib="ABCDEEmps"
        securedfolder="Department XYZZY"
        pw=secret
```

```
        require_encryption=yes
        encrypt=aes
        encryptkey=abc ;
run;
quit;
```

Results: The library ABCDE is bound, and all of the data sets are bound and AES-encrypted with the same encryption key.

Log Examples

Example Code 8.13 *Library ABCDE Requiring AES Encryption When the Data Sets Are Already Encrypted with the Same Encryption Key*

```
40   proc authlib lib=abcde;
41   create  seclib="ABCDEEmps"
42         securedfolder="Department XYZZY"
43         pw=XXXXXX
44         require_encryption=yes
45         encrypt=aes
46         encryptkey=XXX ;
47   run;

NOTE: Setting library to require encryption.
NOTE: Required encryption will use AES encryption with the recorded key.


NOTE: Successfully created a secured library object for the physical library ABCDE and recorded its
location as:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ABCDEEmps
           SecuredLibraryGUID: 9FD6C5D9-EF00-4CDC-8D0A-348D08BB329E
NOTE: Copying data set ABCDE.DEPTNAME in place to do required encryption with the library's required
encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.DEPTNAME to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.DEPTNAME.
NOTE: Metadata-bound library permissions are used for ABCDE.DEPTNAME.DATA.
NOTE: Successfully added new secured table object "DEPTNAME.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.DEPTNAME.DATA.
NOTE: There were 10 observations read from the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.DEPTNAME has 10 observations and 2 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on ABCDE.DEPTNAME.DATA were successfully modified.
NOTE: Successfully added new secured table object "EMPINFO.DATA" to the secured library object at path
"/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.EMPINFO.DATA.
NOTE: The passwords on ABCDE.EMPINFO.DATA were successfully modified.
NOTE: Copying data set ABCDE.EMPLOYEE in place to do required encryption with the library's required
encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.EMPLOYEE to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPLOYEE.
NOTE: Metadata-bound library permissions are used for ABCDE.EMPLOYEE.DATA.
NOTE: Successfully added new secured table object "EMPLOYEE.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.EMPLOYEE.DATA.
NOTE: There were 22 observations read from the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPLOYEE has 22 observations and 11 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on ABCDE.EMPLOYEE.DATA were successfully modified.
48   quit;
```

Example 14: Changing the Encryption Key on a Metadata-Bound Library That Requires AES Encryption

Features: PROC AUTHLIB statement options
MODIFY statement options:
ENCRYPT=
ENCRYPTKEY=
PW=

Details

This example demonstrates how to use the MODIFY statement to change the stored library encryption key if you believe that the metadata-bound library encryption keys might have been compromised.

Program

```
proc authlib lib=abcde;

    modify
       pw=secret
       encrypt=aes
       encryptkey=/new;

run;
quit;
```

Program Description

Library ABCDE has three data sets: Employees, EmpInfo, and DeptName. In this library, all data sets are AES-encrypted with encryption key value `abc` since AES encryption is required for the metadata bound library.

```
proc authlib lib=abcde;
```

Use the MODIFY statement to change the library encryption key and the data set encryption key. You must specify ENCRYPT=AES or ENCRYPT=AES2. Note that

the key generation algorithm can also be changed here between AES and AES2 simply by changing the value in the ENCRYPT= option.

```
      modify
         pw=secret
         encrypt=aes
         encryptkey=/new;

run;
quit;
```

Results: The library ABCDE remains bound with the same password and a new encryption key. All three data sets remain bound with the same password and a new encryption key. Note that the data sets were copied-in-place to be encrypted with the new key value and the specified encryption key algorithm, AES in this case.

Example Code 8.14 *Changing the Encryption Key ABCDE Library*

```
502  proc authlib lib=abcde;
503  modify
504  pw=XXXXXX
505  encrypt=aes
506  encryptkey=/XXX;
507  run;

NOTE: Changing the required encryption key.


NOTE: The passwords on ABCDE.DEPTNAME.DATA do not require modification.
NOTE: Copying data set ABCDE.DEPTNAME in place to do required encryption with the
library's required encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.DEPTNAME to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.DEPTNAME.
NOTE: There were 4 observations read from the data set
ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.DEPTNAME has 4 observations and 2 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on ABCDE.EMPINFO.DATA do not require modification.
NOTE: Copying data set ABCDE.EMPINFO in place to do required encryption with the
library's required encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.EMPINFO to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPINFO.
NOTE: There were 5 observations read from the data set
ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPINFO has 5 observations and 6 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on ABCDE.EMPLOYEE.DATA do not require modification.
NOTE: Copying data set ABCDE.EMPLOYEE in place to do required encryption with the
library's required encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.EMPLOYEE to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPLOYEE.
NOTE: There were 5 observations read from the data set
ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPLOYEE has 5 observations and 6 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords and/or encryption options for the secured library object with
path "/System/Secured Libraries/Department
      XYZZY/ABCDEEmps" were successfully modified."
NOTE: All data sets in library ABCDE are properly protected with the metadata-bound
library passwords and encryption options.
      Replaced Passwords and encryption keys were purged.
NOTE: Purged 1 versions of the replaced passwords and encryption keys older than
2015-05-04T15:40:57-05:00.
508  quit;
NOTE: Renaming the data set ABCDE.EMPLOYEE to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPLOYEE.
NOTE: There were 22 observations read from the data set
ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPLOYEE has 22 observations and 11 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords and/or encryption options for the secured library object with
path "/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" were successfully modified.
```

Example 15: Binding a Library with Existing Data Sets That Are AES-Encrypted with Different Encryption Keys

Features:

PROC AUTHLIB statement options
CREATE statement options:
ENCRYPT=
ENCRYPTKEY=
PW=
REQUIRE_ENCRYPTION
SECUREDLIBRARY=
SECUREDFOLDER=
TABLES statement option:
ENCRYPTKEY=

Details

This example demonstrates how to change all data sets in the metadata-bound library that contain different encryption keys to have the required AES encryption and have the same encryption key. None of the data sets have passwords.

Program

```
proc authlib lib=abcde;

    create  seclib="ABCDEEmps"
        securedfolder="Department XYZZY"
        pw=secret
        require_encryption=yes
        encrypt=aes
        encryptkey=new ;
    tables employee /
        encryptkey=abc;
    tables empinfo /
        encryptkey=def;
    tables deptname ;
run;
quit;
```

Program Description

Library ABCDE has three data sets: Employee, EmpInfo, and DeptName. The Employee and EmpInfo data sets are already AES-encrypted with different keys. The DeptName data set is not encrypted.

```
proc authlib lib=abcde;
```

Using the CREATE statement, enter the name of the metadata folder and name the secured library object in the SAS Metadata Server. REQUIRE_ENCRYPTION=YES specifies that all data sets in the metadata-bound library are automatically AES-encrypted.

```
      create  seclib="ABCDEEmps"
          securedfolder="Department XYZZY"
          pw=secret
          require_encryption=yes
          encrypt=aes
          encryptkey=new ;
```

Using the TABLES statement, specify the encrypt key for each data set. TABLES statements are required for each data set.

```
      tables employee /
          encryptkey=abc;
      tables empinfo /
          encryptkey=def;
      tables deptname ;
run;
quit;
```

Results: The library ABCDE is bound. All data sets in the metadata-bound library ABCDE have been copied-in-place to be encrypted with the required key and the specified encryption key algorithm, AES in this case.

Log Examples

Example Code 8.15 *Library ABCDE Requiring AES Encryption When Each Data Set Has Different Encryption Key Values*

```
554  proc authlib lib=abcde;
555  create seclib="ABCDEEmps"
556  securedfolder="Department XYZZY"
557  pw=XXXXXX
558  require_encryption=yes
559  encrypt=aes
560  encryptkey=XXX ;
561  tables employee /
562  encryptkey=XXX;
563  tables empinfo /
564  encryptkey=XXX;
565  tables deptname ;
566  run;

NOTE: Setting library to require encryption.
NOTE: Required encryption will use AES encryption with the recorded key.


NOTE: Successfully created a secured library object for the physical library ABCDE and recorded its
location as:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ABCDEEmps
           SecuredLibraryGUID: 097E9A84-D6E8-488E-B779-1E2AB0670036
NOTE: Copying data set ABCDE.EMPLOYEE in place to do required encryption with the library's required
encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.EMPLOYEE to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPLOYEE.
NOTE: Metadata-bound library permissions are used for ABCDE.EMPLOYEE.DATA.
NOTE: Successfully added new secured table object "EMPLOYEE.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.EMPLOYEE.DATA.
NOTE: There were 5 observations read from the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPLOYEE has 5 observations and 6 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on ABCDE.EMPLOYEE.DATA were successfully modified.
NOTE: Copying data set ABCDE.EMPINFO in place to do required encryption with the library's required
encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.EMPINFO to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPINFO.
NOTE: Metadata-bound library permissions are used for ABCDE.EMPINFO.DATA.
NOTE: Successfully added new secured table object "EMPINFO.DATA" to the secured library object at path
"/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.EMPINFO.DATA.
NOTE: There were 5 observations read from the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPINFO has 5 observations and 6 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on ABCDE.EMPINFO.DATA were successfully modified.
NOTE: Copying data set ABCDE.DEPTNAME in place to do required encryption with the library's required
encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.DEPTNAME to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.DEPTNAME.
NOTE: Metadata-bound library permissions are used for ABCDE.DEPTNAME.DATA.
NOTE: Successfully added new secured table object "DEPTNAME.DATA" to the secured library object at
path "/System/Secured
      Libraries/Department XYZZY/ABCDEEmps" for data set ABCDE.DEPTNAME.DATA.
NOTE: There were 4 observations read from the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.DEPTNAME has 4 observations and 2 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on ABCDE.DEPTNAME.DATA were successfully modified.
567  quit;
```

Example 16: Changing a Metadata-Bound Library to Require AES Encryption When Existing Data Sets Are Encrypted with Different Encryption Keys

Features: PROC AUTHLIB statement options
MODIFY statement options:
ENCRYPT=
ENCRYPTKEY=
PW=
REQUIRE_ENCRYPTION
SECUREDLIBRARY=
SECUREDFOLDER=
TABLES statement option:
ENCRYPTKEY=

Details

This example is similar to the previous example. The difference is that the library is already bound to metadata, so the MODIFY statement is used to change the binding to require AES encryption.

Program

```
proc authlib lib=abcde;

    modify  seclib="ABCDEEmps"
        securedfolder="Department XYZZY"
        pw=secret
        require_encryption=yes
        encrypt=aes
        encryptkey=new;

    tables employee /
        encryptkey=abc;
    tables empinfo /
        encryptkey=def;
    tables deptname ;
run;
quit;
```

Program Description

Library ABCDE has three data sets: Employees, EmpInfo, and DeptName. In this library, the Employees data set has the encryption key value `abc`. The EmpInfo data set has the encryption key value `def`. The DeptName data set is not AES-encrypted.

```
proc authlib lib=abcde;
```

Using the MODIFY statement, enter the name of the metadata folder and name the secured library object in the SAS Metadata Server. You use the REQUIRE_ENCRYPTION=YES option to require that all data sets in the metadata-bound library have AES encryption. Note that the name of the secured library object and the name of the metadata folder are optional, but can be specified to ensure that the library is bound to that secured library object before making the change.

```
      modify  seclib="ABCDEEmps"
          securedfolder="Department XYZZY"
          pw=secret
          require_encryption=yes
          encrypt=aes
          encryptkey=new;
```

Using the TABLES statement, specify the encrypt key for each data set. TABLES statements are required for each data set.

```
      tables employee /
          encryptkey=abc;
      tables empinfo /
          encryptkey=def;
      tables deptname ;
run;
quit;
```

Results: The library ABCDE remains bound. The MODIFY statement changed the binding to require AES encryption. All three data sets are copied-in-place to encrypt the data sets with the required encrypt key and the specified encryption key algorithm, AES in this case.

Log Examples

Example Code 8.16 *Library ABCDE Requiring AES Encryption and Changing the Encryption Key Values of Each Data Set to a Recorded Encryption Key Value*

```
628  proc authlib lib=abcde;
629  modify seclib="ABCDEEmps"
630  securedfolder="Department XYZZY"
631  pw=XXXXXX
632  require_encryption=yes
633  encrypt=aes
634  encryptkey=XXX;
635  tables employee /
636  encryptkey=XXX;
637  tables empinfo /
638  encryptkey=XXX;
639  tables deptname ;
640  run;

NOTE: Changing library to require encryption.
NOTE: Required encryption will use AES encryption with the recorded key.


NOTE: The passwords on ABCDE.EMPLOYEE.DATA do not require modification.
NOTE: Copying data set ABCDE.EMPLOYEE in place to do required encryption with the library's required
encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.EMPLOYEE to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPLOYEE.
NOTE: There were 5 observations read from the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPLOYEE has 5 observations and 6 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on ABCDE.EMPINFO.DATA do not require modification.
NOTE: Copying data set ABCDE.EMPINFO in place to do required encryption with the library's required
encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.EMPINFO to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPINFO.
NOTE: There were 5 observations read from the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPINFO has 5 observations and 6 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords on ABCDE.DEPTNAME.DATA do not require modification.
NOTE: Copying data set ABCDE.DEPTNAME in place to do required encryption with the library's required
encryption key and
      passwords.
NOTE: Renaming the data set ABCDE.DEPTNAME to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.DEPTNAME.
NOTE: There were 4 observations read from the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.DEPTNAME has 4 observations and 2 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The passwords and/or encryption options for the secured library object with path "/System/
Secured Libraries/Department
      XYZZY/ABCDEEmps" were successfully modified."
641  quit;
```

Example 17: Using the REMOVE Statement on a Metadata-Bound Library with Required AES Encryption

Features: PROC AUTHLIB statement options
REMOVE statement options:
PW=
ENCRYPT=

Details

This example demonstrates how to unbind a metadata-bound library. The code does the following:

- deletes metadata that describes the library and its tables from the SAS Metadata Repository
- removes security bindings from the physical library and data sets
- removes the assigned password and encryption from the data sets, leaving them unprotected

The slash (/) after the password is optional and is used to remove or replace the password from the data sets. If a library is bound with READ=, WRITE=, and ALTER= passwords, as in Example 4 on page 173, then you must specify all of the passwords, and they must each have a slash (/).

Program

```
proc authlib lib=abcde;


    remove
        pw=currntpw/
        encrypt=no;
run;
quit;
```

Program Description

Unbinding the metadata-bound library ABCDE.

```
proc authlib lib=abcde;
```

Use the REMOVE statement to unbind the metadata-bound library. The slash (/) after the password is used to remove the password from the data sets. ENCRYPT=NO specifies that encryption is removed from all data sets.

```
    remove
        pw=currntpw/
        encrypt=no;
run;
quit;
```

Results: The library ABCDE and all the data sets bound to it are no longer bound. All passwords and encryption are removed from the unbound data sets making them unprotected.

Example Code 8.17 *Using the REMOVE Statement on a Metadata-Bound Library with Required AES Encryption*

```
642  proc authlib lib=abcde;
643  remove
644  pw=XXXXXX/
645  encrypt=no;
646  run;

NOTE: Copying data set ABCDE.DEPTNAME in place to remove encryption.
NOTE: Renaming the data set ABCDE.DEPTNAME to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.DEPTNAME.
NOTE: There were 4 observations read from the data set
ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.DEPTNAME has 4 observations and 2 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
WARNING: Some or all the passwords on ABCDE.DEPTNAME.DATA were removed along with
the secured library object location,
         leaving the data set unprotected.
NOTE: The secured table object location for ABCDE.DEPTNAME.DATA was successfully
removed.
NOTE: Copying data set ABCDE.EMPINFO in place to remove encryption.
NOTE: Renaming the data set ABCDE.EMPINFO to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPINFO.
NOTE: There were 5 observations read from the data set
ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPINFO has 5 observations and 6 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
WARNING: Some or all the passwords on ABCDE.EMPINFO.DATA were removed along with the
secured library object location, leaving
         the data set unprotected.
NOTE: The secured table object location for ABCDE.EMPINFO.DATA was successfully
removed.
NOTE: Copying data set ABCDE.EMPLOYEE in place to remove encryption.
NOTE: Renaming the data set ABCDE.EMPLOYEE to ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: Copying the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__ to ABCDE.EMPLOYEE.
NOTE: There were 5 observations read from the data set
ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
NOTE: The data set ABCDE.EMPLOYEE has 5 observations and 6 variables.
NOTE: Deleting the data set ABCDE.__TEMP_ENCRYPT_FILE_NAME__.
WARNING: Some or all the passwords on ABCDE.EMPLOYEE.DATA were removed along with
the secured library object location,
         leaving the data set unprotected.
NOTE: The secured table object location for ABCDE.EMPLOYEE.DATA was successfully
removed.
NOTE: Successfully deleted the secured library object that was located at:
           SecuredFolder:      /System/Secured Libraries/Department XYZZY
           SecuredLibrary:     ABCDEEmps
           SecuredLibraryGUID: 157F7ACD-5B71-4BC3-A490-DCED4BD275E8
NOTE: Successfully deleted the recorded location of the secured library object for
the physical library ABCDE.
647  quit;
```

Example 18: Resetting Credentials on Imported SecuredLibrary Objects

Features: PROC AUTHLIB statement options
MODIFY statement options:
LIBRARY=
PW=
ENCRYPT=
ENCRYPTKEY=

Details

This example shows how to reset the passwords and encryption key on SecuredLibrary objects that are imported from a backup package.

- The LIBNAME statement without the AUTHADMIN=YES option fails because there are no associated password values restored by the import.
- The AUTHADMIN=YES option is used to enable the AUTHLIB procedure to execute with the binding information in the physical library.
- The MODIFY statement is used to reset the metadata-bound library passwords and encryption key value on the library from "Example 13: Binding a Library with Required AES Encryption When Existing Data Sets Are Encrypted with the Same Encryption Key" on page 192 assuming that the SecuredLibrary object was imported from a backup package without those values.

Program

```
libname abcde "sas-library" ;

libname abcde "sas-library" authadmin=yes;

proc authlib lib=abcde;
    modify
        pw=secret
        encrypt=aes
        encryptkey=value;
run;
quit;

libname abcde "sas-library";
```

Program Description

Library ABCDE has three data sets: Employees, EmpInfo, and DeptName. This LIBNAME statement fails because there are no associated password values.

```
libname abcde "sas-library" ;
```

Use the AUTHADMIN=YES option. The AUTHADMIN=YES option enables the AUTHLIB procedure to execute with the binding information in the physical library.

```
libname abcde "sas-library" authadmin=yes;
```

Use the MODIFY statement to reset the metadata-bound library passwords and encryption key value. The PW= option resets the password. The ENCRYPTKEY= option resets the encryption key value.

```
proc authlib lib=abcde;
    modify
        pw=secret
        encrypt=aes
        encryptkey=value;
run;
quit;
```

Reissue the LIBNAME statement without the AUTHADMIN=YES option . It is good practice to reassign the library without AUTHADMIN=YES as soon as your administrative need is complete, so that any other access that you make to the library is not in administrative mode. In this case, it also ensures that the credentials are reset.

```
libname abcde "sas-library";
```

Example Code 8.18 *Resetting Credentials*

```
253 libname abcde "library-name" ;
ERROR: The secured library object information for library ABCDE could not be obtained
       from the metadata server or has invalid data.
ERROR: Association not found.
ERROR: Error in the LIBNAME statement.
254  libname abcde "library-name" authadmin=yes;
NOTE: Libref ABCDE was successfully assigned as follows:
      Engine:             V9
      Physical Name:      library-name
      Secured Library:    /System/Secured Libraries/Department XYZZY/ABCDEEmps
      Authenticated ID:   user-id@site as user-id
      Encryption Key:     YES
      Require Encryption: YES
255  proc authlib lib=abcde;
256  modify
257        pw=XXXXXX
258        encrypt=aes
259        encryptkey=XXX ;
260  run;

NOTE: Required encryption will use AES encryption with the recorded key.


NOTE: The passwords on ABCDE.DEPTNAME.DATA do not require modification.
NOTE: The passwords on ABCDE.EMPINFO.DATA do not require modification.
NOTE: The passwords on ABCDE.EMPLOYEE.DATA do not require modification.
261  quit;
```

9

CALENDAR Procedure

Overview: CALENDAR Procedure

What Does the CALENDAR Procedure Do?

The CALENDAR procedure displays data from a SAS data set in a monthly calendar format. You can produce a *schedule calendar*, which schedules events around holidays and nonwork periods, or you can produce a *summary calendar*, which summarizes data and displays only one-day events and holidays. When you use PROC CALENDAR, you can perform the following tasks:

- schedule work around holidays and other nonwork periods
- display holidays
- process data about *multiple calendars* in a single step and print them in a separate, mixed, or combined format
- apply different holidays, weekly work schedules, and daily work shifts to multiple calendars in a single PROC step
- produce a mean and a sum for variables based on either the number of days in a month or the number of observations

PROC CALENDAR also contains features that are specifically designed to work with PROC CPM in SAS/OR software, a project management scheduling tool.

What Types of Calendars Can PROC CALENDAR Produce?

Simple Schedule Calendar

The following output illustrates the simplest type of schedule calendar that you can produce. This calendar output displays activities that are planned by a banking executive. The following statements produce Output 9.30 on page 214.

```
proc calendar data=allacty;
   start date;
   dur long;
run;
```

For the activities data set shown that is in this calendar, see “Example 1: Schedule Calendar with Holidays: 5-Day Default” on page 261.

The following calendar uses one of the two default calendars, the 24-hour-day, 7-day-week calendar.

Output 9.1 *Simple Schedule Calendar*

The SAS System

July 2002

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1 +Dist. Mtg./+	2 +Mgrs. Meeting/	3 +Interview/J+ District 6=+	4	5 +VIP Banquet+	6
7	8 +============Trade Show/Knox============+ +======================Sales Drive/District 6======================+	9	10	11 +Planning Co+ +Mgrs. Meeting/	12 +Seminar/Whi+ District 7=+	13
14	15 +======================Sales Drive/District 7======================+	16 +Dentist/JW=+	17 +Bank Meetin+	18 +NewsLetter + +Planning Co+	19 +Co. Picnic/+ +Seminar/Whi+	20
21	22 +=========Inventors Show/Melvin==========+	23	24 +Birthday/Ma+	25 +==Close Sale/ +Planning Co+	26 WYGIX Co.===+	27
28	29	30	31			

Advanced Schedule Calendar

The following output is an advanced schedule calendar produced by PROC CALENDAR. The statements that create this calendar can perform the following tasks:

- schedule activities around holidays
- identify separate calendars
- print multiple calendars in the same report
- apply different holidays to different calendars
- apply different work patterns to different calendars

For an explanation of the program that produces this calendar, see "Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278.

Output 9.2 *Advanced Schedule Calendar*

Well Drilling Work Schedule: Combined Calendars

July 2002

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
CAL1		1	2	3	4	5	6
					Independence	+Assemble T>	
						+Lay Power >	
		+========Drill Well/$1,000.00========>				<Drill Well+	
CAL2				+================Excavate/$3,500.00================>			
	7	8	9	10	11	12	13
CAL1		+============Build Pump House/$2,000.00============+					
		<=============Assemble Tank/$1,000.00=============+					
		<Lay Power Line/$2,000.0+			+Pour Foundation/$1,500.>		
CAL2		<Excavate/$>	**Vacation**	<Excavate/$+			
	14	15	16	17	18	19	20
CAL1		+======================Install Pump/$500.00======================+					
		<=====Pour Foundation/$1,500.00======+				+Install Pi>	
	21	22	23	24	25	26	27
CAL1		+======================Erect Tower/$2,500.00======================>					
		<Install Pipe/$1,000.00=+					
	28	29	30	31			
CAL1		<Erect Towe+					

Simple Summary Calendar

The following output shows a simple summary calendar that displays the number of meals served daily in a hospital cafeteria:

```
proc calendar data=meals;
   start date;
   sum brkfst lunch dinner;
   mean brkfst lunch dinner;
run;
```

In a summary calendar, each piece of information for a given day is the value of a variable for that day. The variables can be either numeric or character, and you can format them as necessary. You can use the SUM and MEAN options to calculate sums and means for any numeric variables. These statistics appear in a box below the calendar, as shown in the following output. The data set that is shown in this calendar is created in "Example 7: Summary Calendar with MEAN Values by Observation" on page 295.

Output 9.3 *Simple Summary Calendar*

The SAS System

December 2008

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1 123 234 238	2 188 188 198	3 123 183 176	4 200 267 243	5 176 165 177	6
7	8 178 198 187	9 165 176 187	10 187 176 231	11 176 187 222	12 187 187 123	13
14	15 176 165 177	16 156 . 167	17 198 143 167	18 178 198 187	19 165 176 187	20
21	22 187 187 123	23	24	25	26	27
28	29	30	31			

	Sum	Mean
Brkfst	2763	172.688
Lunch	2830	188.667
Dinner	2990	186.875

Advanced Scheduling and Project Management Tasks

For more complex scheduling tasks, consider using the CPM procedure in SAS/OR software. PROC CALENDAR requires that you specify the starting date of each activity. When the beginning of one task depends on the completion of others and a date slips in a schedule, recalculating the schedule can be time-consuming. Instead of manually recalculating dates, you can use PROC CPM to calculate dates for project activities based on an initial starting date, activity durations, and which tasks are identified as *successors* to others. For an example, see "Example 6: Calculating a Schedule Based on Completion of Predecessor Tasks" on page 287.

Concepts: CALENDAR Procedure

Types of Calendars

PROC CALENDAR can produce two types of calendars: schedule and summary.

Table 9.1 *Summary of Schedule and Summary Calendars*

Type of Calendar	Task	Restriction
Schedule calendar	Schedule activities around holidays and nonwork periods	Cannot calculate sums and means
Schedule calendar	Schedule activities that last more than one day	
Summary calendar	Calculate sums and means	Activities can last only one day

Note: PROC CALENDAR produces a summary calendar if you do not use a DUR or FIN statement in the PROC step.

Schedule Calendar

Definition

A report in calendar format that shows when activities and holidays start and end.

Required Statements

You must supply a START statement and either a DUR or FIN statement. If you do not use a DUR or FIN statement, then PROC CALENDAR assumes that you want to create a summary calendar report.

Table 9.2 *Required Statements*

Statement	Variable Value
"START Statement" on page 256	Starting date of an activity
"DUR Statement" on page 248	Duration of an activity
"FIN Statement" on page 249	Ending date of an activity

Examples

- "Simple Schedule Calendar" on page 213
- "Advanced Schedule Calendar" on page 215
- "Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261
- "Example 2: Schedule Calendar Containing Multiple Calendars" on page 266
- "Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271
- "Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278
- "Example 5: Schedule Calendar, Blank or with Holidays" on page 284
- "Example 6: Calculating a Schedule Based on Completion of Predecessor Tasks" on page 287

Summary Calendar

Definition

A report in calendar format that displays activities and holidays that last only one day and that can provide summary information in the form of sums and means.

Required Statements

You must supply a START statement. This statement identifies the variable in the activities data set that contains an activity's starting date.

Multiple Events on a Single Day

A summary calendar report can display only one activity on a given date. Therefore, if more than one activity has the same START value, then only the last observation that was read is used. In such situations, you might find PROC SUMMARY useful in collapsing your data set to contain one activity per starting date.

Examples

- "Simple Summary Calendar" on page 216
- "Example 7: Summary Calendar with MEAN Values by Observation" on page 295
- "Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

The Default Calendars

Description

PROC CALENDAR provides two default calendars for simple applications. You can produce calendars without having to specify detailed work shifts and weekly work patterns if your application can use one of two simple work patterns. Consider using a default calendar if the following conditions are true:

- your application uses a 5-day work week with 8-hour days or a 7-day work week with 24-hour days, as shown in the following table
- you want to print all activities on the same calendar
- you do not need to identify separate calendars

Table 9.3 *Default Calendar Settings and Examples*

Scheduled Work Days	INTERVAL=	Default DAYLENGTH=	Work Period Length	Example
7 (M-Sun)	DAY	24	24-hour days	2
5 (M-F)	WORKDAY	8	8-hour days	1

When You Unexpectedly Produce a Default Calendar

If you want to produce a specialized calendar but do not provide all the necessary information, then PROC CALENDAR attempts to produce a default calendar. These errors cause PROC CALENDAR to produce a calendar with default features:

- If the activities data set does not contain a CALID variable, then PROC CALENDAR produces a default calendar.
- If *both* the holidays and calendar data sets do not contain a CALID variable, then PROC CALENDAR produces a default calendar *even if the activities data set contains a CALID variable*.
- If the activities and calendar data sets contain the CALID variable, but the holidays data set does not, then the default holidays are used.

Examples

- See the 7-day default calendar in Output 9.30 on page 214
- See the 5-day default calendar in “Example 1: Schedule Calendar with Holidays: 5-Day Default” on page 261

Calendars and Multiple Calendars

Definitions

calendar
: a logical entity that represents a weekly work pattern, which consists of weekly work schedules and daily shifts. PROC CALENDAR contains two default work patterns: 5-day week with an 8-hour day or a 7-day week with a 24-hour day. You can also define your own work patterns by using CALENDAR and WORKDAYS data sets.

calendar report
: a report in calendar format that displays activities, holidays, and nonwork periods. A calendar report can contain multiple calendars in one of three formats:

  separate
  : each identified calendar is printed on separate output pages.

  combined
  : all identified calendars are printed on the same output pages and each is identified.

  mixed
  : all identified calendars are printed on the same output pages but are not identified as belonging to separate calendars.

multiple calendar
: a logical entity that represents multiple weekly work patterns.

Advantages of Creating Multiple Calendars

Create a multiple calendar if you want to print a calendar report that shows activities that follow different work schedules or different weekly work patterns. For example, a construction project report might need to use different work

schedules and weekly work patterns for work crews on different parts of the project.

Another use for multiple calendars is to identify activities so that you can choose to print them in the same calendar report. For example, if you identify activities as belonging to separate departments within a division, then you can choose to print a calendar report that shows all departmental activities on the same calendar.

Finally, using multiple calendars, you can produce separate calendar reports for each calendar in a single step. For example, if activities are identified by department, then you can produce a calendar report that prints the activities of each department on separate pages.

How to Identify Multiple Calendars

Because PROC CALENDAR can process only one data set of each type (activities, holidays, calendar, workdays) in a single PROC step, you must be able to identify for PROC CALENDAR which calendar an activity, holiday, or weekly work pattern belongs to. Use the CALID statement to specify the variable whose values identify the appropriate calendar. This variable can be numeric or character.

You can use the special variable name _CAL_ or you can use another variable name. PROC CALENDAR automatically looks for a variable named _CAL_ in the holiday and calendar data sets, even when the activities data set uses a variable with another name as the CALID variable. Therefore, if you use the name _CAL_ in your holiday and calendar data sets, then you can more easily reuse these data sets in different calendar applications.

Using Holidays or Calendar Data Sets with Multiple Calendars

When using a holidays or calendar data set with multiple calendars, PROC CALENDAR treats the variable values in the following way:

- Every value of the CALID variable that appears in either the holidays or calendar data sets defines a calendar.
- If a CALID value appears in the HOLIDATA= data set but not in the CALEDATA= data set, then the work schedule of the default calendar is used.
- If a CALID value appears in the CALEDATA= data set but not in the HOLIDATA= data set, then the holidays of the default calendar are used.
- If a CALID value does not appear in either the HOLIDATA= or CALEDATA= data set, then the work schedule and holidays of the default calendar are used.
- If the CALID variable is not found in the holiday or calendar data set, then PROC CALENDAR looks for the default variable _CAL_ instead. If neither the CALID variable nor a _CAL_ variable appears in a data set, then the observations in that data set are applied to a default calendar.

Types of Reports That Contain Multiple Calendars

Because you can associate different observations with different calendars, you can print a calendar report that shows activities that follow different work schedules or different work shifts or that contain different holidays. You can perform the following tasks:

- print separate calendars on the same page and identify each one
- print separate calendars on the same page without identifying them
- print separate pages for each identified calendar

For example, consider a calendar that shows the activities of all departments within a division. Each department can have its own calendar identification value and, if necessary, can have individual weekly work patterns, daily work shifts, and holidays.

If you place activities that are associated with different calendars in the same activities data sets, then you use PROC CALENDAR to produce calendar reports that print the following:

- the schedule and events for each department on a separate page (separate output)
- the schedule and events for the entire division, each identified by department (combined output)
- the schedule and events for the entire division, but *not* identified by department (mixed output)

The multiple-calendar feature was added specifically to enable PROC CALENDAR to process the output of PROC CPM in SAS/OR software, a project management tool. See "Example 6: Calculating a Schedule Based on Completion of Predecessor Tasks" on page 287.

How to Identify Calendars with the CALID Statement and the Special Variable _CAL_

To identify multiple calendars, you must use the CALID statement to specify the variable whose values identify which calendar an event belongs with. This variable can be numeric or character.

You can use the special variable name _CAL_ or you can use another variable name. PROC CALENDAR automatically looks for a variable named _CAL_ in the holiday and calendar data sets, even when the activities data set uses a variable with another name as the CALID variable. Therefore, if you use the name _CAL_ in your holiday and calendar data sets, then you can more easily reuse these data sets in different calendar applications.

When You Use Holidays or Calendar Data Sets

When you use a holidays or calendar data set with multiple calendars, PROC CALENDAR treats the variable values in the following way:

- Every value of the CALID variable that appears in either the holidays or calendar data sets defines a calendar.
- If a CALID value appears in the HOLIDATA= data set but not in the CALEDATA= data set, then the work schedule of the default calendar is used.
- If a CALID value appears in the CALEDATA= data set but not in the HOLIDATA= data set, then the holidays of the default calendar are used.
- If a CALID value does not appear in either the HOLIDATA= or CALEDATA= data set, then the work schedule and holidays of the default calendar are used.
- If the CALID variable is not found in the holiday or calendar data sets, then PROC CALENDAR looks for the default variable _CAL_ instead. If neither the CALID variable nor a _CAL_ variable appears in a data set, then the observations in that data set are applied to a default calendar.

Examples

- "Example 2: Schedule Calendar Containing Multiple Calendars" on page 266
- "Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271
- "Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278
- "Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

Input Data Sets

You might need several data sets to produce a calendar, depending on the complexity of your application. PROC CALENDAR can process one of each of four data sets, as shown in the following table.

Table 9.4 *Four Possible Input Data Sets for PROC CALENDAR*

Data Set	Description	Option
Activities	Each *observation* contains information about a single activity.	"DATA=*SAS-data-set*" on page 237
Holidays	Each *observation* contains information about a holiday.	"HOLIDATA=*SAS-data-set*" on page 242
Calendar	Each *observation* defines one weekly work schedule.	"CALEDATA=*SAS-data-set*" on page 237
Workdays	Each *variable* represents one daily schedule of alternating work and nonwork periods.	"WORKDATA=*SAS-data-set*" on page 244

Activities Data Set

Purpose

The activities data set, specified with the DATA= option, contains information about the activities to be scheduled by PROC CALENDAR. Each observation describes a single activity.

Requirements and Restrictions

- An activities data set is required. (If you do not specify an activities data set with the DATA= option, then PROC CALENDAR uses the _LAST_ data set.)
- Only one activities data set is allowed.
- The activities data set must always be sorted or indexed by the START variable.
- If you use a CALID (calendar identifier) variable and want to produce output that shows multiple calendars on separate pages, then the activities data set must be sorted by or indexed on the CALID variable and then the START variable.
- If you use a BY statement, then the activities data set must be sorted by or indexed on the BY variables.

Structure

Each *observation* in the activities data set contains information about one activity. One variable must contain the starting date. If you are producing a schedule calendar, then another variable must contain either the activity duration or finishing date. Other variables can contain additional information about an activity.

Table 9.5 *Required Statements*

Variable Content	Statement	Calendar Type
Starting date	"START Statement" on page 256	Schedule Summary
Duration	"DUR Statement" on page 248	Schedule
Finishing date	"FIN Statement" on page 249	Schedule

Multiple Activities per Day in Summary Calendars

A summary calendar can display only one activity on a given date. Therefore, if more than one activity has the same START value, then only the last observation that is read is used. In such situations, you might find PROC SUMMARY useful to collapse your data set to contain one activity per starting date.

Examples

Every example in the Examples section uses an activities data set.

Holidays Data Set

Purpose

You can use a holidays data set, specified with the HOLIDATA= option, to identify the following:

- holidays on your calendar output.
- days that are not available for scheduling work. (In a schedule calendar, PROC CALENDAR does not schedule activities on these days.)

Structure

Each observation in the holidays data set must contain at least the holiday starting date. A holiday lasts only one day unless a duration or finishing date is specified. Supplying a holiday name is recommended, though not required. If you do not specify which variable contains the holiday name, then PROC CALENDAR uses the word **DATE** to identify each holiday.

Table 9.6 *Required Statements*

Variable Content	Statement
Starting date	"HOLISTART Statement" on page 251
Name	"HOLIVAR Statement" on page 252
Duration	"HOLIDUR Statement" on page 250
Finishing date	"HOLIFIN Statement" on page 251

No Sorting Needed

You do not need to sort or index the holidays data set.

Using SAS Date versus SAS Datetime Values

PROC CALENDAR calculates time using SAS datetime values. Even when your data is in DATE. format, the procedure automatically calculates time in minutes and seconds. Therefore, if you specify only date values, then PROC CALENDAR prints messages similar to the following ones to the SAS log:

```
NOTE: All holidays are assumed to start at the
      time/date specified for the holiday variable
      and last one DTWRKDAY.
WARNING: The units of calculation are SAS datetime
         values while all the holiday variables are
         not. All holidays are converted to SAS
         datetime values.
```

Create a Generic Holidays Data Set

If you have many applications that require PROC CALENDAR output, then consider creating a generic holidays data set that contains standard holidays. You can begin with the generic holidays and add observations that contain holidays or nonwork events specific to an application.

Holidays and Nonwork Periods

Do not schedule holidays during nonwork periods. Holidays that are defined in the HOLIDATA= data set cannot occur during any nonwork periods that are defined in the work schedule. For example, you cannot schedule Sunday as a vacation day if the work week is defined as Monday through Friday. When such a conflict occurs, the holiday is rescheduled to the next available working period following the nonwork day.

Examples

Every example in the Examples section uses a holidays data set.

Calendar Data Set

Purpose

You can use a calendar data set, specified with the CALEDATA= option, to specify work schedules for different calendars.

Structure

Each observation in the calendar data set defines one weekly work schedule. The data set created in the DATA step shown below defines weekly work schedules for two calendars, CALONE and CALTWO.

```
data cale;
   input _sun_ $ _mon_ $ _tue_ $ _wed_ $ _thu_ $ /
         _fri_ $ _sat_ $ _cal_ $ d_length time6.;
   datalines;
```

```
holiday workday workday workday workday
workday holiday calone 8:00
holiday shift1 shift1 shift1 shift1
shift2 holiday caltwo 9:00
;
```

These are the variables in this calendar data set:

SUN through _SAT_
the name of each day of the week that appears in the calendar. The values of these variables contain the name of work shifts. These are the valid values for work shifts:

- `WORKDAY` (the default work shift)
- `HOLIDAY` (a nonwork period)
- names of variables in the WORKDATA= data set (in this example, `SHIFT1` and `SHIFT2`)

CAL
the CALID (calendar identifier) variable. The values of this variable identify different calendars. If this variable is not present, then the first observation in this data set defines the work schedule that is applied to all calendars in the activities data set.

If the CALID variable contains a missing value, then the character or numeric value for the default calendar (`DEFAULT` or 0) is used. For more details, see "The Default Calendars" on page 221.

D_LENGTH
the daylength identifier variable. Values of D_LENGTH indicate the length of the standard workday to be used in calendar calculations. You can set the workday length either by placing this variable in your calendar data set or by using the DAYLENGTH= option.

Missing values for this variable default to the number of hours specified in the DAYLENGTH= option. If the DAYLENGTH= option is not used, then the day length defaults to 24 hours if INTERVAL=DAY, or eight hours if INTERVAL=WORKDAY.

Using Default Work Shifts Instead of a Workdays Data Set

You can use a calendar data set with or without a workdays data set. Without a workdays data set, WORKDAY in the calendar data set is equal to one of two standard workdays, depending on the setting of the INTERVAL= option:

Table 9.7 *Workday Settings*

INTERVAL=	Work-Shift Start	Day Length
DAY	00:00	24 hours

INTERVAL=	Work-Shift Start	Day Length
WORKDAY	9:00	8 hours

You can reset the length of the standard workday with the DAYLENGTH= option or a D_LENGTH variable in the calendar data set. You can define other work shifts in a workdays data set.

Examples

The following examples feature a calendar data set:

- "Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271
- "Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278
- "Example 7: Summary Calendar with MEAN Values by Observation" on page 295

Workdays Data Set

Purpose

You can use a workdays data set, specified with the WORKDATA= option, to define the daily work shifts named in a CALEDATA= data set.

Use Default Work Shifts or Create Your Own?

You do not need a workdays data set if your application can use one of two default work shifts:

Table 9.8 *Default Work Shifts*

INTERVAL=	Work-Shift Start	Day Length
DAY	00:00	24 hours
WORKDAY	9:00	8 hours

See the "INTERVAL=DAY | WORKDAY " on page 242.

Structure

Each variable in the workdays data set contains one daily schedule of alternating work and nonwork periods. For example, this DATA step creates a data set that contains specifications for two work shifts:

```
data work;
   input shift1 time6. shift2 time6.;
   datalines;
7:00  7:00
12:00 11:00
13:00   .
17:00   .
;
```

The variable SHIFT1 specifies a 10-hour workday, with one nonwork period (a lunch hour); the variable SHIFT2 specifies a 4-hour workday with no nonwork periods.

How Missing Values Are Treated

The missing values default to 00:00 in the first observation and to 24:00 in all other observations. Two consecutive values of 24:00 define a zero-length time period, which is ignored.

Examples

See "Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271

Missing Values in Input Data Sets

The following table summarizes the treatment of missing values for variables in the data sets used by PROC CALENDAR.

Table 9.9 *Treatment of Missing Values in PROC CALENDAR*

Data set	Variable	Treatment of Missing Values
Activities (DATA=)	"_CAL_" on page 230	Default calendar value is used.
	"START Statement" on page 256	Observation is not used.

Data set	Variable	Treatment of Missing Values
	"DUR Statement" on page 248	1.0 is used.
	"FIN Statement" on page 249	START value + daylength is used.
	"VAR Statement" on page 258	If a summary calendar or the MISSING option is specified, then the missing value is used. Otherwise, no value is used.
	"SUM Statement" on page 257 , "MEAN Statement" on page 253	0
Calendar (CALEDATA=)	"_CAL_" on page 230	Default calendar value is used.
	"_SUN_ through _SAT_" on page 230	Corresponding shift for default calendar is used.
	"D_LENGTH" on page 230	If available, DAYLENGTH= value is used, or, if INTERVAL=DAY, 24:00 is used. Otherwise, 8:00 is used.
	"SUM Statement" on page 257 , "MEAN Statement" on page 253	0
Holiday (HOLIDATA=)	"_CAL_" on page 230	All holidays apply to all calendars.
	"HOLISTART Statement" on page 251	Observation is not used.
	"HOLIDUR Statement" on page 250	If available, HOLIFIN value is used instead of HOLIDUR value. Otherwise, 1.0 is used.
	"HOLIFIN Statement" on page 251	If available, HOLIDUR value is used instead of HOLIFIN value. Otherwise, HOLISTART value + day length is used.
	"HOLIVAR Statement" on page 252	No value is used.
Workdays (WORKDATA=)	any	For the first observation, 00:00 is used. Otherwise, 24:00 is used.

Syntax: CALENDAR Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Requirements: You must use a START statement.

For schedule calendars, you must also use a DUR or FIN statement.

Tips: If you use a DUR or FIN statement, then PROC CALENDAR produces a schedule calendar.

You can use the FORMAT, LABEL, and WHERE statements with PROC CALENDAR. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

You can also use any global statement. For a list, see "Global Statements" on page 25 and "Dictionary of SAS Global Statements" in *SAS Global Statements: Reference*.

PROC CALENDAR <*options*>;

START *variable*;

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

CALID *variable*
</ OUTPUT=COMBINE | MIX | SEPARATE>;

DUR *variable*;

FIN *variable*;

HOLISTART *variable*;

HOLIDUR *variable*;

HOLIFIN *variable*;

HOLIVAR *variable*;

MEAN *variable(s)* </ FORMAT=*format-name*>;

OUTSTART *day-of-week*;

OUTDUR *number-of-days*;

OUTFIN *day-of-week*;

SUM *variable(s)* </ FORMAT=*format-name*>;

VAR *variable(s)*;

Statement	Task	Example
PROC CALENDAR	Display data from a SAS data set in a monthly calendar format	Ex. 1, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 8

Statement	Task	Example
BY	Process activities separately for each BY group, producing a separate calendar for each value of the BY variable	
CALID	Process activities in groups defined by the values of a calendar identifier variable	Ex. 2, Ex. 3, Ex. 4, Ex. 6, Ex. 7, Ex. 8
DUR	Specify the variable that contains the duration of each activity	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5
FIN	Specify the variable in the activities data set that contains the finishing date of each activity	Ex. 6
HOLIDUR	Specify the variable in the holidays data set that contains the duration of each holiday for a schedule calendar	Ex. 1, Ex. 5
HOLIFIN	Specify the variable in the holidays data set that contains the finishing date of each holiday	
HOLISTART	Specify a variable in the holidays data set that contains the starting date of each holiday	Ex. 1, Ex. 5
HOLIVAR	Specify a variable in the holidays data set whose values are used to label the holidays	Ex. 1, Ex. 5
MEAN	Specify numeric variables in the activities data set for which mean values are to be calculated for each month	
OUTDUR	Specify in days the length of the week to be displayed	
OUTFIN	Specify the last day of the week to display in the calendar	Ex. 3, Ex. 4, Ex. 8
OUTSTART	Specify the starting day of the week to display in the calendar	Ex. 3, Ex. 4, Ex. 8
START	Specify the variable in the activities data set that contains the starting date of each activity	Ex. 1
SUM	Specify numeric variables in the activities data set to total for each month	Ex. 8
VAR	Specify the variables that you want to display for each activity	Ex. 6

PROC CALENDAR Statement

Displays data from a SAS data set in a monthly calendar format.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Examples:
"Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261
"Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271
"Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278
"Example 5: Schedule Calendar, Blank or with Holidays" on page 284
"Example 6: Calculating a Schedule Based on Completion of Predecessor Tasks" on page 287
"Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

Syntax

PROC CALENDAR <*options*>;

Summary of Optional Arguments

Control printing

FILL
: displays all months, even if no activities exist.

FORMCHAR <(*position(s)*)>='*formatting-character(s)*'
: defines characters used for outlines, dividers, and so on.

HEADER=SMALL | MEDIUM | LARGE
: specifies the type of heading to use in printing the name of the month.

LOCALE
: displays month and weekday names in the local language.

MISSING
: specifies how to show missing values.

WEEKDAYS
: suppresses the display of Saturdays and Sundays in the output.

Control summary information

LEGEND
: prints the names of the variables whose values appear in the calendar.

MEANTYPE=NOBS | NDAYS

specifies the type of mean to calculate for each month.

Specify data sets containing

CALEDATA=*SAS-data-set*
: weekly work schedules

DATA=*SAS-data-set*
: activities

HOLIDATA=*SAS-data-set*
: holidays

WORKDATA=*SAS-data-set*
: unique shift patterns

Specify time or duration

DATETIME
: specifies that START and FIN variables contain values in DATETIME. format.

DAYLENGTH=*hours*
: specifies the number of hours in a standard work day.

INTERVAL=DAY | WORKDAY
: specifies the units of the DUR and HOLIDUR variables.

Optional Arguments

CALEDATA=*SAS-data-set*

specifies the *calendar data set*, a SAS data set that contains weekly work schedules for multiple calendars.

Default: If you omit the CALEDATA= option, then PROC CALENDAR uses a default work schedule.

Tip: A calendar data set is useful if you are using multiple calendars or a nonstandard work schedule.

See: "The Default Calendars" on page 221

"Calendar Data Set " on page 229

Examples: "Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271

"Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278

DATA=*SAS-data-set*

specifies the *activities data set*, a SAS data set that contains starting dates for all activities and variables to display for each activity. Activities must be sorted or indexed by starting date.

Default: If you omit the DATA= option, then the most recently created SAS data set is used.

See: "Activities Data Set " on page 226

Example "Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261

DATETIME
specifies that START and FIN variables contain values in DATETIME. format.

Default If you omit the DATETIME option, then PROC CALENDAR assumes that the START and FIN values are in the DATE. format.

Examples "Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271

"Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278

"Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

DAYLENGTH=*hours*
The hour value must be a SAS TIME value.

Default 24 if INTERVAL=DAY (the default), 8 if INTERVAL=WORKDAY.

Restriction DAYLENGTH= applies only to schedule calendars.

Interactions If you specify the DAYLENGTH= option and the calendar data set contains a D_LENGTH variable, then PROC CALENDAR uses the DAYLENGTH= value only when the D_LENGTH value is missing.

When INTERVAL=DAY and you have no CALEDATA= data set, specifying a DAYLENGTH= value has no effect.

Tips The DAYLENGTH= option is useful when you use the DUR statement and your work schedule contains days of varying lengths (for example, a work week of five half-days). In a work week with varying day lengths, you need to set a standard day length to use in calculating duration times. For example, an activity with a duration of 3.0 workdays lasts 24 hours if DAYLENGTH=8:00 or 30 hours if DAYLENGTH=10:00.

Instead of specifying the DAYLENGTH= option, you can specify the length of the working day by using a D_LENGTH variable in the CALEDATA= data set. If you use this method, then you can specify different standard day lengths for different calendars.

See "Calendar Data Set " on page 229 for more information about setting the length of the standard workday

FILL
displays all months between the first and last activity, start and finish dates inclusive, including months that contain no activities.

Default If you do not specify FILL, then PROC CALENDAR prints only months that contain *activities*. (Months that contain only *holidays* are not printed.)

Example "Example 5: Schedule Calendar, Blank or with Holidays" on page 284

FORMCHAR <(*position(s)*)>='*formatting-character(s)*'

defines the characters to use for constructing the outlines and dividers for the cells in the calendar as well as all identifying markers (such as asterisks and arrows) used to indicate holidays or continuation of activities in PROC CALENDAR output.

position(s)

identifies the position of one or more characters in the SAS formatting-character string. A space or a comma separates the positions.

Default Omitting (*position(s)*) is the same as specifying all 20 possible system formatting characters, in order.

Range PROC CALENDAR uses 17 of the 20 formatting characters that SAS provides.

See Table 9.15 on page 240 shows the formatting characters that PROC CALENDAR uses.

Figure 9.12 on page 240 illustrates their use in PROC CALENDAR output.

formatting-character(s)

lists the characters to use for the specified positions. PROC CALENDAR assigns characters in *formatting-character(s)* to *position(s)*, in the order in which they are listed. For example, the following option assigns an asterisk (*) to the 12th position, assigns a single hyphen (-) to the 13th, and does not alter remaining characters:

```
formchar(12 13)='*-'
```

These new settings change the activity line from this:

```
+=================ACTIVITY===============+
```

to this:

```
*-----------------ACTIVITY--------------*
```

Figure 9.1 Formatting Characters in PROC CALENDAR Output

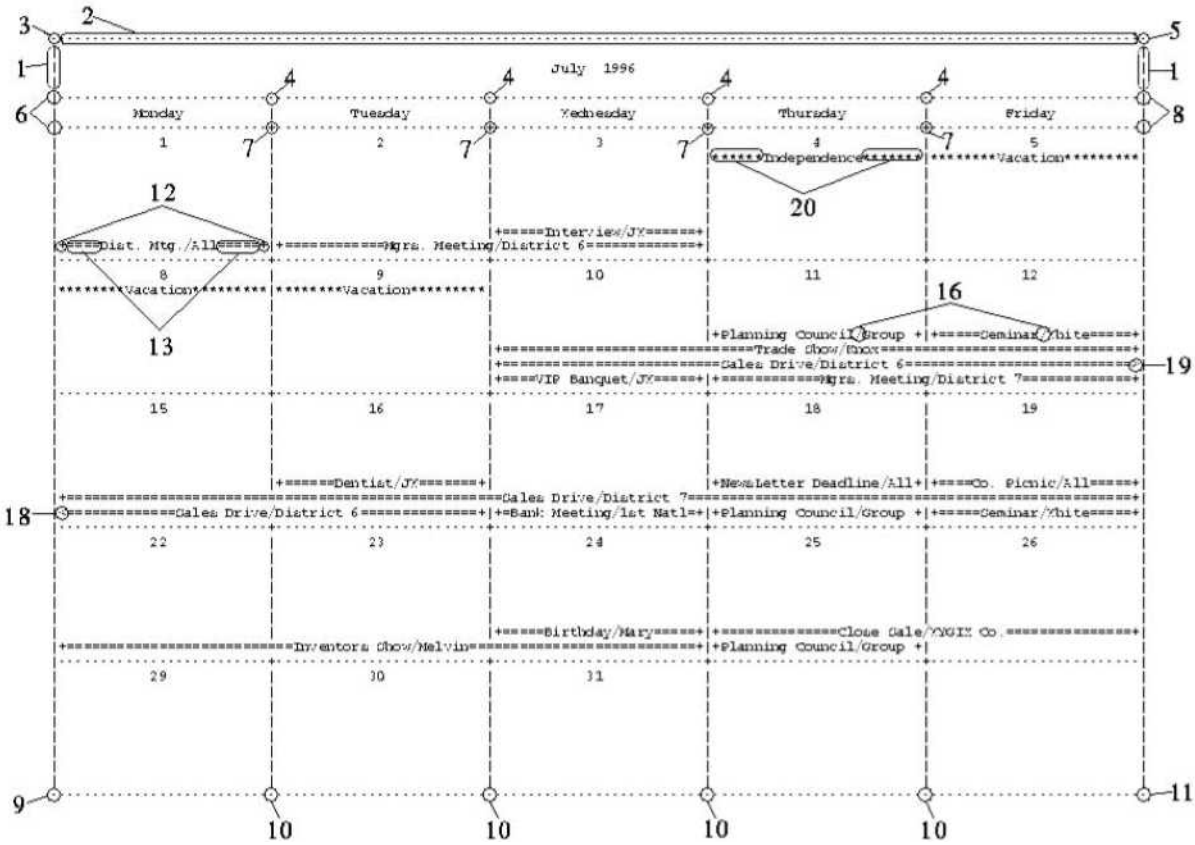


Table 9.10 Formatting Characters Used by PROC CALENDAR

Position	Default	Used to Draw
1	|	Vertical bar
2	-	Horizontal bar
3	-	Cell: upper left corner
4	-	Cell: upper middle intersection
5	-	Cell: upper right corner
6	|	Cell: middle left cell side
7	+	Cell: middle middle intersection
8	|	Cell: middle right cell side
9	-	Cell: lower left corner

Position	Default	Used to Draw
10	-	Cell: lower middle intersection
11	-	Cell: lower right corner
12	+	Activity start and finish
13	=	Activity line
16	/	Activity separator
18	<	Activity continuation from
19	>	Activity continuation to
20	*	Holiday marker

Interaction The SAS system option FORMCHAR= specifies the default formatting characters. The SAS system option defines the entire string of formatting characters. The FORMCHAR= option in a procedure can redefine selected characters.

Tip You can use any character in *formatting-characters*, including hexadecimal characters. If you use hexadecimal characters, then you must put an `x` after the closing quotation mark. For example, the following option assigns the hexadecimal character 2-D to the third formatting character, the hexadecimal character 7C to the seventh character, and does not alter the remaining characters:

```
formchar(3,7)='2D7C'x
```

See For information about which hexadecimal codes to use for which characters, consult the documentation for your hardware.

HEADER=SMALL | MEDIUM | LARGE

specifies the type of heading to use in printing the name of the month.

SMALL

prints the month and year on one line.

MEDIUM

prints the month and year in a box four lines high.

LARGE

prints the month seven lines high using asterisks (*). The year is included if space is available.

Default MEDIUM

HOLIDATA=*SAS-data-set*

specifies the *holidays data set*, a SAS data set that contains the holidays that you want to display in the output. One variable must contain the holiday names and another must contain the starting dates for each holiday. PROC CALENDAR marks holidays in the calendar output with asterisks (*) when space permits.

Interaction Displaying holidays on a calendar requires a holidays data set and a HOLISTART statement. A HOLIVAR statement is recommended for naming holidays. HOLIDUR is required if any holiday lasts longer than one day.

Tip The holidays data set does not require sorting.

See "Holidays Data Set " on page 227

Examples "Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261

"Example 5: Schedule Calendar, Blank or with Holidays" on page 284

INTERVAL=DAY | WORKDAY

specifies the units of the DUR and HOLIDUR variables to one of two default day lengths:

DAY

specifies the values of the DUR and HOLIDUR variables in units of 24-hour days and specifies the default 7-day calendar. For example, a DUR value of 3.0 is treated as 72 hours. The default calendar work schedule consists of seven working days, all starting at 00:00 with a length of 24:00.

WORKDAY

specifies the values of the DUR and HOLIDUR variables in units of 8-hour days. WORKDAY also specifies that the default calendar contains five days a week, Monday through Friday, all starting at 09:00 with a length of 08:00. When WORKDAY is specified, PROC CALENDAR treats the values of the DUR and HOLIDUR variables in units of working days, as defined in the DAYLENGTH= option, the CALEDATA= data set, or the default calendar. For example, if the working day is eight hours long, then a DUR value of 3.0 is treated as 24 hours.

Example "Example 5: Schedule Calendar, Blank or with Holidays" on page 284

Default DAY

Interactions If there is no CALEDATA= data set, PROC CALENDAR uses the work schedule defined in a default calendar.

The WEEKDAYS option automatically sets the INTERVAL= value to WORKDAY.

See "Calendars and Multiple Calendars" on page 222 and "Calendar Data Set " on page 229 for more information about the INTERVAL= option and the specification of working days; "The Default Calendars" on page 221

Example "Example 5: Schedule Calendar, Blank or with Holidays" on page 284

LEGEND

prints the names of the variables whose values appear in the calendar. This identifying text, or legend box, appears at the bottom of the page for each month if space permits. Otherwise, it is printed on the following page. PROC CALENDAR identifies each variable by name or by label if one exists. The order of variables in the legend matches their order in the calendar.

Restriction LEGEND applies only to summary calendars.

Interaction If you use the SUM and MEAN statements, then the legend box also contains SUM and MEAN values.

Example "Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

LOCALE

prints the names of months and weekdays in the language that is indicated by the value of the LOCALE= SAS system option. The LOCALE option in PROC CALENDAR does not change the starting day of the week.

Default If LOCALE is not specified, then names of months and weekdays are printed in English.

MEANTYPE=NOBS | NDAYS

specifies the type of mean to calculate for each month.

NOBS

calculates the mean over the number of *observations* displayed in the month.

NDAYS

calculates the mean over the number of *days* displayed in the month.

Default NOBS

Restriction MEANTYPE= applies only to summary calendars.

Interaction Normally, PROC CALENDAR displays all days for each month. However, it might omit some days if you use the OUTSTART statement with the OUTDUR or OUTFIN statement.

Example "Example 7: Summary Calendar with MEAN Values by Observation" on page 295

MISSING

determines how missing values are treated, based on the type of calendar.

Summary Calendar

If there is a day without an activity scheduled, then PROC CALENDAR prints the values of variables for that day by using the SAS or user-defined that is format specified for missing values.

Default If you omit MISSING, then days without activities contain no values.

Schedule Calendar
variables with missing values appear in the label of an activity, using the format specified for missing values.

Default If you do not specify MISSING, then PROC CALENDAR ignores missing values in labeling activities.

See "Missing Values in Input Data Sets" on page 232 for more information about missing values

WEEKDAYS
suppresses the display of Saturdays and Sundays in the output. It also specifies that the value of the INTERVAL= option is WORKDAY.

```
  proc calendar weekdays;
    start date;
run;
proc calendar interval=workday;
    start date;
outstart monday;
outfin friday;
run;
```

Default If you omit WEEKDAYS, then the calendar displays all seven days.

Tip The WEEKDAYS option is an alternative to using the combination of INTERVAL=WORKDAY and the OUTSTART and OUTFIN statements, as shown here:

Example "Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261

WORKDATA=*SAS-data-set*
specifies the *workdays data set*, a SAS data set that defines the work pattern during a standard working day. Each numeric variable in the workdays data set denotes a unique work-shift pattern during one working day.

Tip The workdays data set is useful in conjunction with the calendar data set.

See "Workdays Data Set " on page 231 and "Calendar Data Set " on page 229

Examples "Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271

"Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278

BY Statement

Processes activities separately for each BY group, producing a separate calendar for each value of the BY variable.

Supports: Summary and schedule calendars

See: "CALID Statement" on page 246
"BY" on page 74 (main discussion)
Example: "Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261

Syntax

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable, but the observations in the data set must be sorted by all the variables that you specify or have an appropriate index. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the observations are sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The observations are grouped in another way (for example, chronological order).

Details

When you use the CALID statement, you can process activities that apply to different calendars, indicated by the value of the CALID variable. Because you can specify only one CALID variable, however, you can create only one level of grouping. For example, if you want a calendar report to show the activities of several departments within a company, then you can identify each department with

the value of the CALID variable and produce calendar output that shows the calendars for all departments.

When you use a BY statement, however, you can further divide activities into related groups. For example, you can print calendar output that groups departmental calendars by division. The observations for activities must contain a variable that identifies which department an activity belongs to and a variable that identifies the division that a department resides in. Specify the variable that identifies the department with the CALID statement. Specify the variable that identifies the division with the BY statement.

CALID Statement

Processes activities in groups defined by the values of a calendar identifier variable.

Supports: Summary and schedule calendars

Tip: CALID is useful for producing multiple schedule calendars and for use with SAS/OR software.

See: "Calendar Data Set " on page 229

Examples: "Example 2: Schedule Calendar Containing Multiple Calendars" on page 266

"Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271

"Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278

"Example 6: Calculating a Schedule Based on Completion of Predecessor Tasks" on page 287

"Example 7: Summary Calendar with MEAN Values by Observation" on page 295

"Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

Syntax

CALID *variable*

</ OUTPUT=COMBINE | MIX | SEPARATE>;

Required Argument

variable

a character or numeric variable that identifies which calendar an observation contains data for.

Requirement If you specify the CALID variable, then both the activities and holidays data sets must contain this variable. If either of these data sets does not contain the CALID variable, then a default calendar is used.

Interaction SAS/OR software uses this variable to identify which calendar an observation contains data for.

Tip You do not need to use a CALID statement to create this variable. You can include the default variable _CALID_ in the input data sets.

See "Calendar Data Set " on page 229

Optional Argument

OUTPUT=COMBINE | MIX | SEPARATE
controls the amount of space required to display output for multiple calendars.

COMBINE
produces one page for each month that contains activities and subdivides each day by the CALID value.

Restriction The input data must be sorted by or indexed on the START variable.

Examples "Example 2: Schedule Calendar Containing Multiple Calendars" on page 266

"Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278

MIX
produces one page for each month that contains activities and does not identify activities by the CALID value.

Restriction The input data must be sorted by or indexed on the START variable.

Tip MIX requires the least space for output.

Example "Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278

SEPARATE
produces a separate page for each value of the CALID variable.

Restriction The input data must be sorted by the CALID variable and then by the START variable or must contain an appropriate composite index.

Examples "Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271

"Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

"Example 7: Summary Calendar with MEAN Values by Observation" on page 295

Default COMBINE

DUR Statement

Specifies the variable that contains the duration of each activity.

Alias: DURATION

Interaction: If you use both a DUR statement and a FIN statement, then DUR is ignored.

Supports: Schedule calendars

Tip: To produce a schedule calendar, you must use either a DUR or FIN statement.

Examples:
"Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261
"Example 2: Schedule Calendar Containing Multiple Calendars" on page 266
"Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271
"Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278
"Example 5: Schedule Calendar, Blank or with Holidays" on page 284

Syntax

DUR *variable*;

Required Argument

variable
contains the duration of each activity in a schedule calendar.

Range The duration can be a real or integral value.

Restriction This variable must be in the activities data set.

See For more information about activity durations, see "Activities Data Set " on page 226 and "Calendar Data Set " on page 229

Details

Duration is measured inclusively from the start of the activity (as given in the START variable). In the output, any activity that lasts part of a day is displayed as lasting a full day.

The INTERVAL= option in a PROC CALENDAR statement automatically sets the unit of the duration variable, depending on its own value as follows:

Table 9.11 *INTERVAL= Settings*

INTERVAL=	Default Length of the Duration Unit
DAY (the default)	24 hours
WORKDAY	8 hours

You can override the default length of a duration unit by using one of the following:

- the DAYLENGTH= option
- a D_LENGTH variable in the CALEDATA= data set

FIN Statement

Specifies the variable in the activities data set that contains the finishing date of each activity.

Alias: FINISH

Interaction: If you use both a FIN statement and a DUR statement, then FIN is used.

Supports: Schedule calendars

Tip: To produce a schedule calendar, you must use either a FIN or DUR statement.

Example: "Example 6: Calculating a Schedule Based on Completion of Predecessor Tasks" on page 287

Syntax

FIN *variable*;

Required Argument

variable
contains the finishing date of each activity.

Restrictions The values of *variable* must be either SAS date or datetime values.

If the FIN variable contains datetime values, then you must specify the DATETIME option in the PROC CALENDAR statement.

Both the START and FIN variables must have matching formats. For example, if one contains datetime values, then so must the other.

HOLIDUR Statement

Specifies the variable in the holidays data set that contains the duration of each holiday for a schedule calendar.

Alias: HOLIDURATION

Default: If you do not use a HOLIDUR or HOLIFIN statement, then all holidays last one day.

Restriction: You cannot use the HOLIDUR statement with a HOLIFIN statement.

Supports: Schedule calendars

Examples: "Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261
"Example 5: Schedule Calendar, Blank or with Holidays" on page 284

Syntax

HOLIDUR *variable*;

Required Argument

variable
contains the duration of each holiday.

Range: The duration can be a real or integral value.

Restriction: This variable must be in the holidays data set.

Examples: "Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271

"Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

Details

- If you use both the HOLIFIN and HOLIDUR statements, then PROC CALENDAR uses the HOLIFIN variable value to define each holiday's duration.
- Set the *unit* of the holiday duration variable in the same way that you set the unit of the duration variable; use either the INTERVAL= and DAYLENGTH= options or the CALEDATA= data set.
- Duration is measured inclusively from the start of the holiday (as given in the HOLISTART variable). In the output, any holiday lasting at least half a day appears as lasting a full day.

HOLIFIN Statement

Specifies the variable in the holidays data set that contains the finishing date of each holiday.

Alias: HOLIFINISH

Default: If you do not use a HOLIFIN or HOLIDUR statement, then all holidays last one day.

Supports: Schedule calendars

Syntax

HOLIFIN *variable*;

Required Argument

variable
contains the finishing date of each holiday.

Restrictions This variable must be in the holidays data set.

Values of *variable* must be in either SAS date or datetime values.

If the HOLIFIN variable contains datetime values, then you must specify the DATETIME option in the PROC CALENDAR statement.

If a HOLIFIN statement or a HOLIDUR statement is not specified, then all holidays last one day.

Details

If you use both the HOLIFIN and HOLIDUR statements, then PROC CALENDAR uses only the HOLIFIN variable.

HOLISTART Statement

Specifies a variable in the holidays data set that contains the starting date of each holiday.

Aliases: HOLISTA
HOLIDAY

Requirement: When you use a holidays data set, HOLISTART is required.

Supports: Summary and schedule calendars

Examples: "Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261
"Example 5: Schedule Calendar, Blank or with Holidays" on page 284

Syntax

HOLISTART *variable*;

Required Argument

variable
contains the starting date of each holiday.

Restrictions Values of *variable* must be in either SAS date or datetime values.

If the HOLISTART variable contains datetime values, then specify the DATETIME option in the PROC CALENDAR statement.

Details

- The holidays data set do not need to be sorted.
- All holidays last only one day, unless you use a HOLIFIN or HOLIDUR statement.
- If two or more holidays occur on the same day, then PROC CALENDAR uses only the first observation.

HOLIVAR Statement

Specifies a variable in the holidays data set whose values are used to label the holidays.

Aliases: HOLIVARIABLE
HOLINAME

Default: If you do not use a HOLIVAR statement, then PROC CALENDAR uses the word *DATE* to identify holidays.

Supports: Summary and schedule calendars

Examples: "Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261
"Example 5: Schedule Calendar, Blank or with Holidays" on page 284

Syntax

HOLIVAR *variable*;

Required Argument

variable
a variable whose values are used to label the holidays. Typically, this variable contains the names of the holidays.

Range character or numeric.

Restrictions This variable must be in the holidays data set.

If a HOLIVAR statement is not specified, then PROC CALENDAR use the word `DATE` to identify holidays.

Tip You can format the HOLIVAR variable as you like.

MEAN Statement

Specifies numeric variables in the activities data set for which mean values are to be calculated for each month.

Supports: Summary calendars

Tip: You can use multiple MEAN statements.

See: "Example 7: Summary Calendar with MEAN Values by Observation" on page 295

Syntax

MEAN *variable(s)* </ FORMAT=*format-name*>;

Required Argument

variable(s)
numeric variable for which mean values are calculated for each month.

Restriction This variable must be in the activities data set.

Optional Argument

FORMAT=*format-name*
names a SAS or user-defined format to be used in displaying the means requested.

Alias F=

Default BEST. format

Example "Example 7: Summary Calendar with MEAN Values by Observation" on page 295

Details

- The means appear at the bottom of the summary calendar page, if there is room. Otherwise, they appear on the following page.
- The means appear in the **LEGEND** box if you specify the LEGEND option.
- PROC CALENDAR automatically displays variables named in a MEAN statement in the calendar output, even if the variables are not named in the VAR statement.

OUTDUR Statement

Specifies in days the length of the week to be displayed.

Alias: OUTDURATION

Requirement: The OUTSTART statement is required.

Syntax

OUTDUR *number-of-days*;

Required Argument

number-of-days
an integer that expresses the length in days of the week to be displayed.

Details

Use either the OUTDUR or OUTFIN statement to supply the procedure with information about the length of the week to display. If you use both, then PROC CALENDAR ignores the OUTDUR statement.

OUTFIN Statement

Specifies the last day of the week to display in the calendar.

Alias: OUTFINISH

Requirement: The OUTSTART statement is required.

See: "Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

Examples: “Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)” on page 271
“Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)” on page 278
“Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)” on page 300

Syntax

OUTFIN *day-of-week*;

Required Argument

day-of-week
the name of the last day of the week to display. For example,

```
outfin friday;
```

Details

Use either the OUTFIN or OUTDUR statement to supply the procedure with information about the length of the week to display. If you use both, then PROC CALENDAR uses only the OUTFIN statement.

OUTSTART Statement

Specifies the starting day of the week to display in the calendar.

Alias: OUTSTA

Default: If you do not use OUTSTART, then each calendar week begins with Sunday.

See: “Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)” on page 300

Examples: “Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)” on page 271
“Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)” on page 278
“Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)” on page 300

Syntax

OUTSTART *day-of-week*;

Required Argument

day-of-week
the name of the starting day of the week for each week in the calendar. For example,

```
outstart monday;
```

Details

By default, a calendar displays all seven days in a week. Use OUTDUR or OUTFIN, in conjunction with OUTSTART, to control how many days are displayed and which day starts the week.

START Statement

Specifies the variable in the activities data set that contains the starting date of each activity.

Aliases: STA
DATE
ID

Requirement: START is required for both summary and schedule calendars.

Example: "Example 1: Schedule Calendar with Holidays: 5-Day Default" on page 261

Syntax

START *variable*;

Required Argument

variable
contains the starting date of each activity.

Restrictions This variable must be in the activities data set.

Values of *variable* must be in either SAS date or datetime values.

If you use datetime values, then specify the DATETIME option in the PROC CALENDAR statement.

Both the START and FIN variables must have matching formats. For example, if one contains datetime values, then so must the other.

SUM Statement

Specifies numeric variables in the activities data set to total for each month.

Supports: Summary calendars

Tip: To apply different formats to variables that are being summed, use multiple SUM statements.

Examples: "Example 7: Summary Calendar with MEAN Values by Observation" on page 295

"Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

Syntax

SUM *variable(s)* </ FORMAT=*format-name*>;

Required Argument

variable(s)
specifies one or more numeric variables to total for each month.

Restriction This variable must be in the activities data set.

Optional Argument

FORMAT=*format-name*
names a SAS or user-defined format to use in displaying the sums requested.

Alias F=

Default BEST. format

Examples "Example 7: Summary Calendar with MEAN Values by Observation" on page 295

"Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)" on page 300

Details

- The sum appears at the bottom of the calendar page, if there is room. Otherwise, it appears on the following page.
- The sum appears in the **LEGEND** box if you specify the LEGEND option.
- PROC CALENDAR automatically displays variables named in a SUM statement in the calendar output, even if the variables are not named in the VAR statement.

VAR Statement

Specifies the variables that you want to display for each activity.

Alias: VARIABLE

Example: "Example 6: Calculating a Schedule Based on Completion of Predecessor Tasks" on page 287

Syntax

VAR *variable(s)*;

Required Argument

variable(s)
specifies one or more variables that you want to display in the calendar.

Range The values of *variable* can be either character or numeric.

Restriction These variables must be in the activities data set.

Tip You can apply a format to this variable.

Details

When VAR Is Not Used

If you do not use a VAR statement, then the procedure displays all variables in the activities data set in the order in which they occur in the data set, except for the BY, CALID, START, DUR, and FIN variables. However, not all variables are displayed if the LINESIZE= and PAGESIZE= settings do not allow enough space in the calendar.

Display of Variables

- PROC CALENDAR displays variables in the order in which they appear in the VAR statement. Not all variables are displayed, however, if the LINESIZE= and PAGESIZE= settings do not allow enough space in the calendar.
- PROC CALENDAR also displays any variable named in a SUM or MEAN statement for each activity in the calendar output. It displays the variable even if you do not name that variable in a VAR statement.

Results: CALENDAR Procedure

What Affects the Quantity of PROC CALENDAR Output

The quantity of printed calendar output depends on the following variables:

- the range of dates in the activities data set
- whether the FILL option is specified
- the BY statement
- the CALID statement

PROC CALENDAR always prints one calendar for every month that contains any activities. If you specify the FILL option, then the procedure prints every month between the first and last activities, including months that contain no activities. Using the BY statement prints one set of output for each BY value. Using the CALID statement with OUTPUT=SEPARATE prints one set of output for each value of the CALID variable.

How Size Affects the Format of PROC CALENDAR Output

PROC CALENDAR always attempts to fit the calendar within a single page, as defined by the SAS system options PAGESIZE= and LINESIZE=. If the PAGESIZE= and LINESIZE= values do not allow sufficient room, then PROC CALENDAR might print the legend box on a separate page. If necessary, PROC CALENDAR truncates or omits values to make the output fit the page and prints messages to that effect in the SAS log.

What Affects the Lines That Show Activity Duration

In a schedule calendar, the duration of an activity is shown by a continuous line through each day of the activity. Values of variables for each activity are printed on the same line, separated by slashes (/). Each activity begins and ends with a plus sign (+). If an activity continues from one week to the next, then PROC CALENDAR displays arrows (< >) at the points of continuation.

The length of the activity lines depends on the amount of horizontal space available. You can increase the length by specifying the following variables:

- a larger line size with the LINESIZE= option in the OPTIONS statement
- the WEEKDAYS option to suppress the printing of Saturday and Sunday, which provides more space for Monday through Friday

Customizing the Calendar Appearance

PROC CALENDAR uses 17 of the 20 SAS formatting characters to construct the outline of the calendar and to print activity lines and to indicate holidays. You can use the FORMCHAR= option to customize the appearance of your PROC CALENDAR output by substituting your own characters for the default. See Figure 9.12 on page 240 and Table 9.15 on page 240.

If your printer supports an *extended character set* (one that includes graphics characters in addition to the regular alphanumeric characters), then you can greatly improve the appearance of your output by using the FORMCHAR= option to redefine formatting characters with hexadecimal characters. For information about which hexadecimal codes to use for which characters, consult the documentation for your hardware. For an example of assigning hexadecimal values, see *"formatting-character(s)"* on page 239.

Portability of ODS Output with PROC CALENDAR

Under certain circumstances, using PROC CALENDAR with the Output Delivery System produces files that are not portable. If the SAS system option FORMCHAR= in your SAS session uses nonstandard line-drawing characters, then the output might include strange characters instead of lines in operating environments in which the SAS Monospace font is not installed. To avoid this problem, specify the following OPTIONS statement before executing PROC CALENDAR:

```
options formchar="|----|+|---+=|-/\<>*";
```

Examples: CALENDAR Procedure

Example 1: Schedule Calendar with Holidays: 5-Day Default

Features:

PROC CALENDAR statement options
- DATA=
- HOLIDATA=
- WEEKDAYS

Other statements
- DUR statement
- HOLISTART statement
- HOLIVAR statement
- HOLIDUR statement
- START statement

Other features
- PROC SORT statement
- BY statement
- 5-day default calendar

Details

This example does the following:

- creates a schedule calendar
- uses one of the two default work patterns: 8-hour day, 5-day week
- schedules activities around holidays
- displays a 5-day week

Program

```
data allacty;
   input date : date7. event $ 9-36 who $ 37-48 long;
   datalines;
01JUL02 Dist. Mtg.                  All          1
```

```
17JUL02 Bank Meeting               1st Natl     1
02JUL02 Mgrs. Meeting              District 6   2
11JUL02 Mgrs. Meeting              District 7   2
03JUL02 Interview                  JW           1
08JUL02 Sales Drive                District 6   5
15JUL02 Sales Drive                District 7   5
08JUL02 Trade Show                 Knox         3
22JUL02 Inventors Show             Melvin       3
11JUL02 Planning Council           Group II     1
18JUL02 Planning Council           Group III    1
25JUL02 Planning Council           Group IV     1
12JUL02 Seminar                    White        1
19JUL02 Seminar                    White        1
18JUL02 NewsLetter Deadline        All          1
05JUL02 VIP Banquet                JW           1
19JUL02 Co. Picnic                 All          1
16JUL02 Dentist                    JW           1
24JUL02 Birthday                   Mary         1
25JUL02 Close Sale                 WYGIX Co.    2
;

data hol;
   input date : date7. holiday $ 11-25 holilong @27;
   datalines;
05jul02   Vacation        3
04jul02   Independence    1
;

proc sort data=allacty;
   by date;
run;

options formchar="|----|+|---+=|-/\<>*";

proc calendar data=allacty holidata=hol weekdays;

   start date;
   dur long;

   holistart date;
   holivar holiday;
   holidur holilong;

   title1 'Summer Planning Calendar:  Julia Cho';
   title2 'President, Community Bank';
run;
```

Program Description

Create the activities data set. Allacty contains both personal and business activities information for a bank president.

```
data allacty;
   input date : date7. event $ 9-36 who $ 37-48 long;
   datalines;
01JUL02 Dist. Mtg.                 All          1
17JUL02 Bank Meeting               1st Natl     1
02JUL02 Mgrs. Meeting              District 6   2
```

```
11JUL02 Mgrs. Meeting              District 7   2
03JUL02 Interview                  JW           1
08JUL02 Sales Drive                District 6   5
15JUL02 Sales Drive                District 7   5
08JUL02 Trade Show                 Knox         3
22JUL02 Inventors Show             Melvin       3
11JUL02 Planning Council           Group II     1
18JUL02 Planning Council           Group III    1
25JUL02 Planning Council           Group IV     1
12JUL02 Seminar                    White        1
19JUL02 Seminar                    White        1
18JUL02 NewsLetter Deadline        All          1
05JUL02 VIP Banquet                JW           1
19JUL02 Co. Picnic                 All          1
16JUL02 Dentist                    JW           1
24JUL02 Birthday                   Mary         1
25JUL02 Close Sale                 WYGIX Co.    2
;
```

Create the holidays data set.

```
data hol;
   input date : date7. holiday $ 11-25 holilong @27;
   datalines;
05jul02   Vacation        3
04jul02   Independence    1
;
```

Sort the activities data set by the variable that contains the starting date. You are not required to sort the holidays data set.

```
proc sort data=allacty;
   by date;
run;
```

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the schedule calendar. DATA= identifies the activities data set; HOLIDATA= identifies the holidays data set. WEEKDAYS specifies that a week consists of five eight-hour work days.

```
proc calendar data=allacty holidata=hol weekdays;
```

Specify an activity start date variable and an activity duration variable. The START statement specifies the variable in the activities data set that contains the starting date of the activities; DUR specifies the variable that contains the duration of each activity. Creating a schedule calendar requires START and DUR.

```
   start date;
   dur long;
```

Retrieve holiday information. The HOLISTART, HOLIVAR, and HOLIDUR statements specify the variables in the holidays data set that contain the start date, name, and duration of each holiday, respectively. When you use a holidays data set, HOLISTART is required. Because at least one holiday lasts more than one day, HOLIDUR is required.

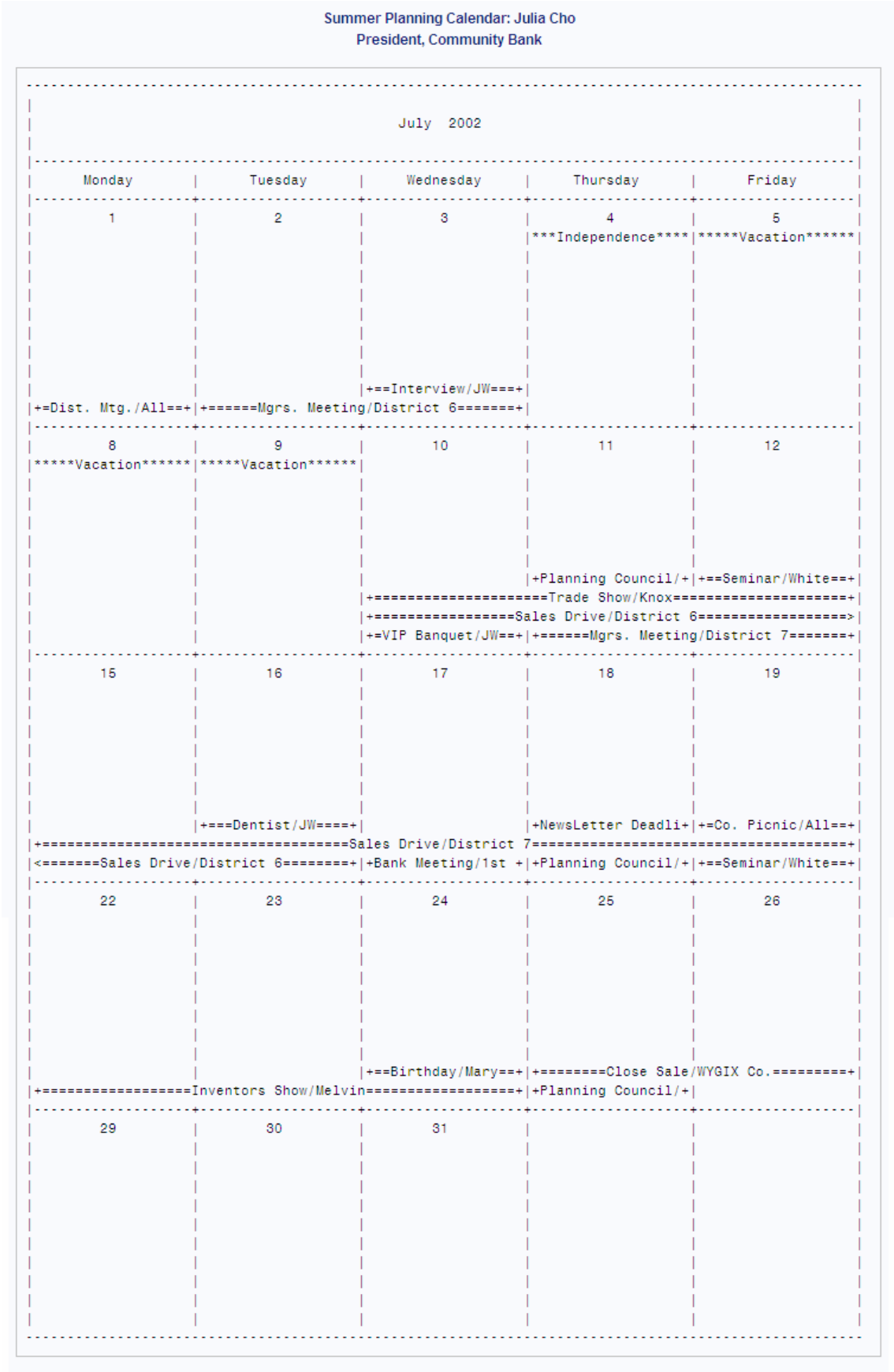
```
   holistart date;
   holivar holiday;
   holidur holilong;
```

Specify the titles.

```
   title1 'Summer Planning Calendar:  Julia Cho';
   title2 'President, Community Bank';
run;
```

Output: HTML

Output 9.4 *Summer Planning Calendar: Julia Cho*



Summer Planning Calendar: Julia Cho
President, Community Bank

July 2002

Monday	Tuesday	Wednesday	Thursday	Friday
1	2	3	4 ***Independence****	5 *****Vacation******
+=Dist. Mtg./All==+	+======Mgrs. Meeting/District 6=======+	+==Interview/JW===+		
8 *****Vacation******	9 *****Vacation******	10	11	12
	+===Dentist/JW====+	+VIP Banquet/JW==+	+Planning Council/+ +NewsLetter Deadli+	+==Seminar/White==+ +=Co. Picnic/All==+
		+=====================Trade Show/Knox=====================+		
		+=================Sales Drive/District 6==================>		
		+======Mgrs. Meeting/District 7=======+		
15	16	17	18	19
<=======Sales Drive/District 6========+		+Bank Meeting/1st +	+Planning Council/+	+==Seminar/White==+
		+=====================Sales Drive/District 7=====================+		
22	23	24	25	26
+==================Inventors Show/Melvin==================+		+==Birthday/Mary==+	+========Close Sale/WYGIX Co.=========+ +Planning Council/+	
29	30	31		

Example 2: Schedule Calendar Containing Multiple Calendars

Features:

CALID statement
- _CAL_ variable
- OUTPUT=COMBINE option

Others
- DUR statement
- 24-hour day, 7-day week

Details

This example builds on Example 1 by identifying activities as belonging to one of two calendars, business or personal. This example does the following:

- produces a schedule calendar report
- prints two calendars on the same output page
- schedules activities around holidays
- uses one of the two default work patterns: 24-hour day, 7-day week
- identifies activities and holidays by calendar name

Program

```
data allacty2;
  input date:date7. happen $ 10-34 who $ 35-47 _CAL_ $ long;
  datalines;
01JUL02  Dist. Mtg.              All          CAL1   1
02JUL02  Mgrs. Meeting           District 6   CAL1   2
03JUL02  Interview               JW           CAL1   1
05JUL02  VIP Banquet             JW           CAL1   1
06JUL02  Beach trip              family       CAL2   2
08JUL02  Sales Drive             District 6   CAL1   5
08JUL02  Trade Show              Knox         CAL1   3
09JUL02  Orthodontist            Meagan       CAL2   1
11JUL02  Mgrs. Meeting           District 7   CAL1   2
11JUL02  Planning Council        Group II     CAL1   1
12JUL02  Seminar                 White        CAL1   1
14JUL02  Co. Picnic              All          CAL1   1
14JUL02  Business trip           Fred         CAL2   2
15JUL02  Sales Drive             District 7   CAL1   5
16JUL02  Dentist                 JW           CAL1   1
```

```
17JUL02  Bank Meeting             1st Natl     CAL1   1
17JUL02  Real estate agent        Family       CAL2   1
18JUL02  NewsLetter Deadline      All          CAL1   1
18JUL02  Planning Council         Group III    CAL1   1
19JUL02  Seminar                  White        CAL1   1
22JUL02  Inventors Show           Melvin       CAL1   3
24JUL02  Birthday                 Mary         CAL1   1
25JUL02  Planning Council         Group IV     CAL1   1
25JUL02  Close Sale               WYGIX Co.    CAL1   2
27JUL02  Ballgame                 Family       CAL2   1
;

data vac;
   input hdate:date7.  holiday $ 11-25 _CAL_ $ ;
   datalines;
29JUL02   vacation               CAL2
04JUL02   Independence           CAL1
;

proc sort data=allacty2;
   by date;
run;

options formchar="|----|+|---+=|-/\<>*";

proc calendar data=allacty2 holidata=vac;

   calid _CAL_ / output=combine;

   start date ;
   dur long;

   holistart hdate;
   holivar holiday;

   title1 'Summer Planning Calendar:  Julia Cho';
   title2 'President, Community Bank';
   title3 'Work and Home Schedule';
run;
```

Program Description

Create the activities data set and identify separate calendars. Allacty2 contains both personal and business activities for a bank president. The _CAL_ variable identifies which calendar an event belongs to.

```
data allacty2;
  input date:date7. happen $ 10-34 who $ 35-47 _CAL_ $ long;
  datalines;
01JUL02  Dist. Mtg.               All          CAL1   1
02JUL02  Mgrs. Meeting            District 6   CAL1   2
03JUL02  Interview                JW           CAL1   1
05JUL02  VIP Banquet              JW           CAL1   1
06JUL02  Beach trip               family       CAL2   2
08JUL02  Sales Drive              District 6   CAL1   5
08JUL02  Trade Show               Knox         CAL1   3
09JUL02  Orthodontist             Meagan       CAL2   1
11JUL02  Mgrs. Meeting            District 7   CAL1   2
```

```
11JUL02  Planning Council         Group II     CAL1   1
12JUL02  Seminar                  White        CAL1   1
14JUL02  Co. Picnic               All          CAL1   1
14JUL02  Business trip            Fred         CAL2   2
15JUL02  Sales Drive              District 7   CAL1   5
16JUL02  Dentist                  JW           CAL1   1
17JUL02  Bank Meeting             1st Natl     CAL1   1
17JUL02  Real estate agent        Family       CAL2   1
18JUL02  NewsLetter Deadline      All          CAL1   1
18JUL02  Planning Council         Group III    CAL1   1
19JUL02  Seminar                  White        CAL1   1
22JUL02  Inventors Show           Melvin       CAL1   3
24JUL02  Birthday                 Mary         CAL1   1
25JUL02  Planning Council         Group IV     CAL1   1
25JUL02  Close Sale               WYGIX Co.    CAL1   2
27JUL02  Ballgame                 Family       CAL2   1
;
```

Create the holidays data set and identify which calendar a holiday affects. The _CAL_ variable identifies which calendar a holiday belongs to.

```
data vac;
   input hdate:date7.  holiday $ 11-25 _CAL_ $ ;
   datalines;
29JUL02   vacation               CAL2
04JUL02   Independence           CAL1
;
```

Sort the activities data set by the variable that contains the starting date. When creating a calendar with combined output, you sort only by the activity starting date, not by the CALID variable. You are not required to sort the holidays data set.

```
proc sort data=allacty2;
   by date;
run;
```

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the schedule calendar. DATA= identifies the activities data set; HOLIDATA= identifies the holidays data set. By default, the output calendar displays a 7-day week.

```
proc calendar data=allacty2 holidata=vac;
```

Combine all events and holidays on a single calendar. The CALID statement specifies the variable that identifies which calendar an event belongs to. OUTPUT=COMBINE places all events and holidays on the same calendar.

```
   calid _CAL_ / output=combine;
```

Specify an activity start date variable and an activity duration variable. The START statement specifies the variable in the activities data set that contains the starting date of the activities; DUR specifies the variable that contains the duration of each activity. Creating a schedule calendar requires START and DUR.

```
   start date ;
```

```
    dur long;
```

Retrieve holiday information. The HOLISTART and HOLIVAR statements specify the variables in the holidays data set that contain the start date and name of each holiday, respectively. HOLISTART is required when you use a holidays data set.

```
    holistart hdate;
    holivar holiday;
```

Specify the titles.

```
    title1 'Summer Planning Calendar:  Julia Cho';
    title2 'President, Community Bank';
    title3 'Work and Home Schedule';
run;
```

Output: HTML

Output 9.5 *Summer Planning Calendar - Work and Home Schedule*

Summer Planning Calendar: Julia Cho
President, Community Bank
Work and Home Schedule

July 2002

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6
CAL2						+Beach trip>
CAL1	+Dist. Mtg.+	+Mgrs. Meeting	+Interview/+ /District +	Independence	+VIP Banque+	
7	8	9	10	11	12	13
CAL2	<Beach trip+	+Orthodonti+				
CAL1	+==========Trade Show/Knox==========+			+Planning C+	+Seminar/Wh+	
	+====================Sales Drive/District 6====================+			+Mgrs. Meeting/District +		
14	15	16	17	18	19	20
CAL2	+==Business trip/Fred===+		+Real estat+			
CAL1		+Dentist/JW+	+Bank Meeti+	+Planning C+ +NewsLetter+	+Seminar/Wh+	
	+Co. Picnic+	+====================Sales Drive/District 7====================+				
21	22	23	24	25	26	27
CAL2						+Ballgame/F+
CAL1			+Birthday/M+	+=Close Sale/WYGIX Co.==+		
	+=======Inventors Show/Melvin========+			+Planning C+		
28	29	30	31			
CAL2	**vacation**					

Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)

Features:

PROC CALENDAR statement options
- CALEDATA=
- DATETIME
- WORKDATA=

CALID statement
- _CAL_ variable
- OUTPUT=SEPARATE option

Other statements
- DUR statement
- OUTSTART statement
- OUTFIN statement

Details

This example does the following:

- produces separate output pages for each calendar in a single PROC step
- schedules activities around holidays
- displays an 8-hour day, 5 1/2-day week
- uses separate work patterns and holidays for each calendar

Producing Different Output for Multiple Calendars

This example and "Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)" on page 278 use the same input data for multiple calendars to produce different output. The only differences in these programs are how the activities data set is sorted and how the OUTPUT= option is set.

Table 9.12 Sort and OUTPUT= Settings

Print Options	Sorting Variables	OUTPUT= Settings	Examples
Separate pages for each calendar	Calendar ID and starting date	SEPARATE	3, 8
All activities on the same page and identify each calendar	Starting date	COMBINE	4, 2
All activities on the same page and NOT identify each calendar	Starting date	MIX	4

Program

```
libname well 'SAS-library';

data well.act;
   input task & $16. dur : 5. date : datetime16.  _cal_ $ cost;
   datalines;
Drill Well          3.50  01JUL02:12:00:00  CAL1   1000
Lay Power Line      3.00  04JUL02:12:00:00  CAL1   2000
Assemble Tank       4.00  05JUL02:08:00:00  CAL1   1000
Build Pump House    3.00  08JUL02:12:00:00  CAL1   2000
Pour Foundation     4.00  11JUL02:08:00:00  CAL1   1500
Install Pump        4.00  15JUL02:14:00:00  CAL1    500
Install Pipe        2.00  19JUL02:08:00:00  CAL1   1000
Erect Tower         6.00  20JUL02:08:00:00  CAL1   2500
Deliver Material    2.00  01JUL02:12:00:00  CAL2    500
Excavate            4.75  03JUL02:08:00:00  CAL2   3500
;

data well.hol;
   input date date. holiday $ 11-25 _cal_ $;
   datalines;
09JUL02   Vacation            CAL2
04JUL02   Independence        CAL1
;

data well.cal;
   input _sun_ $ _sat_ $ _mon_ $ _tue_ $ _wed_ $ _thu_ $
         _fri_ $ _cal_ $;
   datalines;
Holiday Holiday  Workday Workday Workday Workday Workday CAL1
Holiday Halfday  Workday Workday Workday Workday Workday CAL2
;

data well.wor;
   input halfday time5.;
   datalines;
```

```
08:00
12:00
;

proc sort data=well.act;
   by _cal_ date;
run;

options formchar="|----|+|---+=|-/\<>*";

proc calendar data=well.act
              holidata=well.hol
              caledata=well.cal
              workdata=well.wor
              datetime;

   calid _cal_ / output=separate;

   start date;
   dur dur;

   holistart date;
   holivar holiday;

   outstart Monday;
   outfin Saturday;

   title1 'Well Drilling Work Schedule: Separate Calendars';
   format cost dollar9.2;
run;
```

Program Description

Specify a library so that you can permanently store the activities data set.

```
libname well 'SAS-library';
```

Create the activities data set and identify separate calendars. Well.Act is a permanent SAS data set that contains activities for a well construction project. The _CAL_ variable identifies the calendar that an activity belongs to.

```
data well.act;
   input task & $16. dur : 5. date : datetime16.  _cal_ $ cost;
   datalines;
Drill Well          3.50  01JUL02:12:00:00  CAL1   1000
Lay Power Line      3.00  04JUL02:12:00:00  CAL1   2000
Assemble Tank       4.00  05JUL02:08:00:00  CAL1   1000
Build Pump House    3.00  08JUL02:12:00:00  CAL1   2000
Pour Foundation     4.00  11JUL02:08:00:00  CAL1   1500
Install Pump        4.00  15JUL02:14:00:00  CAL1    500
Install Pipe        2.00  19JUL02:08:00:00  CAL1   1000
Erect Tower         6.00  20JUL02:08:00:00  CAL1   2500
Deliver Material    2.00  01JUL02:12:00:00  CAL2    500
Excavate            4.75  03JUL02:08:00:00  CAL2   3500
;
```

Create the holidays data set. The _CAL_ variable identifies the calendar that a holiday belongs to.

```
data well.hol;
   input date date. holiday $ 11-25 _cal_ $;
   datalines;
09JUL02   Vacation            CAL2
04JUL02   Independence        CAL1
;
```

Create the calendar data set. Each observation defines the work shifts for an entire week. The _CAL_ variable identifies to which calendar the work shifts apply. CAL1 uses the default 8-hour work shifts for Monday through Friday. CAL2 uses a half day on Saturday and the default 8-hour work shift for Monday through Friday.

```
data well.cal;
   input _sun_ $ _sat_ $ _mon_ $ _tue_ $ _wed_ $ _thu_ $
         _fri_ $ _cal_ $;
   datalines;
Holiday Holiday  Workday Workday Workday Workday Workday CAL1
Holiday Halfday  Workday Workday Workday Workday Workday CAL2
;
```

Create the workdays data set. This data set defines the daily work shifts that are named in the calendar data set. Each variable (not observation) contains one daily schedule of alternating work and nonwork periods. The HALFDAY work shift lasts 4 hours.

```
data well.wor;
   input halfday time5.;
   datalines;
08:00
12:00
;
```

Sort the activities data set by the variables that contain the calendar identification and the starting date, respectively. You are not required to sort the holidays data set.

```
proc sort data=well.act;
   by _cal_ date;
run;
```

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the schedule calendar. DATA= identifies the activities data set; HOLIDATA= identifies the holidays data set; CALEDATA= identifies the calendar data set; WORKDATA= identifies the workdays data set. DATETIME specifies that the variable specified with the START statement contains values in SAS datetime format.

```
proc calendar data=well.act
              holidata=well.hol
              caledata=well.cal
              workdata=well.wor
              datetime;
```

Print each calendar on a separate page. The CALID statement specifies that the _CAL_ variable identifies calendars. OUTPUT=SEPARATE prints information for each calendar on separate pages.

```
calid _cal_ / output=separate;
```

Specify an activity start date variable and an activity duration variable. The START statement specifies the variable in the activities data set that contains the activity starting date; DUR specifies the variable that contains the activity duration. START and DUR are required for a schedule calendar.

```
start date;
dur dur;
```

Retrieve holiday information. HOLISTART and HOLIVAR specify the variables in the holidays data set that contain the start date and name of each holiday, respectively. HOLISTART is required when you use a holidays data set.

```
holistart date;
holivar holiday;
```

Customize the calendar appearance. OUTSTART and OUTFIN specify that the calendar display a 6-day week, Monday through Saturday.

```
outstart Monday;
outfin Saturday;
```

Specify the title and format the Cost variable.

```
   title1 'Well Drilling Work Schedule: Separate Calendars';
   format cost dollar9.2;
run;
```

Output: HTML

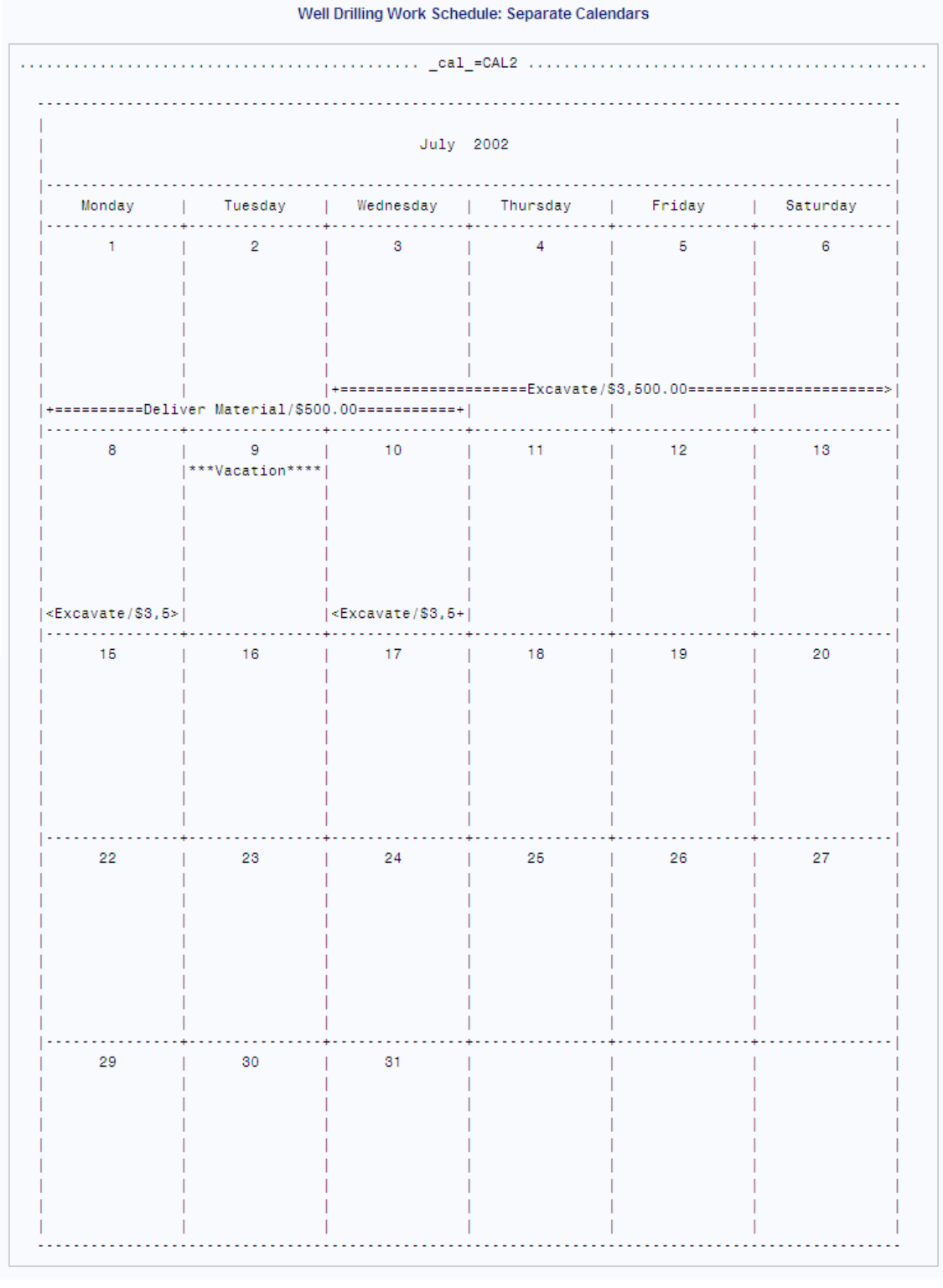
Output 9.6 *Part One of Well Drilling Work Schedule*

Well Drilling Work Schedule: Separate Calendars

```
.............................................. _cal_=CAL1 ..............................................

 -------------------------------------------------------------------------------------------------
|                                                                                                 |
|                                          July  2002                                             |
|                                                                                                 |
|-------------------------------------------------------------------------------------------------|
|    Monday     |    Tuesday    |   Wednesday   |   Thursday    |    Friday     |   Saturday    |
|---------------+---------------+---------------+---------------+---------------+---------------|
|       1       |       2       |       3       |       4       |       5       |       6       |
|               |               |               |*Independence**|               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |+Assemble Tank>|               |
|               |               |               |               |+Lay Power Lin>|               |
|+============Drill Well/$1,000.00=============>|               |<Drill Well/$1+|               |
|---------------+---------------+---------------+---------------+---------------+---------------|
|       8       |       9       |      10       |      11       |      12       |      13       |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|+================Build Pump House/$2,000.00=================+|               |               |
|<==================Assemble Tank/$1,000.00==================+|               |               |
|<==Lay Power Line/$2,000.00===+|               |+==Pour Foundation/$1,500.00==>|               |
|---------------+---------------+---------------+---------------+---------------+---------------|
|      15       |      16       |      17       |      18       |      19       |      20       |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|+============================Install Pump/$500.00============================+|               |
|<==========Pour Foundation/$1,500.00==========+|               |+Install Pipe/>|               |
|---------------+---------------+---------------+---------------+---------------+---------------|
|      22       |      23       |      24       |      25       |      26       |      27       |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|+============================Erect Tower/$2,500.00============================>|               |
|<===Install Pipe/$1,000.00====+|               |               |               |               |
|---------------+---------------+---------------+---------------+---------------+---------------|
|      29       |      30       |      31       |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|               |               |               |               |               |               |
|<Erect Tower/$+|               |               |               |               |               |
 -------------------------------------------------------------------------------------------------
```

Output 9.7 *Part Two of Well Drilling Work Schedule*



Example 4: Multiple Schedule Calendars with Atypical Work Shifts (Combined and Mixed Output)

Features:

PROC CALENDAR statement options
- CALEDATA=
- DATETIME
- WORKDATA=

CALID statement
- _CAL_ variable
- OUTPUT=COMBINE option
- OUTPUT=MIXED option

Other statement
- DUR statement
- OUTSTART statement
- OUTFIN statement

Data sets:

Well.Aact

Well.Hol

Well.Cal

Well.Wor

Details

This example does the following:

- produces a schedule calendar
- schedules activities around holidays
- uses separate work patterns and holidays for each calendar
- uses an 8-hour day, 5 1/2-day work week
- displays and identifies multiple calendars on each calendar page (combined output)
- displays *but does not identify* multiple calendars on each calendar page (mixed output)

This example creates both combined and mixed output. Producing combined or mixed calendar output requires only one change to a PROC CALENDAR step: the setting of the OUTPUT= option in the CALID statement. Combined output is produced first, then mixed output.

This example and "Example 3: Multiple Schedule Calendars with Atypical Work Shifts (Separated Output)" on page 271 use the same input data for multiple calendars to produce different output. The only differences in these programs are how the activities data set is sorted and how the OUTPUT= option is set.

Table 9.13 *Sort and OUTPUT= Settings*

Print Options	Sorting Variables	OUTPUT= Settings	Examples
Separate pages for each calendar	Calendar ID and starting date	SEPARATE	3, 8
All activities on the same page and identify each calendar	Starting date	COMBINE	4, 2
All activities on the same page and NOT identify each calendar	Starting date	MIX	4

Program for Combined Characters

```
libname well
'SAS-library';

proc sort data=well.act;
   by date;
run;

options formchar="|----|+|---+=|-/\<>*";

proc calendar data=well.act
              holidata=well.hol
              caledata=well.cal
              workdata=well.wor
              datetime;

   calid _cal_ / output=combine;

   start date;
   dur dur;

   holistart date;
   holivar holiday;

   title1 'Well Drilling Work Schedule: Combined Calendars';
   format cost dollar9.2;
run;
```

Program Description

Specify the SAS library where the activities data set is stored.

```
libname well
'SAS-library';
```

Sort the activities data set by the variable that contains the starting date. Do not sort by the CALID variable when producing combined calendar output.

```
proc sort data=well.act;
   by date;
run;
```

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the schedule calendar. DATA= identifies the activities data set; HOLIDATA= identifies the holidays data set; CALEDATA= identifies the calendar data set; WORKDATA= identifies the workdays data set. DATETIME specifies that the variable specified with the START statement contains values in SAS datetime format.

```
proc calendar data=well.act
              holidata=well.hol
              caledata=well.cal
              workdata=well.wor
              datetime;
```

Combine all events and holidays on a single calendar. The CALID statement specifies that the _CAL_ variable identifies the calendars. OUTPUT=COMBINE prints multiple calendars on the same page and identifies each calendar.

```
   calid _cal_ / output=combine;
```

Specify an activity start date variable and an activity duration variable. The START statement specifies the variable in the activities data set that contains the starting date of the activities; DUR specifies the variable that contains the duration of each activity. START and DUR are required for a schedule calendar.

```
   start date;
   dur dur;
```

Retrieve holiday information. HOLISTART and HOLIVAR specify the variables in the holidays data set that contain the start date and name of each holiday, respectively. HOLISTART is required when you use a holidays data set.

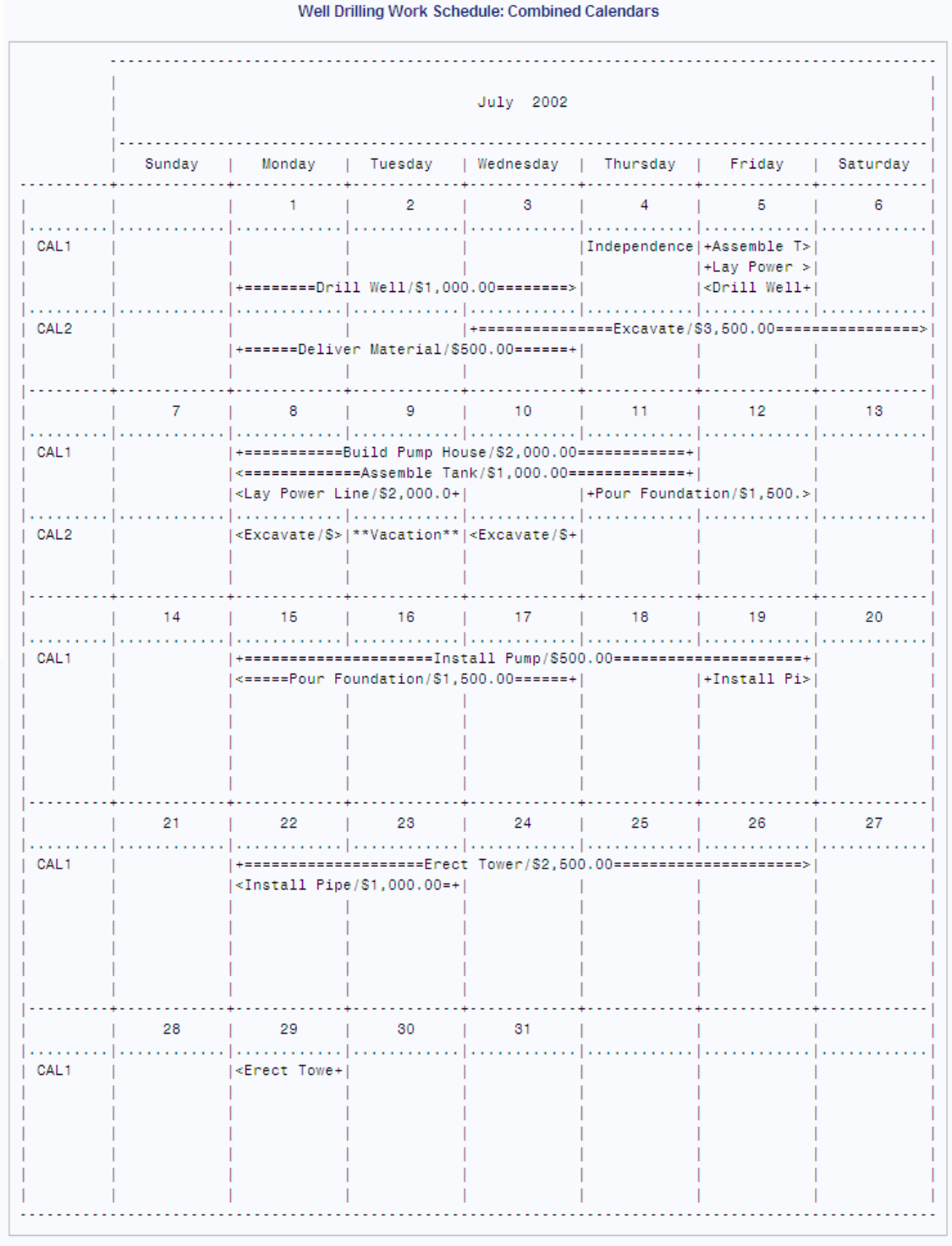
```
   holistart date;
   holivar holiday;
```

Specify the title and format the Cost variable.

```
   title1 'Well Drilling Work Schedule: Combined Calendars';
   format cost dollar9.2;
run;
```

Output: HTML

Output 9.8 *Well Drilling Work Schedule: Combined Calendars*



Well Drilling Work Schedule: Combined Calendars

July 2002

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
CAL1		1	2	3	4	5	6
					Independence	+Assemble T>	
						+Lay Power >	
		+========Drill Well/$1,000.00========>				<Drill Well+	
CAL2				+================Excavate/$3,500.00================>			
		+======Deliver Material/$500.00======+					
	7	8	9	10	11	12	13
CAL1		+===========Build Pump House/$2,000.00============+					
		<=============Assemble Tank/$1,000.00=============+					
		<Lay Power Line/$2,000.0+			+Pour Foundation/$1,500.>		
CAL2		<Excavate/$>	**Vacation**	<Excavate/$+			
	14	15	16	17	18	19	20
CAL1		+====================Install Pump/$500.00====================+					
		<=====Pour Foundation/$1,500.00======+				+Install Pi>	
	21	22	23	24	25	26	27
CAL1		+====================Erect Tower/$2,500.00====================>					
		<Install Pipe/$1,000.00=+					
	28	29	30	31			
CAL1		<Erect Towe+					

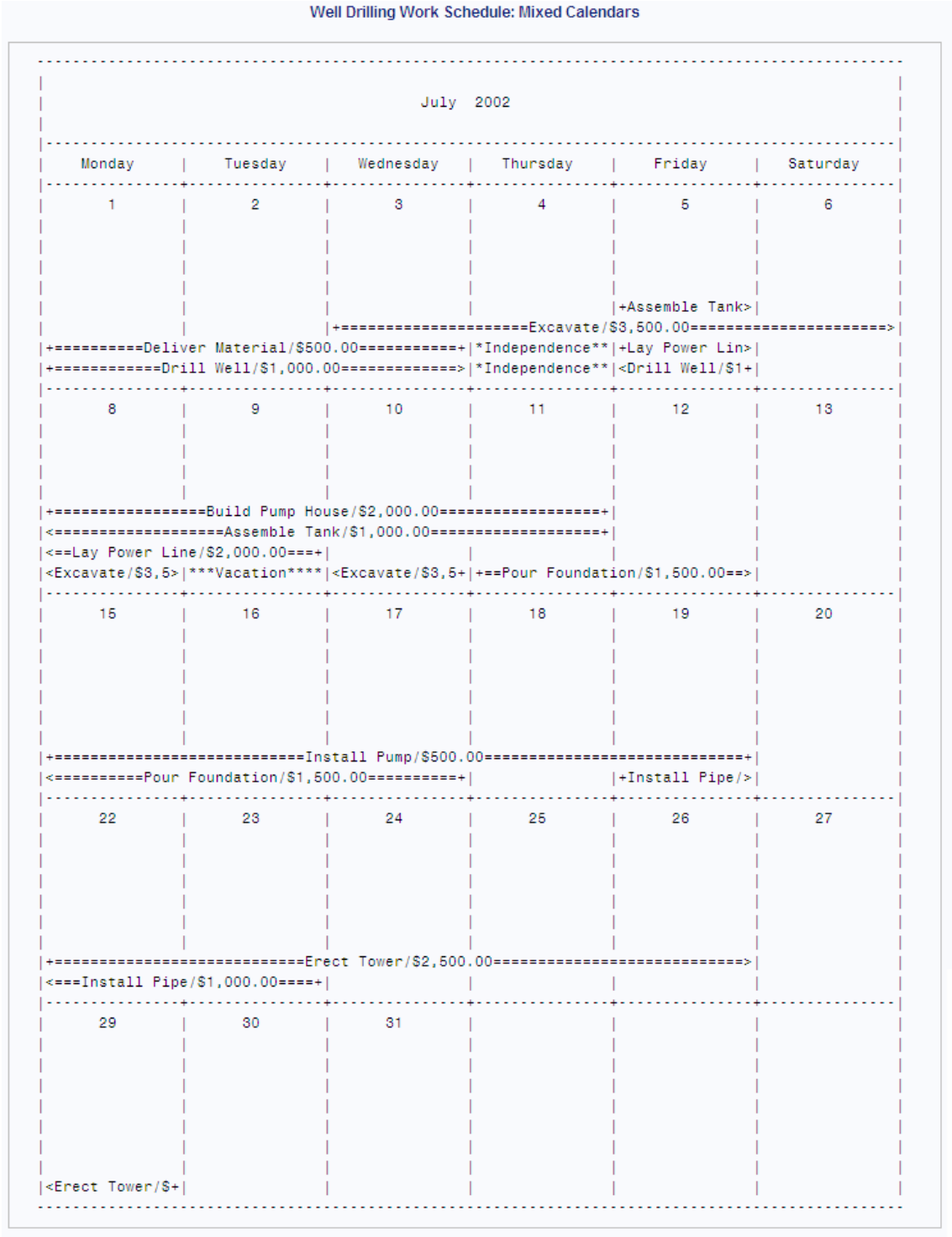
Program for Mixed Calendars

To produce mixed output instead of combined, use the same program and change the setting of the OUTPUT= option to OUTPUT=MIX:

```
proc calendar data=well.act
              holidata=well.hol
              caledata=well.cal
              workdata=well.wor
              datetime;
   calid _cal_ / output=mix;
   start date;
   dur dur;
   holistart date;
   holivar holiday;
   outstart Monday;
   outfin Saturday;
   title1 'Well Drilling Work Schedule: Mixed Calendars';
   format cost dollar9.2;
run;
```

Output: HTML

Output 9.9 *Well Drilling Work Schedule: Mixed Calendars*



Well Drilling Work Schedule: Mixed Calendars

July 2002

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2	3	4	5	6
				+Assemble Tank>	
		+=====Excavate/$3,500.00=====>			
+=====Deliver Material/$500.00=====+			*Independence**	+Lay Power Lin>	
+=====Drill Well/$1,000.00=====>			*Independence**	<Drill Well/$1+	
8	9	10	11	12	13
		+=====Build Pump House/$2,000.00=====+			
		<=====Assemble Tank/$1,000.00=====+			
<==Lay Power Line/$2,000.00===+					
<Excavate/$3,5>	***Vacation****	<Excavate/$3,5+	+==Pour Foundation/$1,500.00==>		
15	16	17	18	19	20
		+=====Install Pump/$500.00=====+			
<=====Pour Foundation/$1,500.00=====+				+Install Pipe/>	
22	23	24	25	26	27
		+=====Erect Tower/$2,500.00=====>			
<===Install Pipe/$1,000.00====+					
29	30	31			
<Erect Tower/$+					

Example 5: Schedule Calendar, Blank or with Holidays

Features:

PROC CALENDAR statement options
- FILL
- HOLIDATA=
- INTERVAL=WORKDAY

Other statements
- DUR statement
- HOLIDUR statement
- HOLISTART statement
- HOLIVAR statement

Details

This example produces a schedule calendar that displays only holidays. You can use this same code to produce a set of blank calendars by removing the HOLIDATA= option and the HOLISTART, HOLIVAR, and HOLIDUR statements from the PROC CALENDAR step.

Program

```
data acts;
   input sta : date7. act $ 11-30 dur;
   datalines;
01JAN03   Start                0
31DEC03   Finish               0
;

data holidays;
   input sta : date7. act $ 11-30 dur;
   datalines;
01JAN03   New Year's           1
30MAR03   Good Friday          1
28MAY03   Memorial Day         1
04JUL03   Independence Day     1
03SEP03   Labor Day            1
22NOV03   Thanksgiving         2
25DEC03   Christmas Break      5
;

options formchar="|----|+|---+=|-/\<>*";

proc calendar data=acts holidata=holidays fill interval=workday;
```

```
   start sta;
   dur dur;

   holistart sta;
   holivar act;
   holidur dur;

   title1 'Calendar of Holidays Only';
run;
```

Program Description

Create the activities data set. Specify one activity in the first month and one in the last, and give each activity a duration of 0. PROC CALENDAR does not print activities with zero durations in the output.

```
data acts;
   input sta : date7. act $ 11-30 dur;
   datalines;
01JAN03   Start                0
31DEC03   Finish               0
;
```

Create the holidays data set.

```
data holidays;
   input sta : date7. act $ 11-30 dur;
   datalines;
01JAN03   New Year's           1
30MAR03   Good Friday          1
28MAY03   Memorial Day         1
04JUL03   Independence Day     1
03SEP03   Labor Day            1
22NOV03   Thanksgiving         2
25DEC03   Christmas Break      5
;
```

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the calendar. DATA= identifies the activities data set; HOLIDATA= identifies the holidays data set. FILL displays all months, even those with no activities. By default, only months with activities appear in the report. INTERVAL=WORKDAY specifies that activities and holidays are measured in 8-hour days and that PROC CALENDAR schedules activities only Monday through Friday.

```
proc calendar data=acts holidata=holidays fill interval=workday;
```

Specify an activity start date variable and an activity duration variable. The START statement specifies the variable in the activities data set that contains the starting date of the activities; DUR specifies the variable that contains the duration of each activity. Creating a schedule calendar requires START and DUR.

```
   start sta;
   dur dur;
```

Retrieve holiday information. The HOLISTART, HOLIVAR, and HOLIDUR statements specify the variables in the holidays data set that contain the start date, name, and duration of each holiday, respectively. When you use a holidays data set, HOLISTART is required. Because at least one holiday lasts more than one day, HOLIDUR (or HOLIFIN) is required.

```
      holistart sta;
      holivar act;
      holidur dur;
```

Specify the title.

```
      title1 'Calendar of Holidays Only';
   run;
```

Output: HTML

The following output shows the December portion of the output. Without the INTERVAL=WORKDAY option, the 5-day Christmas break would be scheduled through the weekend.

Output 9.10 *Calendar of Holidays Only, December*

Calendar of Holidays Only

December 2003

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25 Christmas Br	26 Christmas Br	27
28	29 Christmas Br	30 Christmas Br	31 Christmas Br			

Example 6: Calculating a Schedule Based on Completion of Predecessor Tasks

Features: PROC CALENDAR procedure features
- PROC CALENDAR statement
- CALID statement
- FIN statement
- VAR statement

PROC CPM step

PROC SORT step

Details

Program Description

This example does the following:

- calculates a project schedule containing multiple calendars (PROC CPM)
- produces a listing of the PROC CPM output data set (PROC PRINT)
- displays the schedule in calendar format (PROC CALENDAR)

This example features PROC CPM's ability to calculate a schedule that meets the following criteria:

- is based on an initial starting date
- applies different non-work periods to different calendars, such as personal vacation days to each employee's schedule
- includes milestones (activities with a duration of 0)

Automating Your Scheduling Task with SAS/OR Software

When changes occur to a schedule, you have to adjust the activity starting dates manually if you use PROC CALENDAR to produce a schedule calendar. Alternatively, you can use PROC CPM in SAS/OR software to reschedule work when dates change. Even more importantly, you can provide only an initial starting date for a project and let PROC CPM calculate starting dates for activities, based on identified successor tasks, that is, tasks that cannot begin until their predecessors end.

In order to use PROC CPM, you must complete the following steps:

1. Create an activities data set that contains activities with durations. (You can indicate nonwork days, weekly work schedules, and work shifts with holidays, calendar, and work-shift data sets.)
2. Indicate which activities are successors to others (precedence relationships).
3. Define resource limitations if you want them considered in the schedule.
4. Provide an initial starting date.

PROC CPM can process your data to generate a data set that contains the start and end dates for each activity. PROC CPM schedules the activities, based on the

duration information, weekly work patterns, work shifts, as well as holidays and nonwork days that interrupt the schedule. You can generate several views of the schedule that is computed by PROC CPM, from a simple listing of start and finish dates to a calendar, a Gantt chart, or a network diagram.

See Also

This example introduces users of PROC CALENDAR to more advanced SAS scheduling tools. For an introduction to project management tasks and tools and several examples, see *Project Management Using the SAS System*. For more examples, see *SAS/OR Software: Project Management Examples*. For complete reference documentation, see *SAS/OR(R) 9.3 User's Guide: Mathematical Programming*.

Program

```
options formchar="|----|+|---+=|-/\<>*";

data grant;
   input jobnum Task $ 4-22 Days Succ1 $ 27-45 aldate : date7. altype $
         _cal_ $;
   format aldate date7.;
   datalines;
1  Run Exp 1          11  Analyze Exp 1       .       .   Student
2  Analyze Exp 1       5  Send Report 1       .       .   Prof.
3  Send Report 1       0  Run Exp 2           .       .   Prof.
4  Run Exp 2          11  Analyze Exp 2       .       .   Student
5  Analyze Exp 2       4  Send Report 2       .       .   Prof.
6  Send Report 2       0  Write Final Report  .       .   Prof.
7  Write Final Report  4  Send Final Report   .       .   Prof.
8  Send Final Report   0                      .       .   Student
9  Site Visit          1                    18jul07 ms  Prof.
;

data nowork;
   format holista date7. holifin date7.;
   input holista : date7. holifin : date7. name $ 17-32 _cal_ $;
   datalines;
04jul07 04jul07 Independence Day Prof.
03sep07 03sep07 Labor Day        Prof.
04jul07 04jul07 Independence Day Student
03sep07 03sep07 Labor Day        Student
16jul07 17jul07 PROF Vacation    Prof.
16aug07 17aug07 STUDENT Vacation Student
;

proc cpm data=grant
         date='01jul07'd
         interval=weekday
         out=gcpm1
         holidata=nowork;
   activity task;
```

```
   successor succ1;
   duration days;
   calid _cal_;
   id task;
   aligndate aldate;
   aligntype altype;
   holiday holista / holifin=holifin;
run;

proc print data=gcpm1;
   title 'Data Set GCPM1, Created with PROC CPM';
run;

proc sort data=gcpm1;
   by e_start;
run;

proc calendar data=gcpm1
              holidata=nowork
              interval=workday;
   start e_start;
   fin   e_finish;
   calid _cal_ / output=combine;
   holistart holista;
   holifin   holifin;
   holivar name;
   var task;
   title 'Schedule for Experiment X-15';
   title2 'Professor and Student Schedule';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the activities data set and identify separate calendars. This data identifies two calendars: the professor's (the value of _CAL_ is *Prof.*) and the student's (the value of _CAL_ is *Student*). The Succ1 variable identifies which activity cannot begin until the current one ends. For example, *Analyze Exp 1* cannot begin until *Run Exp 1* is completed. The DAYS value of *0* for JOBNUM *3, 6,* and *8* indicates that these jobs are milestones.

```
data grant;
   input jobnum Task $ 4-22 Days Succ1 $ 27-45 aldate : date7. altype $
         _cal_ $;
   format aldate date7.;
   datalines;
1  Run Exp 1          11  Analyze Exp 1       .      .   Student
2  Analyze Exp 1       5  Send Report 1       .      .   Prof.
3  Send Report 1       0  Run Exp 2           .      .   Prof.
4  Run Exp 2          11  Analyze Exp 2       .      .   Student
5  Analyze Exp 2       4  Send Report 2       .      .   Prof.
```

```
6  Send Report 2       0  Write Final Report  .       .   Prof.
7  Write Final Report  4  Send Final Report   .       .   Prof.
8  Send Final Report   0                      .       .   Student
9  Site Visit          1                   18jul07 ms  Prof.
;
```

Create the holidays data set and identify which calendar a nonwork day belongs to. The two holidays are listed twice, once for the professor's calendar and once for the student's. Because each person is associated with a separate calendar, PROC CPM can apply the personal vacation days to the appropriate calendars.

```
data nowork;
   format holista date7. holifin date7.;
   input holista : date7. holifin : date7. name $ 17-32 _cal_ $;
   datalines;
04jul07 04jul07 Independence Day Prof.
03sep07 03sep07 Labor Day        Prof.
04jul07 04jul07 Independence Day Student
03sep07 03sep07 Labor Day        Student
16jul07 17jul07 PROF Vacation    Prof.
16aug07 17aug07 STUDENT Vacation Student
;
```

Calculate the schedule with PROC CPM. PROC CPM uses information supplied in the activities and holidays data sets to calculate start and finish dates for each activity. The DATE= option supplies the starting date of the project. The CALID statement is not required, even though this example includes two calendars, because the calendar identification variable has the special name _CAL_.

```
proc cpm data=grant
         date='01jul07'd
         interval=weekday
         out=gcpm1
         holidata=nowork;
   activity task;
   successor succ1;
   duration days;
   calid _cal_;
   id task;
   aligndate aldate;
   aligntype altype;
   holiday holista / holifin=holifin;
run;
```

Print the output data set that was created with PROC CPM. This step is not required. PROC PRINT is a useful way to view the calculations produced by PROC CPM.

```
proc print data=gcpm1;
   title 'Data Set GCPM1, Created with PROC CPM';
run;
```

Sort GCPM1 by the variable that contains the activity start dates before using it with PROC CALENDAR.

```
proc sort data=gcpm1;
   by e_start;
run;
```

Create the schedule calendar. GCPM1 is the activity data set. PROC CALENDAR uses the S_START and S_FINISH dates, calculated by PROC CPM, to print the schedule. The VAR statement selects only the variable TASK to display on the calendar output.

```
proc calendar data=gcpm1
              holidata=nowork
              interval=workday;
   start e_start;
   fin   e_finish;
   calid _cal_ / output=combine;
   holistart holista;
   holifin   holifin;
   holivar name;
   var task;
   title 'Schedule for Experiment X-15';
   title2 'Professor and Student Schedule';
run;
```

Output: HTML

PROC PRINT displays the observations in GCPM1, showing the scheduling calculations created by PROC CPM.

Output 9.11 *Data Set GCPM1, Created with PROC CPM*

Data Set GCPM1, Created with PROC CPM

Obs	Task	Succ1	Days	_cal_	E_START	E_FINISH	L_START	L_FINISH	T_FLOAT	F_FLOAT
1	Run Exp 1	Analyze Exp 1	11	Student	02JUL07	17JUL07	02JUL07	17JUL07	0	0
2	Analyze Exp 1	Send Report 1	5	Prof.	18JUL07	24JUL07	18JUL07	24JUL07	0	0
3	Send Report 1	Run Exp 2	0	Prof.	25JUL07	25JUL07	25JUL07	25JUL07	0	0
4	Run Exp 2	Analyze Exp 2	11	Student	25JUL07	08AUG07	25JUL07	08AUG07	0	0
5	Analyze Exp 2	Send Report 2	4	Prof.	09AUG07	14AUG07	09AUG07	14AUG07	0	0
6	Send Report 2	Write Final Report	0	Prof.	15AUG07	15AUG07	15AUG07	15AUG07	0	0
7	Write Final Report	Send Final Report	4	Prof.	15AUG07	20AUG07	15AUG07	20AUG07	0	0
8	Send Final Report		0	Student	21AUG07	21AUG07	21AUG07	21AUG07	0	0
9	Site Visit		1	Prof.	19JUL07	19JUL07	19JUL07	19JUL07	0	0

PROC CALENDAR created the following schedule calendar by using the S_START and S_FINISH dates that were calculated by PROC CPM. The activities on July 25 and August 15, because they are milestones, do not delay the start of a successor activity. Note that Site Visit occurs on July 18, the same day that Analyze Exp 1 occurs. To prevent this overallocation of resources, you can use *resource constrained scheduling*, available in SAS/OR software.

Output 9.12 *Schedule for Experiment X-15, July*

Schedule for Experiment X-15
Professor and Student Schedule

July 2007

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1	2	3	4	5	6	7
PROF.				Independence			
STUDENT		+=======Run Exp 1=======>		Independence	<=======Run Exp 1=======>		
	8	9	10	11	12	13	14
STUDENT		<============================Run Exp 1============================>					
	15	16	17	18	19	20	21
PROF.		PROF Vacatio	PROF Vacatio		+Site Visit+		
				+============Analyze Exp 1============>			
STUDENT		<=======Run Exp 1=======+					
	22	23	24	25	26	27	28
PROF.		<=====Analyze Exp 1=====+		+Send Repor+			
STUDENT				+==============Run Exp 2==============>			
	29	30	31				
STUDENT		<=======Run Exp 2=======>					

Output 9.13 *Schedule for Experiment X-15, August*

Schedule for Experiment X-15
Professor and Student Schedule

August 2007

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
				1	2	3	4
STUDENT				<==========Run Exp 2==========			
	5	6	7	8	9	10	11
PROF.					+=====Analyze Exp 2=====>		
STUDENT		<==========Run Exp 2==========+					
	12	13	14	15	16	17	18
PROF.				+=========Write Final Report=========>			
		<=====Analyze Exp 2=====+		+Send Repor+			
STUDENT					STUDENT Vaca	STUDENT Vaca	
	19	20	21	22	23	24	25
PROF.		<Write Fina+					
STUDENT			+Send Final+				
	26	27	28	29	30	31	

Example 7: Summary Calendar with MEAN Values by Observation

Features:

CALID statement
- _CAL_ variable
- OUTPUT=SEPARATE option

Other statements
- FORMAT statement
- LABEL statement
- MEAN statement
- SUM statement

PROC FORMAT
- PICTURE statement

Details

This example does the following:

- produces a summary calendar
- displays holidays
- produces sum and mean values by business day (observation) for three variables
- prints a legend and uses variable labels
- uses picture formats to display values

To produce MEAN values based on *the number of days in the calendar month*, use MEANTYPE=NDAYS. By default, MEANTYPE=NOBS, which calculates the MEAN values according to *the number of days for which data exists*.

Program

```
data meals;
   input date : date7. Brkfst Lunch Dinner;
   datalines;
01Dec08       123 234 238
02Dec08       188 188 198
03Dec08       123 183 176
04Dec08       200 267 243
05Dec08       176 165 177
08Dec08       178 198 187
09Dec08       165 176 187
```

```
10Dec08       187 176 231
11Dec08       176 187 222
12Dec08       187 187 123
15Dec08       176 165 177
16Dec08       156   . 167
17Dec08       198 143 167
18Dec08       178 198 187
19Dec08       165 176 187
22Dec08       187 187 123
;

data closed;
   input date date. holiday $ 11-25;
   datalines;
26DEC08   Repairs
29DEC08   Repairs
30DEC08   Repairs
31DEC08   Repairs
23DEC08   Vacation
24DEC08   Christmas Eve
25DEC08   Christmas
;

proc sort data=meals;
   by date;
run;

proc format;
   picture bfmt other = '000 Brkfst';
   picture lfmt other = '000 Lunch ';
   picture dfmt other = '000 Dinner';
run;

options formchar="|----|+|---+=|-/\<>*";

proc calendar data=meals holidata=closed;
   start date;

   holistart date;
   holiname holiday;

   sum brkfst lunch dinner / format=4.0;
   mean brkfst lunch dinner / format=6.2;
   label brkfst = 'Breakfasts Served'
         lunch  = '   Lunches Served'
         dinner = '   Dinners Served';
   format brkfst bfmt.
          lunch lfmt.
          dinner dfmt.;

   title 'Meals Served in Company Cafeteria';
   title2 'Mean Number by Business Day';
run;

title;
```

Program Description

Create the Activities data set. MEALS records how many meals were served for breakfast, lunch, and dinner on the days that the cafeteria was open for business.

```
data meals;
   input date : date7. Brkfst Lunch Dinner;
   datalines;
01Dec08       123 234 238
02Dec08       188 188 198
03Dec08       123 183 176
04Dec08       200 267 243
05Dec08       176 165 177
08Dec08       178 198 187
09Dec08       165 176 187
10Dec08       187 176 231
11Dec08       176 187 222
12Dec08       187 187 123
15Dec08       176 165 177
16Dec08       156   . 167
17Dec08       198 143 167
18Dec08       178 198 187
19Dec08       165 176 187
22Dec08       187 187 123
;
```

Create the Holidays data set.

```
data closed;
   input date date. holiday $ 11-25;
   datalines;
26DEC08   Repairs
29DEC08   Repairs
30DEC08   Repairs
31DEC08   Repairs
23DEC08   Vacation
24DEC08   Christmas Eve
25DEC08   Christmas
;
```

Sort the Activities data set by the activity starting date. You are not required to sort the Holidays data set.

```
proc sort data=meals;
   by date;
run;
```

Create picture formats for the variables that indicate how many meals were served.

```
proc format;
   picture bfmt other = '000 Brkfst';
   picture lfmt other = '000 Lunch ';
   picture dfmt other = '000 Dinner';
run;
```

Set the FORMCHAR and LINESIZE options. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the summary calendar. DATA= identifies the Activities data set; HOLIDATA= identifies the Holidays data set. The START statement specifies the variable in the Activities data set that contains the activity starting date; START is required.

```
proc calendar data=meals holidata=closed;
   start date;
```

Retrieve holiday information. The HOLISTART and HOLIVAR statements specify the variables in the Holidays data set that contain the start date and the name of each holiday, respectively. HOLISTART is required when you use a Holidays data set.

```
   holistart date;
   holiname holiday;
```

Calculate, label, and format the sum and mean values. The SUM and MEAN statements calculate sum and mean values for three variables and print them with the specified format. The LABEL statement prints a legend and uses labels instead of variable names. The FORMAT statement associates picture formats with three variables.

```
   sum brkfst lunch dinner / format=4.0;
   mean brkfst lunch dinner / format=6.2;
   label brkfst = 'Breakfasts Served'
         lunch  = '   Lunches Served'
         dinner = '   Dinners Served';
   format brkfst bfmt.
          lunch lfmt.
          dinner dfmt.;
```

Specify the titles.

```
   title 'Meals Served in Company Cafeteria';
   title2 'Mean Number by Business Day';
run;

title;
```

Output: HTML

Output 9.14 *Meals Served in Company Cafeteria - Mean Number by Business Day*

Meals Served in Company Cafeteria
Mean Number by Business Day

December 2008

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	1 123 Brkfst 234 Lunch 238 Dinner	2 188 Brkfst 188 Lunch 198 Dinner	3 123 Brkfst 183 Lunch 176 Dinner	4 200 Brkfst 267 Lunch 243 Dinner	5 176 Brkfst 165 Lunch 177 Dinner	6
7	8 178 Brkfst 198 Lunch 187 Dinner	9 165 Brkfst 176 Lunch 187 Dinner	10 187 Brkfst 176 Lunch 231 Dinner	11 176 Brkfst 187 Lunch 222 Dinner	12 187 Brkfst 187 Lunch 123 Dinner	13
14	15 176 Brkfst 165 Lunch 177 Dinner	16 156 Brkfst . 167 Dinner	17 198 Brkfst 143 Lunch 167 Dinner	18 178 Brkfst 198 Lunch 187 Dinner	19 165 Brkfst 176 Lunch 187 Dinner	20
21	22 187 Brkfst 187 Lunch 123 Dinner	23 **Vacation**	24 Christmas Ev	25 *Christmas**	26 **Repairs***	27
28	29 **Repairs***	30 **Repairs***	31 **Repairs***			

	Sum	Mean
Breakfasts Served	2763	172.69
Lunches Served	2830	188.67
Dinners Served	2990	186.88

Example 8: Multiple Summary Calendars with Atypical Work Shifts (Separated Output)

Features:

PROC CALENDAR statement options
- DATETIME
- LEGEND

CALID statement
- _CAL_ variable
- OUTPUT=SEPARATE option

Other statements
- OUTSTART statement
- OUTFIN statement
- SUM statement

Data sets: Well.Act

Well.Hol

Details

This example does the following:

- produces a summary calendar for multiple calendars in a single PROC step
- prints the calendars on separate pages
- displays holidays
- uses separate work patterns, work shifts, and holidays for each calendar

Producing Different Output for Multiple Calendars

This example produces separate output for multiple calendars. To produce combined or mixed output for this data, you need to change only the following two things:

- how the Activities data set is sorted
- how the OUTPUT= option is set

Table 9.14 *Sort and OUTPUT= Settings*

Print Options	Sorting Variables	OUTPUT= Settings	Examples
Separate pages for each calendar	Calendar ID and starting date	SEPARATE	3, 8
All activities on the same page and identify each calendar	Starting date	COMBINE	4, 2
All activities on the same page and NOT identify each calendar	Starting date	MIX	4

Program

```
libname well
'SAS-library';
run;

proc sort data=well.act;
   by _cal_ date;
run;

options formchar="|----|+|---+=|-/\<>*" linesize=132;

proc calendar data=well.act
              holidata=well.hol
              datetime legend;

   calid _cal_ / output=separate;

   start date;
   holistart date;
   holivar holiday;

   sum cost / format=dollar10.2;

   outstart Monday;
   outfin Saturday;

   title 'Well Drilling Cost Summary';
   title2 'Separate Calendars';
   format cost dollar10.2;
run;
```

Program Description

Specify the SAS library where the Activities data set is stored.

```
libname well
```

```
'SAS-library';
run;
```

Sort the Activities data set by the variables containing the calendar identification and the starting date, respectively.

```
proc sort data=well.act;
   by _cal_ date;
run;
```

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available. LINESIZE needs to be set in this example to prevent truncating data in the output.

```
options formchar="|----|+|---+=|-/\<>*" linesize=132;
```

Create the summary calendar. DATA= identifies the Activities data set; HOLIDATA= identifies the Holidays data set; CALDATA= identifies the Calendar data set; WORKDATA= identifies the Workdays data set. DATETIME specifies that the variable specified with the START statement contains a SAS datetime value. LEGEND prints text that identifies the variables.

```
proc calendar data=well.act
              holidata=well.hol
              datetime legend;
```

Print each calendar on a separate page. The CALID statement specifies that the _CAL_ variable identifies calendars. OUTPUT=SEPARATE prints information for each calendar on separate pages.

```
   calid _cal_ / output=separate;
```

Specify an activity start date variable and retrieve holiday information. The START statement specifies the variable in the Activities data set that contains the activity starting date. The HOLISTART and HOLIVAR statements specify the variables in the Holidays data set that contain the start date and name of each holiday, respectively. These statements are required when you use a Holidays data set.

```
   start date;
   holistart date;
   holivar holiday;
```

Calculate sum values. The SUM statement totals the COST variable for all observations in each calendar.

```
   sum cost / format=dollar10.2;
```

Display a 6-day week. OUTSTART and OUTFIN specify that the calendar display a 6-day week, Monday through Saturday.

```
   outstart Monday;
   outfin Saturday;
```

Specify the titles and format the Cost variable.

```
   title 'Well Drilling Cost Summary';
   title2 'Separate Calendars';
   format cost dollar10.2;
run;
```

Output: HTML

Output 9.15 *Part One of Well Drilling Cost Summary*

Well Drilling Cost Summary
Separate Calendars

cal=CAL1

July 2002

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 Drill Well 3.5 $1,000.00	2	3	4 ***Independence*** Lay Power Line 3 $2,000.00	5 Assemble Tank 4 $1,000.00	6
8 Build Pump House 3 $2,000.00	9	10	11 Pour Foundation 4 $1,500.00	12	13
15 Install Pump 4 $500.00	16	17	18	19 Install Pipe 2 $1,000.00	20 Erect Tower 6 $2,500.00
22	23	24	25	26	27
29	30	31			

Legend	Sum
task	
dur	
cost	$11,500.00

Output 9.16 *Part Two of Well Drilling Cost Summary*

Well Drilling Cost Summary
Separate Calendars

cal=CAL2

July 2002

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1 Deliver Material 2 $500.00	2	3 Excavate 4.75 $3,500.00	4	5	6
8	9 *****Vacation*****	10	11	12	13
15	16	17	18	19	20
22	23	24	25	26	27
29	30	31			

Legend	Sum
task	
dur	
cost	$4,000.00

10

CATALOG Procedure

Overview: CATALOG Procedure

What Does the CATALOG Procedure Do?

The CATALOG procedure manages entries in SAS catalogs. PROC CATALOG is an interactive, statement-driven procedure that enables you to do the following:

- create a listing of the contents of a catalog
- copy a catalog or selected entries within a catalog
- rename, exchange, or delete entries within a catalog
- change the name of a catalog entry
- modify, by changing or deleting, the description of a catalog entry

For more information about SAS libraries and catalogs, see *SAS Language Reference: Concepts*.

Concepts: CATALOG Procedure

Concepts: CATALOG Procedure

To learn how to use the SAS windowing environment to manage entries in a SAS catalog, see the SAS online Help for the Explorer window. You might prefer to use the Explorer window instead of using PROC CATALOG. You can do most of what the procedure does using the Explorer window.

Syntax: CATALOG Procedure

Tips: The CATALOG procedure supports RUN-group processing.

You can perform similar functions with the SAS Explorer window and with DICTIONARY tables in the SQL procedure. For information about the Explorer window, see the online Help. For information about PROC SQL, see *SAS SQL Procedure User's Guide*.

See: CATALOG Procedure under Windows, UNIX, z/OS

PROC CATALOG CATALOG=<*libref.*>*catalog* <ENTRYTYPE=*entry-type*> <FORCE> <KILL>;

CONTENTS <OUT=*SAS-data-set*> <FILE=*fileref*>;

COPY OUT=<*libref.*>*catalog* <*options*>;

SELECT *entry-1* <*entry-2 ...*> </ ENTRYTYPE=*entry-type* >;

EXCLUDE *entry-1* <*entry-2 ...*> </ ENTRYTYPE=*entry-type*>;

CHANGE *old-name-1=new-name-1*
<*old-name-2=new-name-2 ...*>
</ ENTRYTYPE=*entry-type*>;

EXCHANGE *name-1=other-name-1*
<*name-2=other-name-2 ...*>
</ ENTRYTYPE=*entry-type*>;

DELETE *entry-1* <*entry-2 ...*> </ ENTRYTYPE=*entry-type*>;

MODIFY *entry* (DESCRIPTION=<<'>*entry-description*<'>>)
</ ENTRYTYPE=*entry-type*>;

SAVE *entry-1* <*entry-2 ...*> </ ENTRYTYPE=*entry-type* >;

Statement	Task	Example
Chapter 10, "CATALOG Procedure,"	Copy entries from one SAS catalog to another	Ex. 1, Ex. 2, Ex. 3
CHANGE	Change the names of catalog entries	Ex. 2
CONTENTS	Print the contents of a catalog	Ex. 2
COPY	Copy some or all of the entries in one catalog to another catalog	Ex. 1
DELETE	Delete specified entries	Ex. 1
EXCHANGE	Switch the names of two catalog entries	
EXCLUDE	Exclude entries from being copied	Ex. 1
MODIFY	Change the description of a catalog entry	Ex. 2
SAVE	Delete all except the entries specified	
SELECT	Copy only selected entries	Ex. 1

PROC CATALOG Statement

Copies entries from one SAS catalog to another.

Syntax

PROC CATALOG CATALOG=<*libref*.>*catalog* <ENTRYTYPE=*entry-type*> <FORCE> <KILL>;

Summary of Optional Arguments

ENTRYTYPE=*entry-type*
: restricts processing of the current PROC CATALOG step to one entry type.

FORCE
: forces statements to execute on a catalog that is opened by another resource environment.

KILL

Required Argument

CATALOG=<*libref*.>*catalog*
: specifies the SAS catalog to process.

Aliases: CAT=, C=

Default: PROC CATALOG processes all entries in the catalog.

Example: "Example 3: Using the FORCE Option with the KILL Option" on page 331

Optional Arguments

ENTRYTYPE=*entry-type*
: restricts processing of the current PROC CATALOG step to one entry type.

Alias: ET=

Default: PROC CATALOG processes all entries in a catalog.

Interactions The specified entry type applies to any one-level entry names that are used in a subordinate statement. You cannot override this specification in a subordinate statement.

The ENTRYTYPE= option does not restrict the effects of the KILL option.

Tip In order to process multiple entry types in a single PROC CATALOG step, use the ENTRYTYPE= option in a subordinate statement, not in the PROC CATALOG statement.

See "Specifying an Entry Type" on page 320

Examples "Example 1: Copying, Deleting, and Moving Catalog Entries from Multiple Catalogs" on page 325

"Example 2: Displaying Contents, Changing Names, and Changing a Description" on page 329

FORCE

forces statements to execute on a catalog that is opened by another resource environment.

Some CATALOG statements and arguments require exclusive access to the catalog that they operate on if the statement can radically change the contents of a catalog. If exclusive access cannot be obtained, then the action fails. Here are the statements and arguments and the catalogs that are affected by the FORCE option:

COPY	affects the OUT= catalog.
COPY MOVE	affects the IN= catalog and the OUT= catalog.
SAVE	affects the specified catalog.

Tip Use the FORCE option to execute the statement, even if exclusive access cannot be obtained.

Example "Example 3: Using the FORCE Option with the KILL Option" on page 331

KILL

affects the specified catalog and deletes all entries in a SAS catalog.

deletes all entries in a SAS catalog.

CAUTION

Do not attempt to limit the effects of the KILL option. This option deletes all entries in a SAS catalog before any option or other statement takes effect.

Interactions The KILL option deletes all catalog entries even when the ENTRYTYPE= option is specified.

The SAVE statement has no effect because the KILL option deletes all entries in a SAS catalog before any other statements are processed.

Tip The KILL option deletes all entries but does not remove an empty catalog from the SAS library. You must use another method, such as PROC DATASETS or the DIR window to delete an empty SAS catalog.

Example "Example 3: Using the FORCE Option with the KILL Option" on page 331

CHANGE Statement

Renames one or more catalog entry names.

Tip: You can change multiple entry names in a single CHANGE statement or use multiple CHANGE statements.

Example: "Example 2: Displaying Contents, Changing Names, and Changing a Description" on page 329

Syntax

CHANGE *old-name-1=new-name-1*
<*old-name-2=new-name-2 ...*>
</ ENTRYTYPE=*entry-type*>;

Required Argument

old-name=new-name
specifies the current name of a catalog entry and the new name that you want to assign to it. Specify any valid SAS name.

Restriction You must designate the type of the entry, either with the name (*entry-name.entry-type*) or with the ENTRYTYPE= option.

Optional Argument

ENTRYTYPE=*entry-type*
restricts processing to one entry type.

Alias ET=

See "The ENTRYTYPE= Option" on page 322

"Specifying an Entry Type" on page 320

CONTENTS Statement

Lists the contents of a catalog in the procedure output or writes a list of the contents to a SAS data set, an external file, or both.

Note: The ENTRYTYPE= option is not available for the CONTENTS statement.

Example: "Example 2: Displaying Contents, Changing Names, and Changing a Description" on page 329

Syntax

CONTENTS <CATALOG=<*libref.*>*catalog* > <OUT=*SAS-data-set*> <FILE=*fileref*>;

Without Arguments

The output is sent to the procedure output.

Optional Arguments

CATALOG=<*libref.*>*catalog*
specifies the SAS catalog to process.

Aliases CAT=

C=

Default None

FILE=*fileref*
sends the contents to an external file that is identified with a SAS fileref.

Interaction If *fileref* has not been previously assigned to a file, then the file is created and named according to operating environment-dependent rules for external files.

OUT=*SAS-data-set*
sends the contents to a SAS data set. When the statement executes, a message in the SAS log reports that a data set has been created. The data set contains six variables in the following order:

Table 10.1 *OUT= Outpput*

LIBNAME	the libref
MEMNAME	the catalog name

NAME	the names of entries
TYPE	the types of entries
DESC	the descriptions of entries
DATE	the dates entries were last modified

COPY Statement

Copies some or all of the entries in one catalog to another catalog.

Restriction: A COPY statement's effect ends at a RUN statement or at the beginning of a statement other than the SELECT or EXCLUDE statement.

Tips: Use the SELECT or EXCLUDE statement, but not both, after the COPY statement to limit which entries are copied.

You can copy entries from multiple catalogs in a single PROC step, not just the one specified in the PROC CATALOG statement.

The ENTRYTYPE= option does not require a forward slash (/) in the COPY statement.

Example: "Example 1: Copying, Deleting, and Moving Catalog Entries from Multiple Catalogs" on page 325

Syntax

COPY OUT=<*libref.*>*catalog* <*options*>;

Required Argument

OUT=<*libref.*>*catalog*
names the catalog to which entries are copied.

Optional Arguments

ENTRYTYPE=*entry-type*
restricts processing to one entry type for the current COPY statement and any subsequent SELECT or EXCLUDE statements.

Alias ET=

See "The ENTRYTYPE= Option" on page 322

"Specifying an Entry Type" on page 320

IN=<*libref*.>*catalog*
specifies the catalog to copy.

Interaction The IN= option overrides a CATALOG= argument that was specified in the PROC CATALOG statement.

Example "Example 1: Copying, Deleting, and Moving Catalog Entries from Multiple Catalogs" on page 325

LOCKCAT=EXCLUSIVE | SHARE
specifies whether to enable more than one user to copy to the same catalog at the same time. Using LOCKCAT=SHARE locks individual entries rather than the entire catalog, which enables greater throughput. The default is LOCKCAT=EXCLUSIVE, which locks the entire catalog to one user. Note that using the LOCKCAT=SHARE option can lessen performance if used in a single-user environment because of the overhead associated with locking and unlocking each entry.

MOVE
deletes the original catalog or entries after the new copy is made.

Interaction When the MOVE option removes all entries from a catalog, the procedure deletes the catalog from the library.

NEW
overwrites the catalog (specified by the OUT= option) if it already exists. If you omit the NEW option , then PROC CATALOG updates the catalog.

See For information about using the NEW option with concatenated catalogs, see "Catalog Concatenation" on page 323.

NOEDIT
prevents the copied version of the following SAS/AF entry types from being edited by the BUILD procedure:

CBT
FRAME
HELP
MENU
PROGRAM
SCL
SYSTEM

Restriction If you specify the NOEDIT option for an entry that is not one of the above types, then it is ignored.

Tip When creating SAS/AF applications for other users, use the NOEDIT option to protect the application by preventing certain catalog entries from being altered.

Example "Example 1: Copying, Deleting, and Moving Catalog Entries from Multiple Catalogs" on page 325

NOSOURCE
omits copying the source lines when you copy a SAS/AF PROGRAM, FRAME, or SCL entry.

Alias NOSRC

Restriction If you specify this option for an entry other than a PROGRAM, FRAME, or SCL entry, then it is ignored.

DELETE Statement

Deletes entries from a SAS catalog.

Restriction: This procedure is not supported on the CAS server.

Tips: Use the DELETE statement to delete only a few entries; use the SAVE option when it is more convenient to specify which entries not to delete.

You can specify multiple entries. You can also use multiple DELETE statements.

See: SAVE Statement on page 317

Example: "Example 1: Copying, Deleting, and Moving Catalog Entries from Multiple Catalogs" on page 325

Syntax

DELETE *entry-1 <entry-2 ...>* </ ENTRYTYPE=*entry-type*>;

Required Argument

entry-1 <entry-2 ...>
specifies the name of one or more SAS catalog entries.

Restriction You must designate the type of the entry, either with the name (*entry-name.entry-type*) or with the ENTRYTYPE= option.

Optional Argument

ENTRYTYPE=*entry-type*
restricts processing to one entry type.

See "The ENTRYTYPE= Option" on page 322

"Specifying an Entry Type" on page 320

EXCHANGE Statement

Switches the name of two catalog entries.

Restriction: When using the EXCHANGE statement, the catalog entries must be of the same type.

Syntax

EXCHANGE *name-1=other-name-1*
<*name-2=other-name-2 ...*>
</ ENTRYTYPE=*entry-type*>;

Required Argument

name=other-name
specifies two catalog entry names that the procedure switches.

Interaction: You can specify only the entry name without the entry type if you use the ENTRYTYPE= option on either the PROC CATALOG statement or the EXCHANGE statement.

See "Specifying an Entry Type" on page 320

Optional Argument

ENTRYTYPE=*entry-type*
restricts processing to one entry type.

Alias: ET=

See "The ENTRYTYPE= Option" on page 322

"Specifying an Entry Type" on page 320

EXCLUDE Statement

Specifies entries that the COPY statement does not copy.

Restrictions: The EXCLUDE statement requires the COPY statement.
Do not use the EXCLUDE statement with the SELECT statement.

Tips: You can specify multiple entries in a single EXCLUDE statement.

You can use multiple EXCLUDE statements with a single COPY statement within a RUN group.

See: COPY Statement on page 312 and SELECT Statement on page 318

Example: "Example 1: Copying, Deleting, and Moving Catalog Entries from Multiple Catalogs" on page 325

Syntax

EXCLUDE *entry-1 <entry-2 ...>* </ ENTRYTYPE=*entry-type*>;

Required Argument

entry-1 <entry-2 ...>
specifies the name of one or more SAS catalog entries.

Restriction: You must designate the type of the entry, either when you specify the name (*entry-name.entry-type*) or with the ENTRYTYPE= option.

See: "Specifying an Entry Type" on page 320

Optional Argument

ENTRYTYPE=*entry-type*
restricts processing to one entry type.

Alias: ET=

See: "The ENTRYTYPE= Option" on page 322

"Specifying an Entry Type" on page 320

MODIFY Statement

Changes the description of a catalog entry.

Example: "Example 2: Displaying Contents, Changing Names, and Changing a Description" on page 329

Syntax

MODIFY *entry* (DESCRIPTION=<<'>*entry-description*<'>>)
</ ENTRYTYPE=*entry-type*>;

Required Arguments

entry
specifies the name of one SAS catalog entry. You can specify the entry type with the name (*entry-name.entry-type*).

Restriction: You must designate the type of the entry, either when you specify the name (*entry-name.entry-type*) or with the ENTRYTYPE= option.

See: "Specifying an Entry Type" on page 320

DESCRIPTION=<<'>*entry-description*<'>>
changes the description of a catalog entry by replacing it with a new description, up to 256 characters long, or by removing it altogether. You can enclose the description in single or double quotation marks.

Alias: DESC

Tip: When using the MODIFY statement with the CATALOG procedure, use the DESCRIPTION= option with no text to remove the current description.

Optional Argument

ENTRYTYPE=*entry-type*
restricts processing to one entry type.

Alias: ET=

See: "The ENTRYTYPE= Option" on page 322

"Specifying an Entry Type" on page 320

SAVE Statement

Specifies entries not to delete from a SAS catalog.

Restriction: The SAVE statement cannot limit the effects of the KILL option.

Tips: Use the SAVE statement to delete all but a few entries in a catalog. Use the DELETE statement when it is more convenient to specify which entries to delete.

You can specify multiple entries and use multiple SAVE statements.

See: DELETE Statement on page 314

Syntax

SAVE *entry-1 <entry-2 ...>* </ ENTRYTYPE=*entry-type* >;

Required Argument

entry-1 <entry-2...>
specifies the name of one or more SAS catalog entries.

Restriction You must designate the type of the entry, either with the name (*entry-name.entry-type*) or with the ENTRYTYPE= option when using the SAVE statement.

Optional Argument

ENTRYTYPE=*entry-type*
restricts processing to one entry type.

Alias ET=

See "The ENTRYTYPE= Option" on page 322

"Specifying an Entry Type" on page 320

SELECT Statement

Specifies entries that the COPY statement copies.

Restrictions: The SELECT statement requires the COPY statement.
The SELECT statement cannot be used with an EXCLUDE statement.

Tips: You can specify multiple entries in a single SELECT statement.
You can use multiple SELECT statements with a single COPY statement within a RUN group.

See: COPY Statement on page 312 and EXCLUDE Statement on page 315

Example: "Example 1: Copying, Deleting, and Moving Catalog Entries from Multiple Catalogs" on page 325

Syntax

SELECT *entry-1 <entry-2 ...>* </ ENTRYTYPE=*entry-type* >;

Required Argument

entry-1 <entry-2 ...>
specifies the name of one or more SAS catalog entries.

Restriction You must designate the type of the entry, either when you specify the name (*entry-name.entry-type*) or with the ENTRYTYPE= option.

Optional Argument

ENTRYTYPE=*entry-type*
restricts processing to one entry type.

Alias ET=

See "The ENTRYTYPE= Option" on page 322.

"Specifying an Entry Type" on page 320.

Usage: CATALOG Procedure

Interactive Processing with RUN Groups

Definition

The CATALOG procedure is interactive. Once you submit a PROC CATALOG statement, you can continue to submit and execute statements or groups of statements without repeating the PROC CATALOG statement.

A set of procedure statements ending with a RUN statement is called a *RUN group*. The changes specified in a given group of statements take effect when a RUN statement is encountered.

How to End a PROC CATALOG Step

In the DATA step and most SAS procedures, a RUN statement is a step boundary and ends the step. However, a simple RUN statement does not end an interactive procedure. The following list contains ways to terminate a PROC CATALOG step:

- submit a QUIT statement
- submit a RUN statement with the CANCEL option
- submit another DATA or PROC statement
- end your SAS session

Note: When you enter a QUIT, DATA, or PROC statement, any statements following the last RUN group execute before the CATALOG procedure terminates. If

you enter a RUN statement with the CANCEL option, then the remaining statements *do not execute* before the procedure ends.

See "Example 2: Displaying Contents, Changing Names, and Changing a Description" on page 329.

Error Handling and RUN Groups

Error handling is based in part on the division of statements into RUN groups. If a syntax error is encountered, then none of the statements in the current RUN group execute, and execution proceeds to the next RUN group.

For example, the following statements contain a misspelled DELETE statement:

```
proc catalog catalog=misc entrytype=help;
      copy out=drink;
         select coffee tea;
      del juices;        /* INCORRECT!!! */
      exchange glass=plastic;
   run;
      change calstats=nutri;
   run;
quit;
```

Because the DELETE statement is incorrectly specified as DEL, no statements in that RUN group execute, except the PROC CATALOG statement itself. The CHANGE statement does execute because it is in a different RUN group.

Note: Be careful when setting up batch jobs in which one RUN group's statements depend on the effects of a previous RUN group, especially when deleting and renaming entries.

Specifying an Entry Type

Four Ways to Supply an Entry Type

There is no default entry type, so if you do not supply one, then PROC CATALOG generates an error. You can supply an entry type in one of four ways, as shown in the following table:

Table 10.2 *Supplying an Entry Type*

Entry Type	Example
Entry name	`delete test1.program test1.log test2.log;`
ET= in parentheses	`delete test1 (et=program);`
ET= after a slash [1]	`delete test1 (et=program) test1 test2 / et=log;`
ENTRYTYPE= without a slash [2]	`proc catalog catalog=mycat et=log; delete test1 test2;`

1 in a subordinate statement
2 in the PROC CATALOG or the COPY statement

Note: All statements, except the CONTENTS statement, accept the ENTRYTYPE= option.

Advantages of Using the ENTRYTYPE= Option

The ENTRYTYPE= option can save keystrokes when you are processing multiple entries of the same type.

To create a default for entry type for all statements in the current step, use the ENTRYTYPE= option in the PROC CATALOG statement. To set the default for only the current statement, use the ENTRYTYPE= option in a subordinate statement.

You can have many entries of one type and a few of other types. You can use the ENTRYTYPE= option to specify a default and then override that for individual entries with (ENTRYTYPE=) *in parentheses* after those entries.

Avoid a Common Error

You cannot specify the ENTRYTYPE= option in both the PROC CATALOG statement and a subordinate statement. For example, these statements generate an error and do not delete any entries because the ENTRYTYPE= option specifications contradict each other:

```
   /* THIS IS INCORRECT CODE. */
proc catalog cat=sample et=help;
   delete a b c / et=program;
run;
quit;
```

The ENTRYTYPE= Option

The ENTRYTYPE= option is available in every statement in the CATALOG procedure except the CONTENTS statement.

ENTRYTYPE=*entry-type*
not in parentheses, sets a default entry type for the entire PROC step when used in the PROC CATALOG statement. In all other statements, this option sets a default entry type for the current statement. If you omit the ENTRYTYPE= option, then PROC CATALOG processes all entries in the catalog.

Alias ET=

Default PROC CATALOG processes all entries in the catalog.

Interactions If you specify the ENTRYTYPE= option in the PROC CATALOG statement, then you do not specify either ENTRYTYPE= or (ENTRYTYPE=) in a subordinate statement.

(ENTRYTYPE=) in parentheses immediately following an entry name overrides the ENTRYTYPE= option in that same statement.

Tips On all statements except the PROC CATALOG and COPY statements, the ENTRYTYPE= option follows a slash.

To process multiple entry types in a single PROC CATALOG step, use the ENTRYTYPE= option in a subordinate statement, not in the PROC CATALOG statement.

See "Specifying an Entry Type" on page 320 and "Example 1: Copying, Deleting, and Moving Catalog Entries from Multiple Catalogs" on page 325

(ENTRYTYPE=*entry-type*)
in parentheses, identifies the type of the entry just preceding it.

Alias (ET=)

Restriction An (ENTRYTYPE=) option immediately following an entry name in a subordinate statement cannot override an ENTRYTYPE= option in the PROC CATALOG statement. It generates a syntax error.

Interaction The (ENTRYTYPE=) option immediately following an entry name overrides the ENTRYTYPE= option in that same statement.

Tips This form is useful mainly for specifying exceptions to an ENTRYTYPE= option that is used in a subordinate statement. The following statement deletes A.Help, B.Format, and C.Help:

```
delete a b (et=format) c / et=help;
```

For the CHANGE and EXCHANGE statements, specify the (ENTRYTYPE=) option in parentheses only once for each pair of names following the second name in the pair. Here is an example:

```
change old1=new1 (et=log)
       old1=new2 (et=help);
```

See "Specifying an Entry Type" on page 320, "Example 1: Copying, Deleting, and Moving Catalog Entries from Multiple Catalogs" on page 325 and "Example 2: Displaying Contents, Changing Names, and Changing a Description" on page 329

Catalog Concatenation

About Catalog Concatenation

There are two types of CATALOG concatenation. The first type is specified by the LIBNAME statement and the second type is specified by the global CATNAME statement. All statements and options that can be used on single (unconcatenated) catalogs can be used on catalog concatenations.

Restrictions

When you use the CATALOG procedure to copy concatenated catalogs and you use the NEW option, the following rules apply:

- If the input catalog is a concatenation and if the output catalog exists in any level of the input concatenation, then the copy is not allowed.
- If the output catalog is a concatenation and if the input catalog exists in the first level of the output concatenation, then the copy is not allowed.

For example, the following code demonstrates these two rules, and the copy fails:

```
libname first 'SAS-library-1';
libname second 'SAS-library-2';
   /* create concat.x */
libname concat (first second);

   /* fails rule #1 */
proc catalog c=concat.x;
   copy out=first.x new;
run;
quit;

   /* fails rule #2 */
proc catalog c=first.x;
```

```
   copy out=concat.x new;
run;
quit;
```

In summary, the following table shows when copies are allowed. In the table, A and B are libraries, and each contains catalog X. Catalog C is an automatic concatenation of A and B, and catalog D is an automatic concatenation of B and A.

Table 10.3 *Allowing Copies*

Input Catalog	Output Catalog	Copy Allowed?
C.X	B.X	No
C.X	D.X	No
D.X	C.X	No
A.X	A.X	No
A.X	B.X	Yes
B.X	A.X	Yes
C.X	A.X	No
B.X	C.X	Yes
A.X	C.X	No

Results: CATALOG Procedure

Results: CATALOG Procedure

The CATALOG procedure produces output when the CONTENTS statement is executed without options. The procedure output is assigned a name. You can use this name to reference the table when using the Output Delivery System (ODS) to select tables and create output data sets. For more information, see "ODS Table Names Produced by Base SAS Procedures" in *SAS Output Delivery System: Procedures Guide*.

Table 10.4 *ODS Tables Produced by the CATALOG Procedure*

Table Name	Type of Library
Catalog_Random	When the catalog is in a random-access library
Catalog_Sequential	When the catalog is in a sequential library

Examples: CATALOG Procedure

Example 1: Copying, Deleting, and Moving Catalog Entries from Multiple Catalogs

Features: PROC CATALOG statement options
CAT=
COPY statement
DELETE statement

Details

This example demonstrates the following tasks:

- copies entries by excluding a few entries
- copies entries by specifying a few entries
- protects entries from being edited
- moves entries
- deletes entries
- processes entries from multiple catalogs
- processes entries in multiple run groups

The SAS catalog Perm.Sample contains the following entries:

```
DEFAULT     FORM        Default form for printing
FSLETTER    FORM        Standard form for letters (HP Laserjet)
LOAN        FRAME       Loan analysis application
LOAN        HELP        Information about the application
```

```
BUILD       KEYS        Function Key Definitions
LOAN        KEYS        Custom key definitions for application
CREDIT      LOG         credit application log
TEST1       LOG         Inventory program
TEST2       LOG         Inventory program
TEST3       LOG         Inventory program
LOAN        PMENU       Custom menu definitions for applicaticm
CREDIT      PROGRAM     credit application pgm
TEST1       PROGRAM     testing budget applic.
TEST2       PROGRAM     testing budget applic.
TEST3       PROGRAM     testing budget applic.
LOAN        SCL         SCL code for loan analysis application
PASSIST     SLIST       User profile
```

The SAS catalog Perm.Formats contains the following entries:

```
REVENUE    FORMAT      FORMAT:MAXLEN=16,16,12
DEPT       FORMATC     FORMAT:MAXLEN=1,1,14
```

Program

```
libname perm 'SAS-library';

proc catalog cat=perm.sample;
   delete credit.program credit.log;
run;

   copy out=tcatall;
run;

   copy out=testcat;
      exclude test1 test2 test3  passist (et=slist) / et=log;
run;

   copy out=logcat move;
      select test1 test2 test3 / et=log;
run;

   copy out=perm.finance noedit;
      select loan.frame loan.help loan.keys loan.pmenu;
run;

   copy in=perm.formats out=perm.finance;
      select revenue.format dept.formatc;
run;
quit;
```

Program Description

Assign a library reference to a SAS library. The LIBNAME statement assigns the libref Perm to the SAS library that contains a permanent SAS catalog.

```
libname perm 'SAS-library';
```

Delete two entries from the Perm.Sample catalog.

```
proc catalog cat=perm.sample;
   delete credit.program credit.log;
run;
```

Copy all entries in the Perm.Sample catalog to the Work.TCatAll catalog.

```
   copy out=tcatall;
run;
```

Copy everything except three LOG entries and Passist.Slist from Perm.Sample to Work.TestCat. The EXCLUDE statement specifies which entries not to copy. ET= specifies a default type. (ET=) specifies an exception to the default type.

```
   copy out=testcat;
      exclude test1 test2 test3  passist (et=slist) / et=log;
run;
```

Move three LOG entries from Perm.Sample to Work.LogCat. The SELECT statement specifies which entries to move. ET= restricts processing to LOG entries.

```
   copy out=logcat move;
      select test1 test2 test3 / et=log;
run;
```

Copy four SAS/AF software entries from Perm.Sample to Perm.Finance. The NOEDIT option protects these entries in Perm.Finance from further editing with PROC BUILD.

```
   copy out=perm.finance noedit;
      select loan.frame loan.help loan.keys loan.pmenu;
run;
```

Copy two formats from Perm.Formats to Perm.Finance. The IN= option enables you to copy from a different catalog than the one specified in the PROC CATALOG statement. Note the entry types for numeric and character formats: REVENUE.FORMAT is a numeric format and DEPT.FORMATC is a character format. The COPY and SELECT statements execute before the QUIT statement ends the PROC CATALOG step.

```
   copy in=perm.formats out=perm.finance;
      select revenue.format dept.formatc;
run;
quit;
```

The SAS Log

Example Code 10.1 *Copying, Protecting, Removing, Deleting, and Processing Entries Using PROC CATALOG*

```
1    libname perm 'SAS-library';
NOTE: Libref PERM was successfully assigned as follows:
      Engine:        V9
      Physical Name: SAS-library\perm
2    proc catalog cat=perm.sample;
NOTE: Writing HTML Body file: sashtml.htm
3       delete credit.program credit.log;
4    run;

NOTE: Deleting entry CREDIT.PROGRAM in catalog PERM.SAMPLE.
NOTE: Deleting entry CREDIT.LOG in catalog PERM.SAMPLE.
5       copy out=tcatall;
6    run;

NOTE: Copying entry DEFAULT.FORM from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry FSLETTER.FORM from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry LOAN.FRAME from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry LOAN.HELP from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry BUILD.KEYS from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry LOAN.KEYS from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry TEST1.LOG from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry TEST2.LOG from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry TEST3.LOG from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry LOAN.PMENU from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry TEST1.PROGRAM from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry TEST2.PROGRAM from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry TEST3.PROGRAM from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry LOAN.SCL from catalog PERM.SAMPLE to catalog WORK.TCATALL.
NOTE: Copying entry PASSIST.SLIST from catalog PERM.SAMPLE to catalog WORK.TCATALL.
7       copy out=testcat;
8          exclude test1 test2 test3  passist (et=slist) / et=log;
9    run;

NOTE: Copying entry DEFAULT.FORM from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
NOTE: Copying entry FSLETTER.FORM from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
NOTE: Copying entry LOAN.FRAME from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
NOTE: Copying entry LOAN.HELP from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
NOTE: Copying entry BUILD.KEYS from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
NOTE: Copying entry LOAN.KEYS from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
NOTE: Copying entry LOAN.PMENU from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
NOTE: Copying entry TEST1.PROGRAM from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
NOTE: Copying entry TEST2.PROGRAM from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
NOTE: Copying entry TEST3.PROGRAM from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
NOTE: Copying entry LOAN.SCL from catalog PERM.SAMPLE to catalog WORK.TESTCAT.
10      copy out=logcat move;
11         select test1 test2 test3 / et=log;
12   run;

NOTE: Moving entry TEST1.LOG from catalog PERM.SAMPLE to catalog WORK.LOGCAT.
NOTE: Moving entry TEST2.LOG from catalog PERM.SAMPLE to catalog WORK.LOGCAT.
NOTE: Moving entry TEST3.LOG from catalog PERM.SAMPLE to catalog WORK.LOGCAT.
13      copy out=perm.finance noedit;
14         select loan.frame loan.help loan.keys loan.pmenu;
15   run;
```

```
NOTE: Copying entry LOAN.FRAME from catalog PERM.SAMPLE to catalog PERM.FINANCE.
NOTE: Copying entry LOAN.HELP from catalog PERM.SAMPLE to catalog PERM.FINANCE.
NOTE: Copying entry LOAN.KEYS from catalog PERM.SAMPLE to catalog PERM.FINANCE.
NOTE: Copying entry LOAN.PMENU from catalog PERM.SAMPLE to catalog PERM.FINANCE.
16      copy in=perm.formats out=perm.finance;
17         select revenue.format dept.formatc;
18   quit;

NOTE: Copying entry REVENUE.FORMAT from catalog PERM.FORMATS to catalog PERM.FINANCE.
NOTE: Copying entry DEPT.FORMATC from catalog PERM.FORMATS to catalog PERM.FINANCE.
```

Example 2: Displaying Contents, Changing Names, and Changing a Description

Features: PROC CATALOG statement options
- CATALOGS=
- CHANGE statement
- CONTENTS statement
- MODIFY statement

TITLE statement

Details

This example demonstrates the following tasks:

- lists the entries in a catalog and routes the output to a file
- changes entry names
- changes entry descriptions
- processes entries in multiple run groups

Program

```
libname perm 'SAS-library';

proc catalog catalog=perm.finance;
   contents;
title1 'Contents of PERM.FINANCE before changes are made';
run;

   change dept=deptcode (et=formatc);
run;

   modify loan.frame (description='Loan analysis app. - ver1');
   contents;
```

```
title1 'Contents of PERM.FINANCE after changes are made';
run;

quit;
```

Program Description

Assign a library reference. The LIBNAME statement assigns a libref to the SAS library that contains a permanent SAS catalog.

```
libname perm 'SAS-library';
```

List the entries in a catalog and route the output to a file. The CONTENTS statement creates a listing of the contents of the SAS catalog Perm.Finance and routes the output to a file.

```
proc catalog catalog=perm.finance;
   contents;
title1 'Contents of PERM.FINANCE before changes are made';
run;
```

Change entry names. The CHANGE statement changes the name of an entry that contains a user-written character format. (ET=) specifies the entry type.

```
   change dept=deptcode (et=formatc);
run;
```

Process entries in multiple run groups. The MODIFY statement changes the description of an entry. The CONTENTS statement creates a listing of the contents of Perm.Finance after all the changes have been applied. QUIT ends the procedure.

```
   modify loan.frame (description='Loan analysis app. - ver1');
   contents;
title1 'Contents of PERM.FINANCE after changes are made';
run;

quit;
```

Output Examples

Output 10.1 *Contents of Perm.Finance before and After Changes Are Made*

Contents of PERM.FINANCE before changes are made

Contents of Catalog PERM.FINANCE					
#	Name	Type	Create Date	Modified Date	Description
1	REVENUE	FORMAT	10/16/1996 13:48:11	10/16/1996 13:48:11	FORMAT:MAXLEN=16,16,12
2	DEPTCODE	FORMATC	10/30/1996 13:40:42	10/30/1996 13:40:42	FORMAT:MAXLEN=1,1,14
3	LOAN	FRAME	10/30/1996 13:40:43	02/18/2014 13:31:25	Loan analysis app. - ver1
4	LOAN	HELP	10/16/1996 13:48:10	10/16/1996 13:48:10	Information about the application
5	LOAN	KEYS	10/16/1996 13:48:10	10/16/1996 13:48:10	Custom key definitions for application
6	LOAN	PMENU	10/16/1996 13:48:10	10/16/1996 13:48:10	Custom menu definitions for application
7	LOAN	SCL	10/16/1996 13:48:10	10/16/1996 13:48:10	SCL code for loan analysis application

Contents of PERM.FINANCE after changes are made

Contents of Catalog PERM.FINANCE					
#	Name	Type	Create Date	Modified Date	Description
1	REVENUE	FORMAT	10/16/1996 13:48:11	10/16/1996 13:48:11	FORMAT:MAXLEN=16,16,12
2	DEPTCODE	FORMATC	10/30/1996 13:40:42	10/30/1996 13:40:42	FORMAT:MAXLEN=1,1,14
3	LOAN	FRAME	10/30/1996 13:40:43	03/28/2014 10:26:50	Loan analysis app. - ver1
4	LOAN	HELP	10/16/1996 13:48:10	10/16/1996 13:48:10	Information about the application
5	LOAN	KEYS	10/16/1996 13:48:10	10/16/1996 13:48:10	Custom key definitions for application
6	LOAN	PMENU	10/16/1996 13:48:10	10/16/1996 13:48:10	Custom menu definitions for application
7	LOAN	SCL	10/16/1996 13:48:10	10/16/1996 13:48:10	SCL code for loan analysis application

Example 3: Using the FORCE Option with the KILL Option

Features:

PROC CATALOG statement options
- CATALOG=
- FORCE
- KILL

%MACRO statement

%MEND statement

%PUT statement

Details

This example demonstrates the following tasks:

- creates a resource environment
- tries to delete all catalog entries by using the KILL option but receives an error
- specifies the FORCE option to successfully delete all catalog entries by using the KILL option.

Program

```
 %macro matt;
    %put &syscc;
%mend matt;

proc catalog c=work.sasmacr kill;
run;
quit;

proc catalog c=work.sasmacr kill force;
run;
quit;
```

Program Description

Start a process (resource environment). Do this by opening the catalog entry MATT in the Work.Sasmacr catalog.

```
 %macro matt;
    %put &syscc;
%mend matt;
```

Specify the KILL option to delete all catalog entries in Work.SasMacr. Since there is a resource environment (process using the catalog), KILL does not work and an error is sent to the log.

```
proc catalog c=work.sasmacr kill;
run;
quit;
```

Specify the FORCE option to the KILL option to delete the catalog entries.

```
proc catalog c=work.sasmacr kill force;
run;
quit;
```

Log Examples

Example Code 10.2 *KILL Option Causes Error to Be Sent to the SAS Log*

```
1     %macro matt;
2       %put &syscc;
3       %mend matt;
4
5    proc catalog c=work.sasmacr kill;
NOTE: Writing HTML Body file: sashtml.htm
6    run;

ERROR: You cannot open WORK.SASMACR.CATALOG for update access because
WORK.SASMACR.CATALOG is in
use by you in resource environment _O_TAGS.
WARNING: Command CATALOG not processed because of errors noted above.
7    quit;

NOTE: The SAS System stopped processing this step because of errors.
NOTE: PROCEDURE CATALOG used (Total process time):
      real time           6.46 seconds
      cpu time            0.62 seconds
```

Example Code 10.3 *Adding the FORCE Option to the KILL Option to Delete the Catalog Entry*

```
8    proc catalog c=work.sasmacr kill force;
9    run;

NOTE: Deleting entry MATT.MACRO in catalog WORK.SASMACR.
10   quit;

NOTE: PROCEDURE CATALOG used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

11

CHART Procedure

Overview: CHART Procedure

What Does the CHART Procedure Do?

The CHART procedure produces vertical and horizontal bar charts, block charts, pie charts, and star charts. These types of charts graphically display values of a variable or a statistic associated with those values. The charted variable can be numeric or character.

PROC CHART is a useful tool that lets you visualize data quickly, but if you need to produce presentation-quality graphics that include color and various fonts, then use SAS/GRAPH software. The GCHART procedure in SAS/GRAPH software produces the same types of charts as PROC CHART does. In addition, PROC GCHART can produce donut charts.

What Types of Charts Can PROC CHART Create?

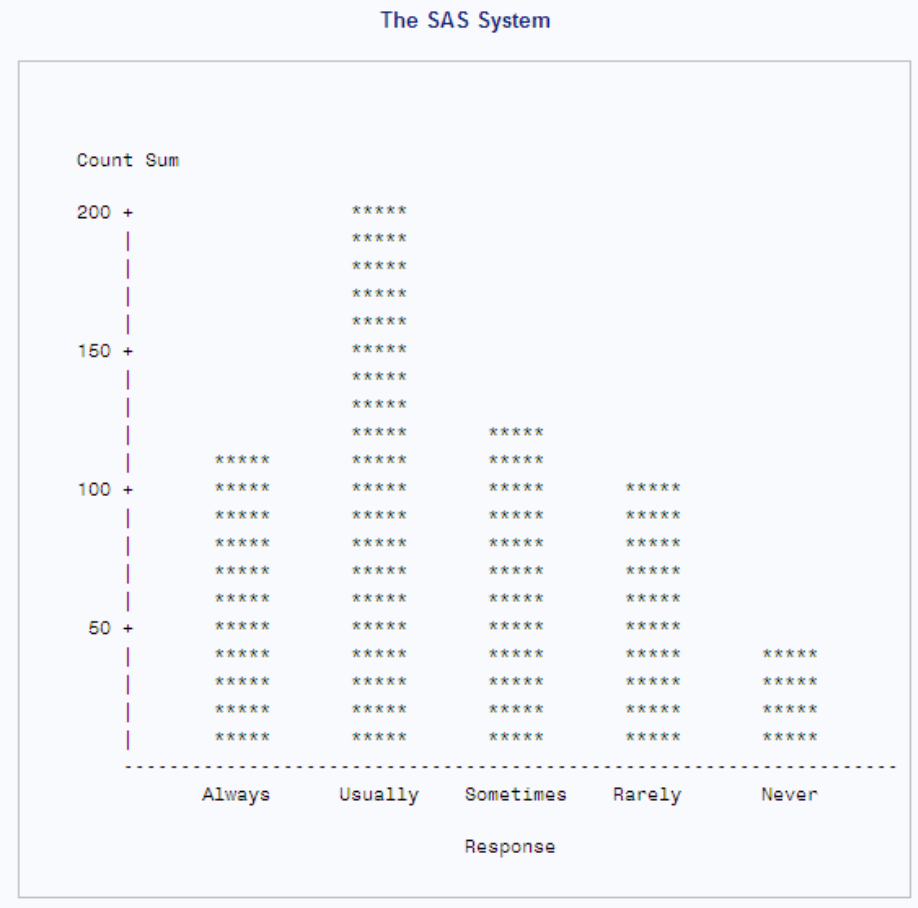
Bar Charts

Horizontal and vertical bar charts display the magnitude of data with bars, each of which represents a category of data. The length or height of the bars represents the value of the chart statistic for each category.

The following output shows a vertical bar chart that displays the number of responses for the five categories from the survey data. The following statements produce the output:

```
proc chart data=survey;
   vbar response / sumvar=count
   axis=0 to 200 by 50
   midpoints='Always' 'Usually'
             'Sometimes' 'Rarely' 'Never';
run;
```

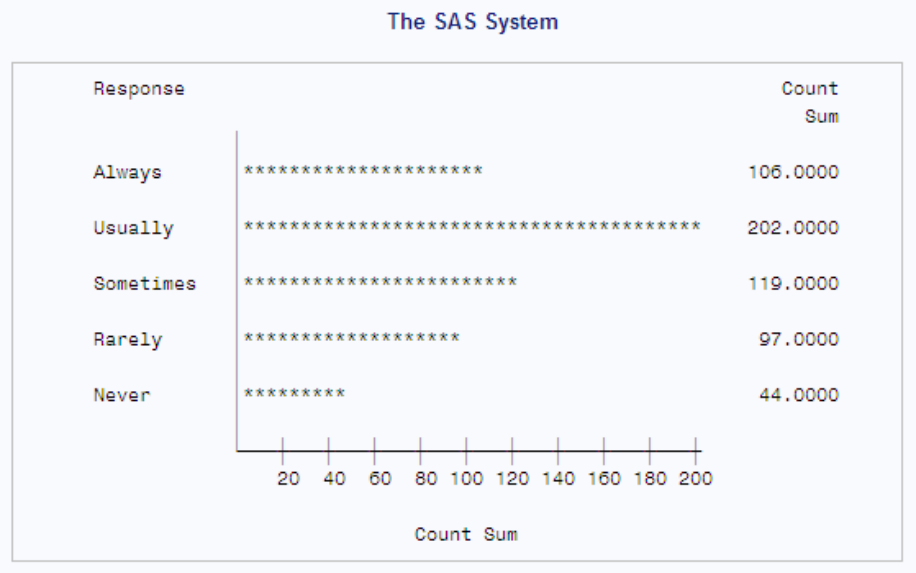
Output 11.1 *Vertical Bar Chart*



The following output shows the same data presented in a horizontal bar chart. The two types of bar charts have essentially the same characteristics, except that horizontal bar charts by default display a table of statistic values to the right of the bars. The following statements produce the output:

```
proc chart data=survey;
   hbar response / sumvar=count
        midpoints='Always' 'Usually'
           'Sometimes' 'Rarely' 'Never';
run;
```

Output 11.2 *Horizontal Bar Chart*

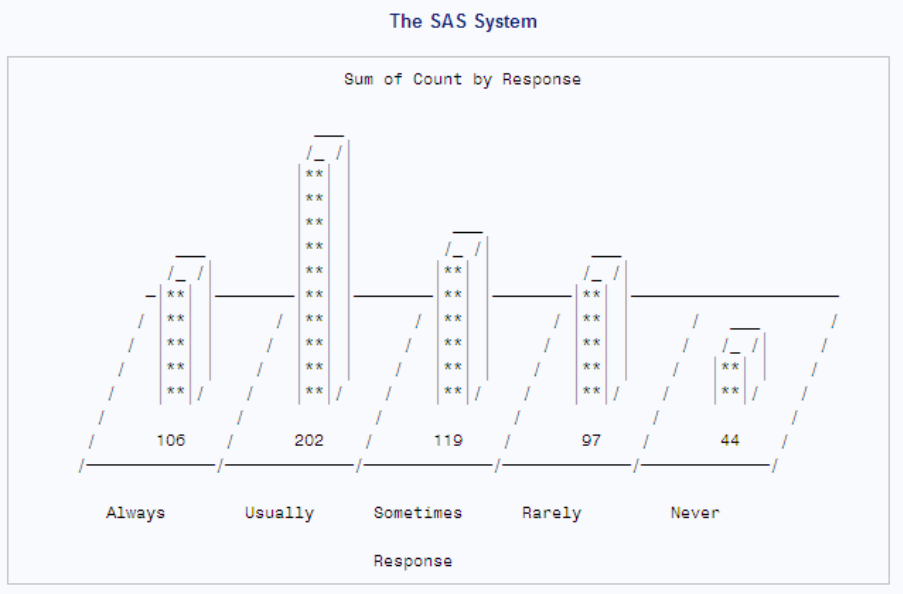


Block Charts

Block charts display the relative magnitude of data by using blocks of varying height, each set in a square that represents a category of data. The following output shows the number of each survey response in the form of a block chart.

```
proc chart data=survey;
    block response / sumvar=count
    midpoints='Always' 'Usually'
              'Sometimes' 'Rarely' 'Never';
run;
```

Output 11.3 *Block Chart*

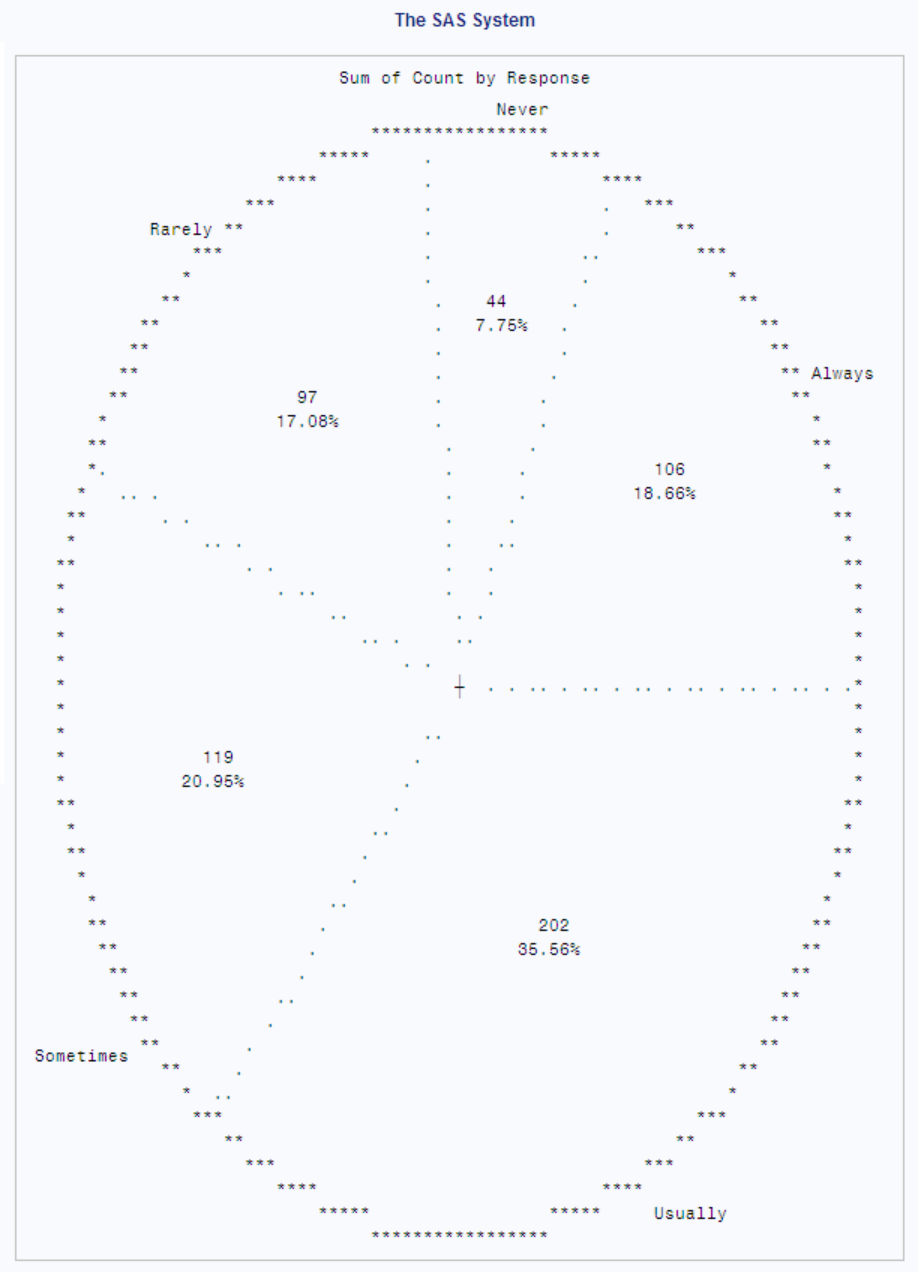


Pie Charts

Pie charts represent the relative contribution of parts to the whole by displaying data as wedge-shaped slices of a circle. Each slice represents a category of the data. The following output shows the survey results divided by response into five pie slices. The following statements produce the output:

```
proc chart data=survey;
   pie response / sumvar=count;
run;
```

Output 11.4 *Pie Chart*



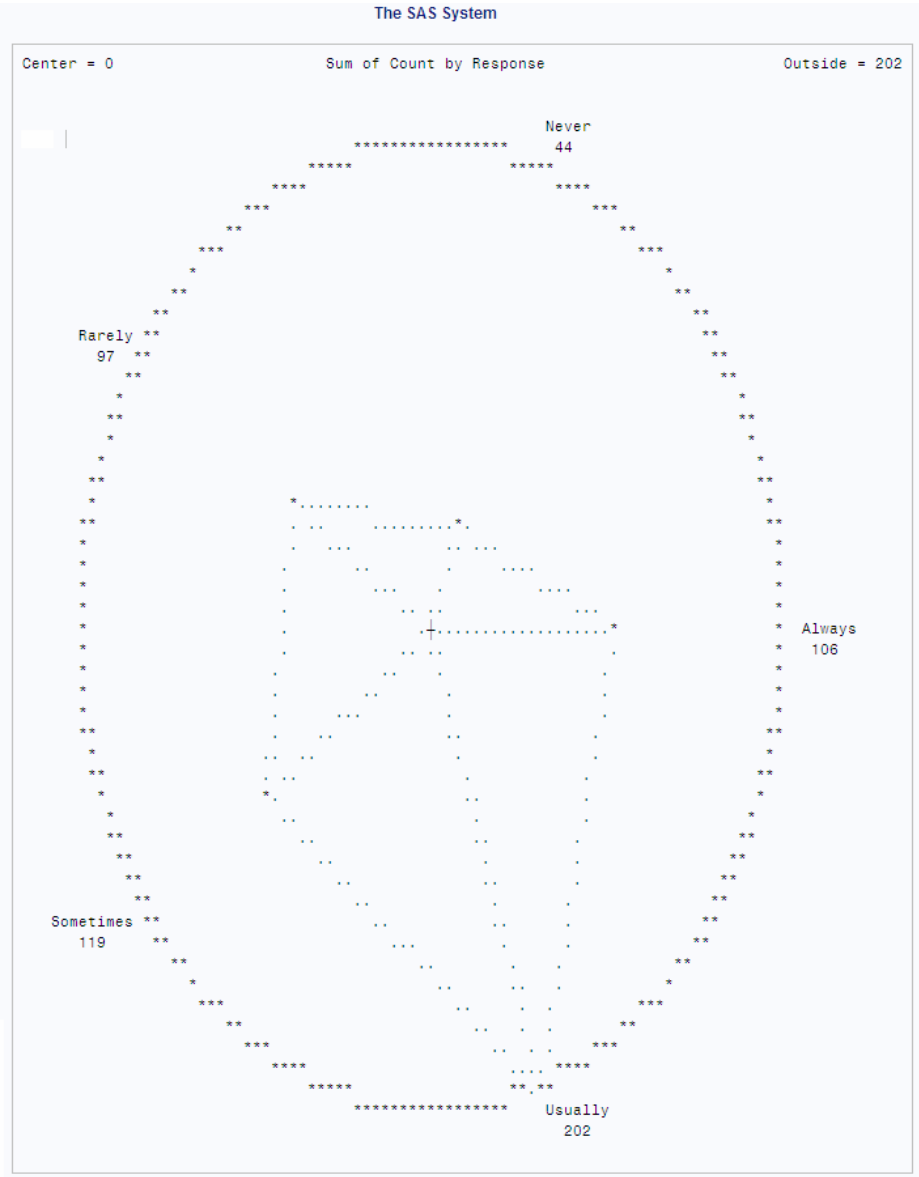
Star Charts

With PROC CHART, you can produce star charts that show group frequencies, totals, or mean values. A star chart is similar to a vertical bar chart, but the bars on a star chart radiate from a center point, like spokes in a wheel. Star charts are commonly used for cyclical data, such as measures taken every month or day or hour. They are also used for data in which the categories have an inherent order ("always" meaning more frequent than "usually," which means more frequent than

"sometimes"). The following output shows the survey data displayed in a star chart. The following statements produce the output:

```
proc chart data=survey;
   star response / sumvar=count;
run;
```

Output 11.5 *Star Chart*



Concepts: CHART Procedure

Concepts: CHART Procedure

Here are characteristics for the CHART procedure:

- Character variables and formats cannot exceed a length of 16.
- For continuous numeric variables, PROC CHART automatically selects display intervals, although you can define interval midpoints.
- For character variables and discrete numeric variables, which contain several distinct values rather than a continuous range, the data values themselves define the intervals.

Syntax: CHART Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Requirement: You must use at least one of the chart-producing statements.

Tips: You can use the ATTRIB, FORMAT, LABEL, and WHERE statements. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

You can also use any global statement. For a list, see "Global Statements" on page 25 and "Dictionary of SAS Global Statements" in *SAS Global Statements: Reference*.

PROC CHART <*options*>;

BLOCK *variable(s)* </ *options*>;

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

HBAR *variable(s)* </ *options*>;

PIE *variable(s)* </ *options*>;

STAR *variable(s)* </ *options*>;

VBAR *variable(s)* </ *options*>;

Statement	Task	Example
PROC CHART	Produce a chart	
BLOCK	Produce a block chart	Ex. 6
BY	Produce a separate chart for each BY group	Ex. 6
HBAR	Produce a horizontal bar chart	Ex. 5
PIE	Produce a PIE chart	
STAR	Produce a STAR chart	
VBAR	Produce a vertical bar chart	Ex. 1, Ex. 2, Ex. 3, Ex. 4

PROC CHART Statement

Produces vertical and horizontal bar charts, block charts, pie charts, and star charts.

Syntax

PROC CHART <*options*>;

Optional Arguments

DATA=*SAS-data-set*
identifies the input SAS data set.

Restriction You cannot use PROC CHART with an engine that supports concurrent access if another user is updating the data set at the same time.

See "Input Data Sets" on page 26

FORMCHAR <(*position(s)*)>='*formatting-character(s)*'
defines the characters to use for constructing the horizontal and vertical axes, reference lines, and other structural parts of a chart. It also defines the symbols to use to create the bars, blocks, or sections in the output.

position(s)
identifies the position of one or more characters in the SAS formatting-character string. A space or a comma separates the positions.

Default Omitting (*position(s)*), is the same as specifying all 20 possible SAS formatting characters, in order.

Note PROC CHART uses 6 of the 20 formatting characters that SAS provides. Table 11.24 on page 344 shows the formatting characters that PROC CHART uses. Figure 11.13 on page 345 illustrates the use of formatting characters commonly used in PROC CHART.

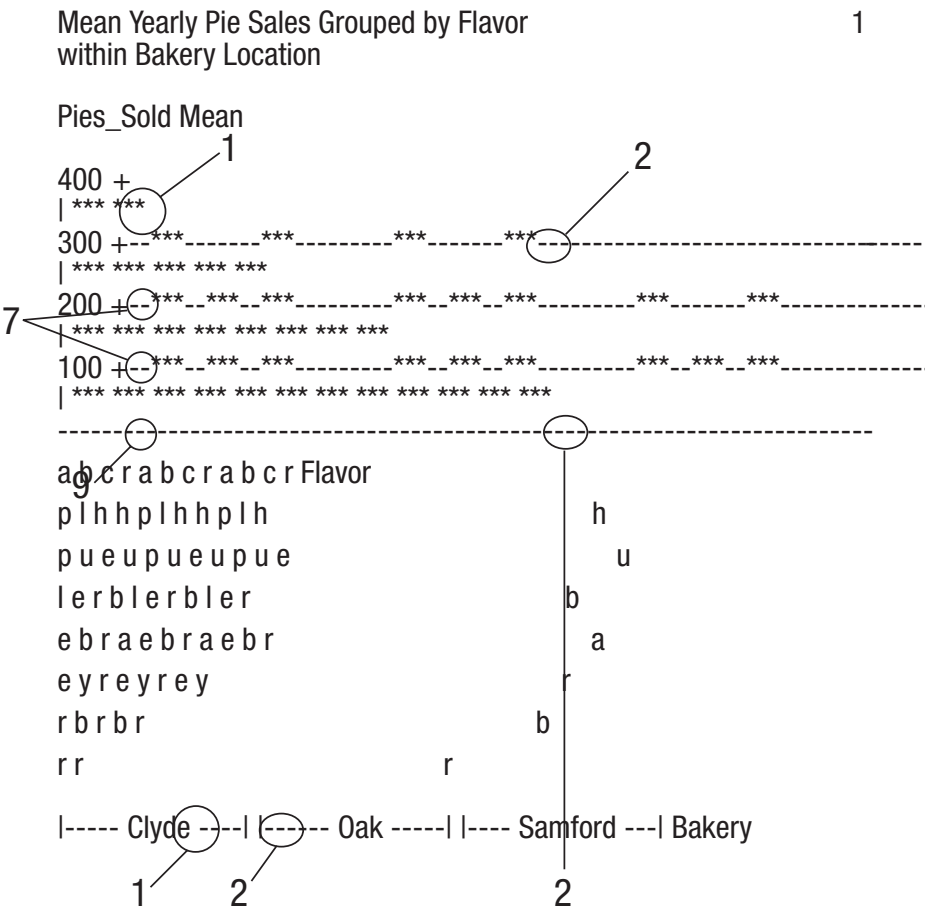
formatting-character(s)
lists the characters to use for the specified positions. PROC CHART assigns characters in *formatting-character(s)* to *position(s)*, in the order which they are listed. For example, the following option assigns the asterisk (*) to the second formatting character, the number sign (#) to the seventh character, and does not alter the remaining characters:

```
formchar(2,7)='*#'
```

Table 11.1 *Formatting Characters Used by PROC CHART*

Position	Default	Used to Draw
1	|	Vertical axes in bar charts, the sides of the blocks in block charts, and reference lines in horizontal bar charts. In side-by-side bar charts, the first and second formatting characters appear around each value of the group variable (below the chart) to indicate the width of each group.
2	-	Horizontal axes in bar charts, the horizontal lines that separate the blocks in a block chart, and reference lines in vertical bar charts. In side-by-side bar charts, the first and second formatting characters appear around each value of the group variable (below the chart) to indicate the width of each group.
7	+	Tick marks in bar charts and the centers in pie and star charts.
9	-	Intersection of axes in bar charts.
16	/	Ends of blocks and the diagonal lines that separate blocks in a block chart.
20	*	Circles in pie and star charts.

Figure 11.1 *Formatting Characters Commonly Used in PROC CHART Output*



Interaction The SAS system option FORMCHAR= specifies the default formatting characters. The system option defines the entire string of formatting characters. The FORMCHAR= option in a procedure can redefine selected characters.

Tip You can use any character in *formatting-characters*, including hexadecimal characters. If you use hexadecimal characters, then you must put an x after the closing quotation mark. For example, the following option assigns the hexadecimal character 2-D to the second formatting character, the hexadecimal character 7C to the seventh character, and does not alter the remaining characters:

```
formchar(2,7)='2D7C'x
```

See For information about which hexadecimal codes to use for which characters, consult the documentation for your hardware.

LPI=*value*

specifies the proportions of PIE and STAR charts. The *value* is determined by

$$(\text{lines per inch} / \text{columns per inch}) * 10$$

For example, if you have a printer with 8 lines per inch and 12 columns per inch, then specify LPI=6.6667.

Default 6

BLOCK Statement

Produces a block chart.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Example: "Example 6: Producing Block Charts for BY Groups" on page 384

Syntax

BLOCK *variable(s)* </ *options*>;

Required Argument

variable(s)
specifies the variables for which PROC CHART produces a block chart, one chart for each variable.

Optional Arguments

AXIS=*value-expression*
specifies the values for the response axis, where *value-expression* is a list of individual values, each separated by a space, or a range with a uniform interval for the values. For example, the following range specifies tick marks on a bar chart from 0 to 100 at intervals of 10: `hbar x / axis=0 to 100 by 10;`

Restrictions Values must be equally spaced, even if you specify them individually.

For frequency charts, values must be integers.

Interactions For BLOCK charts, AXIS= sets the scale of the tallest block. To set the scale, PROC CHART uses the maximum value from the AXIS= list. If no value is greater than 0, then PROC CHART ignores the AXIS= option.

If you use AXIS= and the BY statement, then PROC CHART produces uniform axes over BY groups.

CAUTION **Values in value-expression override the range of the data.** For example, if the data range is 1 to 10 and you specify a range of 3 to 5, then only the data in the range 3 to 5 appears on the chart. Values out of range produce a warning message in the SAS log.

FREQ=*variable*
specifies a data set variable that represents a frequency count for each observation. Normally, each observation contributes a value of one to the frequency counts. With FREQ=, each observation contributes its value of the FREQ= value.

Restriction If the FREQ= values are not integers, then PROC CHART truncates them.

Interaction If you use SUMVAR=, then PROC CHART multiplies the sums by the FREQ= value.

GROUP=*variable*
produces side-by-side charts, with each chart representing the observations that have a common value for the GROUP= variable. The GROUP= variable can be character or numeric and is assumed to be discrete. For example, the following statement produces a frequency bar chart for men and women in each department:

```
vbar gender / group=dept;
```

Missing values for a GROUP= variable are treated as valid levels.

Examples "Example 4: Producing Side-by-Side Bar Charts" on page 379

"Example 5: Producing a Horizontal Bar Chart for a Subset of the Data" on page 382

"Example 6: Producing Block Charts for BY Groups" on page 384

G100
specifies that the sum of percentages for each group equals 100. By default, PROC CHART uses 100% as the total sum. For example, if you produce a bar chart that separates males and females into three age categories, then the six bars, by default, add to 100%. However, with G100, the three bars for females add to 100%, and the three bars for males add to 100%.

Interaction PROC CHART ignores G100 if you omit GROUP=.

LEVELS=*number-of-midpoints*
specifies the number of bars that represent each chart variable when the variables are continuous.

MIDPOINTS=*midpoint-specification* | OLD
defines the range of values that each bar, block, or section represents by specifying the range midpoints.

The value for MIDPOINTS= is one of the following:

midpoint-specification
specifies midpoints, either individually, or across a range at a uniform interval. For example, the following statement produces a chart with five bars. The first bar represents the range of values of X with a midpoint of 10. The second bar represents the range with a midpoint of 20, and so on:

```
vbar x / midpoints=10 20 30 40 50;
```

Here is an example of a midpoint specification for a character variable:

```
vbar x / midpoints='JAN' 'FEB' 'MAR';
```

Here is an example of specifying midpoints across a range at a uniform interval:

```
vbar x / midpoints=10 to 100 by 5;
```

OLD
specifies an algorithm that PROC CHART used in previous versions of SAS to choose midpoints for continuous variables. The old algorithm was based on the work of Nelder (1976). The current algorithm that PROC CHART uses if you omit OLD is based on the work of Terrell and Scott (1985).

Default Without MIDPOINTS=, PROC CHART displays the values in the SAS System's normal sorted order.

MISSING
specifies that missing values are valid levels for the chart variable.

NOHEADER
suppresses the default header line printed at the top of a chart.

Alias NOHEADING

Example "Example 6: Producing Block Charts for BY Groups" on page 384

NOSYMBOL
suppresses printing of the subgroup symbol or legend table.

Alias NOLEGEND

Interaction PROC CHART ignores NOSYMBOL if you omit SUBGROUP=.

SUBGROUP=*variable*
subdivides each bar or block into characters that show the contribution of the values of *variable* to that bar or block. PROC CHART uses the first character of each value to fill in the portion of the bar or block that corresponds to that value, unless more than one value begins with the same first character. In that case, PROC CHART uses the letters A, B, C, and so on, to fill in the bars or blocks. If the variable is formatted, then PROC CHART uses the first character of the formatted value.

The characters used in the chart and the values that they represent are given in a legend at the bottom of the chart. The subgroup symbols are ordered A through Z and 0 through 9 with the characters in ascending order.

PROC CHART calculates the height of a bar or block for each subgroup individually and then rounds the percentage of the total bar up or down. So the total height of the bar can be higher or lower than the same bar without the SUBGROUP= option.

Interaction If you use both TYPE=MEAN and SUBGROUP=, then PROC CHART first calculates the mean for each variable that is listed in the SUMVAR= option. It then subdivides the bar into the percentages that each subgroup contributes.

Example “Example 3: Subdividing the Bars into Categories” on page 376

SUMVAR=*variable*
specifies the variable for which either values or means (depending on the value of TYPE=) PROC CHART displays in the chart.

Interaction If you use SUMVAR= and you use TYPE= with a value other than MEAN or SUM, then TYPE=SUM overrides the specified TYPE= value.

Tip Both HBAR and VBAR charts can print labels for SUMVAR= variables if you use a LABEL statement.

Examples “Example 3: Subdividing the Bars into Categories” on page 376

“Example 4: Producing Side-by-Side Bar Charts” on page 379

“Example 5: Producing a Horizontal Bar Chart for a Subset of the Data” on page 382

“Example 6: Producing Block Charts for BY Groups” on page 384

SYMBOL=*character(s)*
specifies the character or characters that PROC CHART uses in the bars or blocks of the chart when you do not use the SUBGROUP= option.

Default asterisk (*)

Interaction If the SAS system option OVP is in effect and if your printing device supports overprinting, then you can specify up to three characters to produce overprinted charts.

Example “Example 6: Producing Block Charts for BY Groups” on page 384

TYPE=*statistic*
specifies what the bars or sections in the chart represent. The *statistic* is one of the following:

CFREQ
specifies that each bar, block, or section represent the cumulative frequency.

CPERCENT
specifies that each bar, block, or section represent the cumulative percentage.

Alias CPCT

FREQ
specifies that each bar, block, or section represent the frequency with which a value or range occurs for the chart variable in the data.

MEAN
specifies that each bar, block, or section represent the mean of the SUMVAR= variable across all observations that belong to that bar, block, or section.

Interaction With TYPE=MEAN, you can compute only MEAN and FREQ statistics.

Example "Example 4: Producing Side-by-Side Bar Charts" on page 379

PERCENT
specifies that each bar, block, or section represent the percentage of observations that have a given value or that fall into a given range of the chart variable.

Alias PCT

Example "Example 2: Producing a Percentage Bar Chart" on page 373

SUM
specifies that each bar, block, or section represent the sum of the SUMVAR= variable for the observations that correspond to each bar, block, or section.

Default FREQ (unless you use SUMVAR=, which causes a default of SUM)

Interaction With TYPE=SUM, you can compute only SUM and FREQ statistics.

Details

Statement Results

Because each block chart must fit on one output page, you might have to adjust the SAS system options LINESIZE= and PAGESIZE= if you have a large number of charted values for the BLOCK variable and for the variable specified in the GROUP= option.

The following table shows the maximum number of charted values of BLOCK variables for selected LINESIZE= (LS=) specifications that can fit on a 66-line page.

Table 11.2 *Maximum Number of Bars of BLOCK Variables*

GROUP= Value	LS= 132	LS= 120	LS= 105	LS= 90	LS= 76	LS= 64
0,1	9	8	7	6	5	4
2	8	8	7	6	5	4
3	8	7	6	5	4	3
4	7	7	6	5	4	3
5,6	7	6	5	4	3	2

If the value of any GROUP= level is longer than three characters, then the maximum number of charted values for the BLOCK variable that can fit might be reduced by one. BLOCK level values truncate to 12 characters. If you exceed these limits, then PROC CHART produces a horizontal bar chart instead.

BY Statement

Produces a separate chart for each BY group.

See: "BY" on page 74

Example: "Example 6: Producing Block Charts for BY Groups" on page 384

Syntax

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, then the observations in the data set must either be sorted by all the variables that you specify, or they must be indexed appropriately. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the observations are sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The observations are grouped in another way (for example, chronological order).

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

HBAR Statement

Produces a horizontal bar chart.

Tip: HBAR charts can print either the name or the label of the chart variable.

See: "Example 5: Producing a Horizontal Bar Chart for a Subset of the Data" on page 382

Syntax

HBAR *variable(s)* </ *options*>;

Required Argument

variable(s)
specifies the variables for which PROC CHART produces a horizontal bar chart, one chart for each variable.

Optional Arguments

ASCENDING
prints the bars and any associated statistics in ascending order of size within groups.

Alias ASC

AXIS=*value-expression*
specifies the values for the response axis, where *value-expression* is a list of individual values, each separated by a space, or a range with a uniform interval for the values. For example, the following range specifies tick marks on a bar chart from 0 to 100 at intervals of 10: `hbar x / axis=0 to 100 by 10;`

Restrictions Values must be equally spaced, even if you specify them individually.

For frequency charts, values must be integers.

Interactions For HBAR and VBAR charts, AXIS= determines tick marks on the response axis. If the AXIS= specification contains only one value, then the value determines the minimum tick mark if the value is less than 0, or determines the maximum tick mark if the value is greater than 0.

If you use AXIS= and the BY statement, then PROC CHART produces uniform axes over BY groups.

CAUTION **Values in value-expression override the range of the data.** For example, if the data range is 1 to 10 and you specify a range of 3 to 5, then

only the data in the range 3 to 5 appears on the chart. Values out of range produce a warning message in the SAS log.

CFREQ
prints the cumulative frequency.

Restriction Available only in the HBAR statement

CPERCENT
prints the cumulative percentages.

Restriction Available only in the HBAR statement

DISCRETE
specifies that a numeric chart variable is discrete rather than continuous. Without DISCRETE, PROC CHART assumes that all numeric variables are continuous and automatically chooses intervals for them unless you use MIDPOINTS= or LEVELS=.

FREQ
prints the frequency of each bar to the side of the chart.

Restriction Available only in the HBAR statement

FREQ=*variable*
specifies a data set variable that represents a frequency count for each observation. Normally, each observation contributes a value of one to the frequency counts. With FREQ=, each observation contributes its value of the FREQ= value.

Restriction If the FREQ= values are not integers, then PROC CHART truncates them.

Interaction If you use SUMVAR=, then PROC CHART multiplies the sums by the FREQ= value.

GROUP=*variable*
produces side-by-side charts, with each chart representing the observations that have a common value for the GROUP= variable. The GROUP= variable can be character or numeric and is assumed to be discrete. For example, the following statement produces a frequency bar chart for men and women in each department:

```
vbar gender / group=dept;
```

Missing values for a GROUP= variable are treated as valid levels.

Examples "Example 4: Producing Side-by-Side Bar Charts" on page 379

"Example 5: Producing a Horizontal Bar Chart for a Subset of the Data" on page 382

"Example 6: Producing Block Charts for BY Groups" on page 384

GSPACE=*n*
specifies the amount of extra space between groups of bars. Use GSPACE=0 to leave no extra space between adjacent groups of bars.

Interaction PROC CHART ignores GSPACE= if you omit GROUP=

G100
specifies that the sum of percentages for each group equals 100. By default, PROC CHART uses 100% as the total sum. For example, if you produce a bar chart that separates males and females into three age categories, then the six bars, by default, add to 100%. However, with G100, the three bars for females add to 100%, and the three bars for males add to 100%.

Interaction PROC CHART ignores G100 if you omit GROUP=.

LEVELS=*number-of-midpoints*
specifies the number of bars that represent each chart variable when the variables are continuous.

MEAN
prints the mean of the observations represented by each bar.

Restrictions Available only when you use SUMVAR= and TYPE=

Not available when TYPE=CFREQ, CPERCENT, FREQ, or PERCENT

MISSING
specifies that missing values are valid levels for the chart variable.

NOSTATS
suppresses the statistics on a horizontal bar chart.

Alias NOSTAT

NOSYMBOL
suppresses printing of the subgroup symbol or legend table.

Alias NOLEGEND

Interaction PROC CHART ignores NOSYMBOL if you omit SUBGROUP=.

NOZEROS
suppresses any bar with zero frequency.

PERCENT
prints the percentages of observations having a given value for the chart variable.

REF=*value(s)*
draws reference lines on the response axis at the specified positions.

Tip The REF= values should correspond to values of the TYPE= statistic.

Example “Example 4: Producing Side-by-Side Bar Charts” on page 379

SPACE=*n*
specifies the amount of space between individual bars.

Tips Use SPACE=0 to leave no space between adjacent bars.

Use the GSPACE= option to specify the amount of space between the bars within each group.

SUBGROUP=*variable*
subdivides each bar or block into characters that show the contribution of the values of *variable* to that bar or block. PROC CHART uses the first character of each value to fill in the portion of the bar or block that corresponds to that value, unless more than one value begins with the same first character. In that case, PROC CHART uses the letters A, B, C, and so on, to fill in the bars or blocks. If the variable is formatted, then PROC CHART uses the first character of the formatted value.

The characters used in the chart and the values that they represent are given in a legend at the bottom of the chart. The subgroup symbols are ordered A through Z and 0 through 9 with the characters in ascending order.

PROC CHART calculates the height of a bar or block for each subgroup individually and then rounds the percentage of the total bar up or down. So the total height of the bar can be higher or lower than the same bar without the SUBGROUP= option.

Interaction If you use both TYPE=MEAN and SUBGROUP=, then PROC CHART first calculates the mean for each variable that is listed in the SUMVAR= option. It then subdivides the bar into the percentages that each subgroup contributes.

Example “Example 3: Subdividing the Bars into Categories” on page 376

SUM
prints the total number of observations that each bar represents.

Restrictions Available only when you use both SUMVAR= and TYPE=

Not available when TYPE=CFREQ, CPERCENT, FREQ, or PERCENT

SUMVAR=*variable*
specifies the variable for which either values or means (depending on the value of TYPE=) PROC CHART displays in the chart.

Interaction If you use SUMVAR= and you use TYPE= with a value other than MEAN or SUM, then TYPE=SUM overrides the specified TYPE= value.

Tip HBAR charts can print labels for SUMVAR= variables if you use a LABEL statement.

Examples “Example 3: Subdividing the Bars into Categories” on page 376

“Example 4: Producing Side-by-Side Bar Charts” on page 379

"Example 5: Producing a Horizontal Bar Chart for a Subset of the Data" on page 382

"Example 6: Producing Block Charts for BY Groups" on page 384

SYMBOL=*character(s)*
specifies the character or characters that PROC CHART uses in the bars or blocks of the chart when you do not use the SUBGROUP= option.

Default asterisk (*)

Interaction If the SAS system option OVP is in effect and if your printing device supports overprinting, then you can specify up to three characters to produce overprinted charts.

Example "Example 6: Producing Block Charts for BY Groups" on page 384

TYPE=*statistic*
specifies what the bars or sections in the chart represent. The *statistic* is one of the following:

CFREQ
specifies that each bar, block, or section represent the cumulative frequency.

CPERCENT
specifies that each bar, block, or section represent the cumulative percentage.

Alias CPCT

FREQ
specifies that each bar, block, or section represent the frequency with which a value or range occurs for the chart variable in the data.

MEAN
specifies that each bar, block, or section represent the mean of the SUMVAR= variable across all observations that belong to that bar, block, or section.

Interaction With TYPE=MEAN, you can compute only MEAN and FREQ statistics.

Example "Example 4: Producing Side-by-Side Bar Charts" on page 379

PERCENT
specifies that each bar, block, or section represent the percentage of observations that have a given value or that fall into a given range of the chart variable.

Alias PCT

Example "Example 2: Producing a Percentage Bar Chart" on page 373

SUM
specifies that each bar, block, or section represent the sum of the SUMVAR= variable for the observations that correspond to each bar, block, or section.

Default	FREQ (unless you use SUMVAR=, which causes a default of SUM)
Interaction	With TYPE=SUM, you can compute only SUM and FREQ statistics.

WIDTH=*n*
specifies the width of the bars on bar charts.

Details

Statement Results

Each chart occupies one or more output pages, depending on the number of bars; each bar occupies one line, by default.

By default, for horizontal bar charts of TYPE=FREQ, CFREQ, PCT, or CPCT, PROC CHART prints the following statistics: frequency, cumulative frequency, percentage, and cumulative percentage. If you use one or more of the statistics options, then PROC CHART prints only the statistics that you request, plus the frequency.

PIE Statement

Produces a pie chart.

Syntax

PIE *variable(s)* </ *options*>;

Required Argument

variable(s)
specifies the variables for which PROC CHART produces a pie chart, one chart for each variable.

Optional Arguments

FREQ=*variable*
specifies a data set variable that represents a frequency count for each observation. Normally, each observation contributes a value of one to the frequency counts. With FREQ=, each observation contributes its value of the FREQ= value.

Restriction If the FREQ= values are not integers, then PROC CHART truncates them.

Interaction If you use SUMVAR=, then PROC CHART multiplies the sums by the FREQ= value.

LEVELS=*number-of-midpoints*
specifies the number of bars that represent each chart variable when the variables are continuous.

MIDPOINTS=*midpoint-specification* | OLD
defines the range of values that each bar, block, or section represents by specifying the range midpoints.

The value for MIDPOINTS= is one of the following:

midpoint-specification
specifies midpoints, either individually, or across a range at a uniform interval. For example, the following statement produces a chart with five bars. The first bar represents the range of values of X with a midpoint of 10. The second bar represents the range with a midpoint of 20, and so on:

```
vbar x / midpoints=10 20 30 40 50;
```

Here is an example of a midpoint specification for a character variable:

```
vbar x / midpoints='JAN' 'FEB' 'MAR';
```

Here is an example of specifying midpoints across a range at a uniform interval:

```
vbar x / midpoints=10 to 100 by 5;
```

OLD
specifies an algorithm that PROC CHART used in previous versions of SAS to choose midpoints for continuous variables. The old algorithm was based on the work of Nelder (1976). The current algorithm that PROC CHART uses if you omit OLD is based on the work of Terrell and Scott (1985).

Default Without MIDPOINTS=, PROC CHART displays the values in the SAS System's normal sorted order.

MISSING
specifies that missing values are valid levels for the chart variable.

NOHEADER
suppresses the default header line printed at the top of a chart.

Alias NOHEADING

Example "Example 6: Producing Block Charts for BY Groups" on page 384

SUMVAR=*variable*
specifies the variable for which either values or means (depending on the value of TYPE=) PROC CHART displays in the chart.

Interaction If you use SUMVAR= and you use TYPE= with a value other than MEAN or SUM, then TYPE=SUM overrides the specified TYPE= value.

Tip Both HBAR and VBAR charts can print labels for SUMVAR= variables if you use a LABEL statement.

Examples "Example 3: Subdividing the Bars into Categories" on page 376

"Example 4: Producing Side-by-Side Bar Charts" on page 379

"Example 5: Producing a Horizontal Bar Chart for a Subset of the Data" on page 382

"Example 6: Producing Block Charts for BY Groups" on page 384

TYPE=*statistic*

specifies what the bars or sections in the chart represent. The *statistic* is one of the following:

CFREQ

specifies that each bar, block, or section represent the cumulative frequency.

CPERCENT

specifies that each bar, block, or section represent the cumulative percentage.

Alias CPCT

FREQ

specifies that each bar, block, or section represent the frequency with which a value or range occurs for the chart variable in the data.

MEAN

specifies that each bar, block, or section represent the mean of the SUMVAR= variable across all observations that belong to that bar, block, or section.

Interaction With TYPE=MEAN, you can compute only MEAN and FREQ statistics.

Example "Example 4: Producing Side-by-Side Bar Charts" on page 379

PERCENT

specifies that each bar, block, or section represent the percentage of observations that have a given value or that fall into a given range of the chart variable.

Alias PCT

Example "Example 2: Producing a Percentage Bar Chart" on page 373

SUM

specifies that each bar, block, or section represent the sum of the SUMVAR= variable for the observations that correspond to each bar, block, or section.

Default	FREQ (unless you use SUMVAR=, which causes a default of SUM)
Interaction	With TYPE=SUM, you can compute only SUM and FREQ statistics.

Details

Statement Results

PROC CHART determines the number of slices for the pie in the same way that it determines the number of bars for vertical bar charts. Any slices of the pie accounting for less than three print positions are grouped together into an "OTHER" category.

The pie's size is determined only by the SAS system options LINESIZE= and PAGESIZE=. By default, the pie looks elliptical if your printer does not print 6 lines per inch and 10 columns per inch. To make a circular pie chart on a printer that does not print 6 lines and 10 columns per inch, use the LPI= option in the PROC CHART statement. See the description of "LPI=*value*" on page 345 for the formula that gives you the proper LPI= value for your printer.

If you try to create a PIE chart for a variable with more than 50 levels, then PROC CHART produces a horizontal bar chart instead.

STAR Statement

Produces a star chart.

Syntax

STAR *variable(s)* </ *options*>;

Required Argument

variable(s)
specifies the variables for which PROC CHART produces a star chart, one chart for each variable.

Optional Arguments

AXIS=*value-expression*
specifies the values for the response axis, where *value-expression* is a list of individual values, each separated by a space, or a range with a uniform interval

for the values. For example, the following range specifies tick marks on a bar chart from 0 to 100 at intervals of 10: `hbar x / axis=0 to 100 by 10;`

Restrictions Values must be equally spaced, even if you specify them individually.

For frequency charts, values must be integers.

Interactions For STAR charts, a single AXIS= value sets the minimum (the center of the chart) if the value is less than zero, or sets the maximum (the outside circle) if the value is greater than zero. If the AXIS= specification contains more than one value, then PROC CHART uses the minimum and maximum values from the list.

If you use AXIS= and the BY statement, then PROC CHART produces uniform axes over BY groups.

CAUTION **Values in value-expression override the range of the data.** For example, if the data range is 1 to 10 and you specify a range of 3 to 5, then only the data in the range 3 to 5 appears on the chart. Values out of range produce a warning message in the SAS log.

FREQ=*variable*

specifies a data set variable that represents a frequency count for each observation. Normally, each observation contributes a value of one to the frequency counts. With FREQ=, each observation contributes its value of the FREQ= value.

Restriction If the FREQ= values are not integers, then PROC CHART truncates them.

Interaction If you use SUMVAR=, then PROC CHART multiplies the sums by the FREQ= value.

LEVELS=*number-of-midpoints*

specifies the number of bars that represent each chart variable when the variables are continuous.

MIDPOINTS=*midpoint-specification* | OLD

defines the range of values that each bar, block, or section represents by specifying the range midpoints.

The value for MIDPOINTS= is one of the following:

midpoint-specification

specifies midpoints, either individually, or across a range at a uniform interval. For example, the following statement produces a chart with five bars. The first bar represents the range of values of X with a midpoint of 10. The second bar represents the range with a midpoint of 20, and so on:

```
vbar x / midpoints=10 20 30 40 50;
```

Here is an example of a midpoint specification for a character variable:

```
vbar x / midpoints='JAN' 'FEB' 'MAR';
```

Here is an example of specifying midpoints across a range at a uniform interval:

```
vbar x / midpoints=10 to 100 by 5;
```

OLD
specifies an algorithm that PROC CHART used in previous versions of SAS to choose midpoints for continuous variables. The old algorithm was based on the work of Nelder (1976). The current algorithm that PROC CHART uses if you omit OLD is based on the work of Terrell and Scott (1985).

Default Without MIDPOINTS=, PROC CHART displays the values in the SAS System's normal sorted order.

MISSING
specifies that missing values are valid levels for the chart variable.

NOHEADER
suppresses the default header line printed at the top of a chart.

Alias NOHEADING

Example "Example 6: Producing Block Charts for BY Groups" on page 384

SUMVAR=*variable*
specifies the variable for which either values or means (depending on the value of TYPE=) PROC CHART displays in the chart.

Interaction If you use SUMVAR= and you use TYPE= with a value other than MEAN or SUM, then TYPE=SUM overrides the specified TYPE= value.

Tip Both HBAR and VBAR charts can print labels for SUMVAR= variables if you use a LABEL statement.

Examples "Example 3: Subdividing the Bars into Categories" on page 376

"Example 4: Producing Side-by-Side Bar Charts" on page 379

"Example 5: Producing a Horizontal Bar Chart for a Subset of the Data" on page 382

"Example 6: Producing Block Charts for BY Groups" on page 384

TYPE=*statistic*
specifies what the bars or sections in the chart represent. The *statistic* is one of the following:

CFREQ
specifies that each bar, block, or section represent the cumulative frequency.

CPERCENT
specifies that each bar, block, or section represent the cumulative percentage.

Alias CPCT

FREQ
specifies that each bar, block, or section represent the frequency with which a value or range occurs for the chart variable in the data.

MEAN
specifies that each bar, block, or section represent the mean of the SUMVAR= variable across all observations that belong to that bar, block, or section.

Interaction With TYPE=MEAN, you can compute only MEAN and FREQ statistics.

Example "Example 4: Producing Side-by-Side Bar Charts" on page 379

PERCENT
specifies that each bar, block, or section represent the percentage of observations that have a given value or that fall into a given range of the chart variable.

Alias PCT

Example "Example 2: Producing a Percentage Bar Chart" on page 373

SUM
specifies that each bar, block, or section represent the sum of the SUMVAR= variable for the observations that correspond to each bar, block, or section.

Default FREQ (unless you use SUMVAR=, which causes a default of SUM)

Interaction With TYPE=SUM, you can compute only SUM and FREQ statistics.

Details

Statement Results

The number of points in the star is determined in the same way as the number of bars for vertical bar charts.

If all the data values are positive, then the center of the star represents zero and the outside circle represents the maximum value. If any data values are negative, then the center represents the minimum. See the description of the AXIS=*value expression* for more information about how to specify maximum and minimum values. For information about how to specify the proportion of the chart, see the description of the "LPI=*value*" on page 345.

If you try to create a star chart for a variable with more than 24 levels, then PROC CHART produces a horizontal bar chart instead.

VBAR Statement

Produces a vertical bar chart.

Examples:
"Example 1: Producing a Simple Frequency Count" on page 371
"Example 2: Producing a Percentage Bar Chart" on page 373
"Example 3: Subdividing the Bars into Categories" on page 376
"Example 4: Producing Side-by-Side Bar Charts" on page 379

Syntax

VBAR *variable(s)* </ *options*>;

Required Argument

variable(s)
specifies the variables for which PROC CHART produces a vertical bar chart, one chart for each variable.

Optional Arguments

ASCENDING
prints the bars and any associated statistics in ascending order of size within groups.

Alias ASC

AXIS=*value-expression*
specifies the values for the response axis, where *value-expression* is a list of individual values, each separated by a space, or a range with a uniform interval for the values. For example, the following range specifies tick marks on a bar chart from 0 to 100 at intervals of 10: `hbar x / axis=0 to 100 by 10;`

Restrictions Values must be equally spaced, even if you specify them individually.

For frequency charts, values must be integers.

Interactions For HBAR and VBAR charts, AXIS= determines tick marks on the response axis. If the AXIS= specification contains only one value, then the value determines the minimum tick mark if the value is less than 0, or determines the maximum tick mark if the value is greater than 0.

If you use AXIS= and the BY statement, then PROC CHART produces uniform axes over BY groups.

CAUTION **Values in value-expression override the range of the data.** For example, if the data range is 1 to 10 and you specify a range of 3 to 5, then only the data in the range 3 to 5 appears on the chart. Values out of range produce a warning message in the SAS log.

DISCRETE
specifies that a numeric chart variable is discrete rather than continuous. Without DISCRETE, PROC CHART assumes that all numeric variables are continuous and automatically chooses intervals for them unless you use MIDPOINTS= or LEVELS=.

FREQ=*variable*
specifies a data set variable that represents a frequency count for each observation. Normally, each observation contributes a value of one to the frequency counts. With FREQ=, each observation contributes its value of the FREQ= value.

Restriction If the FREQ= values are not integers, then PROC CHART truncates them.

Interaction If you use SUMVAR=, then PROC CHART multiplies the sums by the FREQ= value.

GROUP=*variable*
produces side-by-side charts, with each chart representing the observations that have a common value for the GROUP= variable. The GROUP= variable can be character or numeric and is assumed to be discrete. For example, the following statement produces a frequency bar chart for men and women in each department:

```
vbar gender / group=dept;
```

Missing values for a GROUP= variable are treated as valid levels.

Examples "Example 4: Producing Side-by-Side Bar Charts" on page 379

"Example 5: Producing a Horizontal Bar Chart for a Subset of the Data" on page 382

"Example 6: Producing Block Charts for BY Groups" on page 384

GSPACE=*n*
specifies the amount of extra space between groups of bars. Use GSPACE=0 to leave no extra space between adjacent groups of bars.

Interaction PROC CHART ignores GSPACE= if you omit GROUP=

G100
specifies that the sum of percentages for each group equals 100. By default, PROC CHART uses 100% as the total sum. For example, if you produce a bar chart that separates males and females into three age categories, then the six bars, by default, add to 100%. However, with G100, the three bars for females add to 100%, and the three bars for males add to 100%.

Interaction PROC CHART ignores G100 if you omit GROUP=.

LEVELS=*number-of-midpoints*
specifies the number of bars that represent each chart variable when the variables are continuous.

MIDPOINTS=*midpoint-specification* | OLD
defines the range of values that each bar, block, or section represents by specifying the range midpoints.

The value for MIDPOINTS= is one of the following:

midpoint-specification
specifies midpoints, either individually, or across a range at a uniform interval. For example, the following statement produces a chart with five bars; the first bar represents the range of values of X with a midpoint of 10, the second bar represents the range with a midpoint of 20, and so on:

```
vbar x / midpoints=10 20 30 40 50;
```

Here is an example of a midpoint specification for a character variable:

```
vbar x / midpoints='JAN' 'FEB' 'MAR';
```

Here is an example of specifying midpoints across a range at a uniform interval:

```
vbar x / midpoints=10 to 100 by 5;
```

OLD
specifies an algorithm that PROC CHART used in previous versions of SAS to choose midpoints for continuous variables. The old algorithm was based on the work of Nelder (1976). The current algorithm that PROC CHART uses if you omit OLD is based on the work of Terrell and Scott (1985).

Default Without MIDPOINTS=, PROC CHART displays the values in the SAS System's normal sorted order.

Restriction When the VBAR variables are numeric, the midpoints must be given in ascending order.

MISSING
specifies that missing values are valid levels for the chart variable.

NOSYMBOL
suppresses printing of the subgroup symbol or legend table.

Alias NOLEGEND

Interaction PROC CHART ignores NOSYMBOL if you omit SUBGROUP=.

NOZEROS
suppresses any bar with zero frequency.

REF=*value(s)*
draws reference lines on the response axis at the specified positions.

Tip The REF= values should correspond to values of the TYPE= statistic.

Example "Example 4: Producing Side-by-Side Bar Charts" on page 379

SPACE=*n*
specifies the amount of space between individual bars.

Tips Use SPACE=0 to leave no space between adjacent bars.

Use the GSPACE= option to specify the amount of space between the bars within each group.

SUBGROUP=*variable*
subdivides each bar or block into characters that show the contribution of the values of *variable* to that bar or block. PROC CHART uses the first character of each value to fill in the portion of the bar or block that corresponds to that value, unless more than one value begins with the same first character. In that case, PROC CHART uses the letters A, B, C, and so on, to fill in the bars or blocks. If the variable is formatted, then PROC CHART uses the first character of the formatted value.

The characters used in the chart and the values that they represent are given in a legend at the bottom of the chart. The subgroup symbols are ordered A through Z and 0 through 9 with the characters in ascending order.

PROC CHART calculates the height of a bar or block for each subgroup individually and then rounds the percentage of the total bar up or down. So the total height of the bar can be higher or lower than the same bar without the SUBGROUP= option.

Interaction If you use both TYPE=MEAN and SUBGROUP=, then PROC CHART first calculates the mean for each variable that is listed in the SUMVAR= option. It then subdivides the bar into the percentages that each subgroup contributes.

Example “Example 3: Subdividing the Bars into Categories” on page 376

SUMVAR=*variable*
specifies the variable for which either values or means (depending on the value of TYPE=) PROC CHART displays in the chart.

Interaction If you use SUMVAR= and you use TYPE= with a value other than MEAN or SUM, then TYPE=SUM overrides the specified TYPE= value.

Tip VBAR charts can print labels for SUMVAR= variables if you use a LABEL statement.

Examples “Example 3: Subdividing the Bars into Categories” on page 376

“Example 4: Producing Side-by-Side Bar Charts” on page 379

“Example 5: Producing a Horizontal Bar Chart for a Subset of the Data” on page 382

“Example 6: Producing Block Charts for BY Groups” on page 384

SYMBOL=*character(s)*
specifies the character or characters that PROC CHART uses in the bars or blocks of the chart when you do not use the SUBGROUP= option.

Default asterisk (*)

Interaction If the SAS system option OVP is in effect and if your printing device supports overprinting, then you can specify up to three characters to produce overprinted charts.

Example "Example 6: Producing Block Charts for BY Groups" on page 384

TYPE=*statistic*
specifies what the bars or sections in the chart represent. The *statistic* is one of the following:

CFREQ
specifies that each bar, block, or section represent the cumulative frequency.

CPERCENT
specifies that each bar, block, or section represent the cumulative percentage.

Alias CPCT

FREQ
specifies that each bar, block, or section represent the frequency with which a value or range occurs for the chart variable in the data.

MEAN
specifies that each bar, block, or section represent the mean of the SUMVAR= variable across all observations that belong to that bar, block, or section.

Interaction With TYPE=MEAN, you can compute only MEAN and FREQ statistics.

Example "Example 4: Producing Side-by-Side Bar Charts" on page 379

PERCENT
specifies that each bar, block, or section represent the percentage of observations that have a given value or that fall into a given range of the chart variable.

Alias PCT

Example "Example 2: Producing a Percentage Bar Chart" on page 373

SUM
specifies that each bar, block, or section represent the sum of the SUMVAR= variable for the observations that correspond to each bar, block, or section.

Default FREQ (unless you use SUMVAR=, which causes a default of SUM)

Interaction With TYPE=SUM, you can compute only SUM and FREQ statistics.

WIDTH=*n*
specifies the width of the bars on bar charts.

Details

Statement Results

PROC CHART prints one page per chart. Along the vertical axis, PROC CHART describes the chart frequency, the cumulative frequency, the chart percentage, the cumulative percentage, the sum, or the mean. At the bottom of each bar, PROC CHART prints a value according to the value of the TYPE= option, if specified. For character variables or discrete numeric variables, this value is the actual value represented by the bar. For continuous numeric variables, the value gives the midpoint of the interval represented by the bar.

PROC CHART can automatically scale the vertical axis, determine the bar width, and choose spacing between the bars. However, by using options, you can choose bar intervals and the number of bars, include missing values in the chart, produce side-by-side charts, and subdivide the bars. If the number of characters per line (LINESIZE=) is not sufficient to display all vertical bars, then PROC CHART produces a horizontal bar chart instead.

Results: CHART Procedure

Missing Values

PROC CHART follows these rules when handling missing values:

- Missing values are considered as valid levels for the chart variable when you use the MISSING option.
- Missing values for a GROUP= or SUBGROUP= variable are treated as valid levels.
- PROC CHART ignores missing values for the FREQ= option and the SUMVAR= option.
- If the value of the FREQ= variable is missing, zero, or negative, then the observation is excluded from the calculation of the chart statistic.
- If the value of the SUMVAR= variable is missing, then the observation is excluded from the calculation of the chart statistic.

ODS Table Names

The CHART procedure assigns a name to each table that it creates. You can use these names to reference the table when using the Output Delivery System (ODS) to select tables and create output data sets. For more information, see *SAS Output Delivery System: User's Guide*.

Table 11.3 *ODS Tables Produced by the CHART Procedure*

Name	Description	Statement Used
BLOCK	A block chart	BLOCK
HBAR	A horizontal bar chart	HBAR
PIE	A pie chart	PIE
STAR	A star chart	STAR
VBAR	A vertical bar chart	VBAR

Portability of ODS Output with PROC CHART

Under certain circumstances, using PROC CHART with the Output Delivery System produces files that are not portable. If the SAS system option FORMCHAR= in your SAS session uses nonstandard line-drawing characters, then the output might include strange characters instead of lines in operating environments in which the SAS Monospace font is not installed. To avoid this problem, specify the following OPTIONS statement before executing PROC CHART:

```
options formchar="|----|+|---+=|-/\<>*";
```

Examples: CHART Procedure

Example 1: Producing a Simple Frequency Count

Features: VBAR statement

Details

This example produces a vertical bar chart that shows a frequency count for the values of the chart variable.

Program

```
data shirts;
   input Size $ @@;
   datalines;
medium    large
large     large
large     medium
medium    small
small     medium
medium    large
small     medium
large     large
large     small
medium    medium
medium    medium
medium    large
small     small
;

proc chart data=shirts;
   vbar size;

   title 'Number of Each Shirt Size Sold';
run;
```

Program Description

Create the Shirts data set. Shirts contains the sizes of a particular shirt that is sold during a week at a clothing store, with one observation for each shirt that is sold.

```
data shirts;
   input Size $ @@;
   datalines;
medium    large
large     large
large     medium
medium    small
small     medium
medium    large
small     medium
large     large
large     small
medium    medium
medium    medium
medium    large
small     small
;
```

Create a vertical bar chart with frequency counts. The VBAR statement produces a vertical bar chart for the frequency counts of the Size values.

```
proc chart data=shirts;
   vbar size;
```

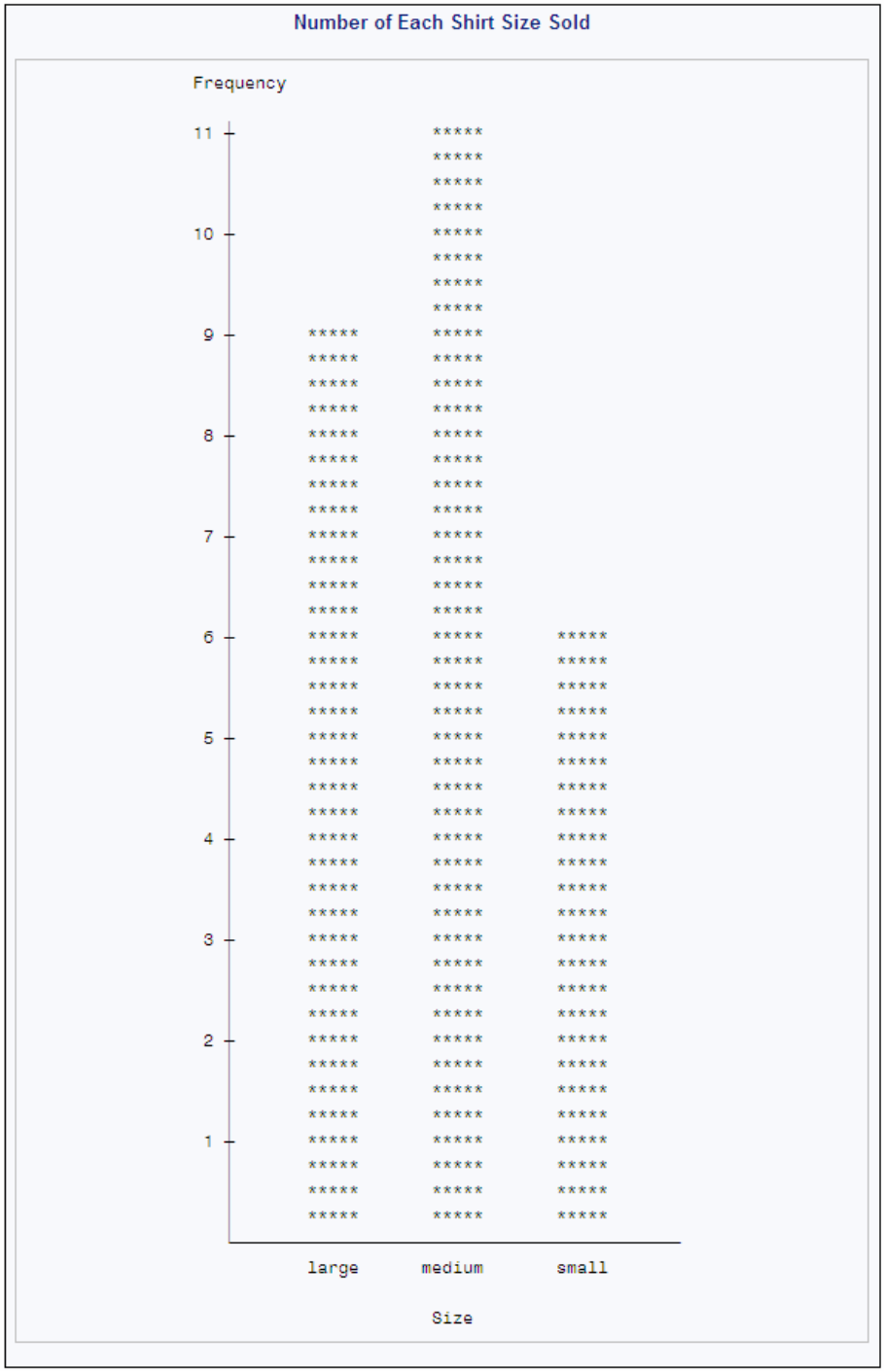
Specify the title.

```
   title 'Number of Each Shirt Size Sold';
run;
```

Output: HTML

The following frequency chart shows the store's sales of each shirt size for the week: 9 large shirts, 11 medium shirts, and 6 small shirts.

Output 11.6 *Number of Each Shirt Size Sold*



Example 2: Producing a Percentage Bar Chart

Features: VBAR statement option
TYPE=

Data set: SHIRTS

Details

This example produces a vertical bar chart. The chart statistic is the percentage for each category of the total number of shirts sold.

Program

```
proc chart data=shirts;
   vbar size / type=percent;

   title 'Percentage of Total Sales for Each Shirt Size';
run;
```

Program Description

Create a vertical bar chart with percentages. The VBAR statement produces a vertical bar chart. TYPE= specifies percentage as the chart statistic for the variable Size.

```
proc chart data=shirts;
   vbar size / type=percent;
```

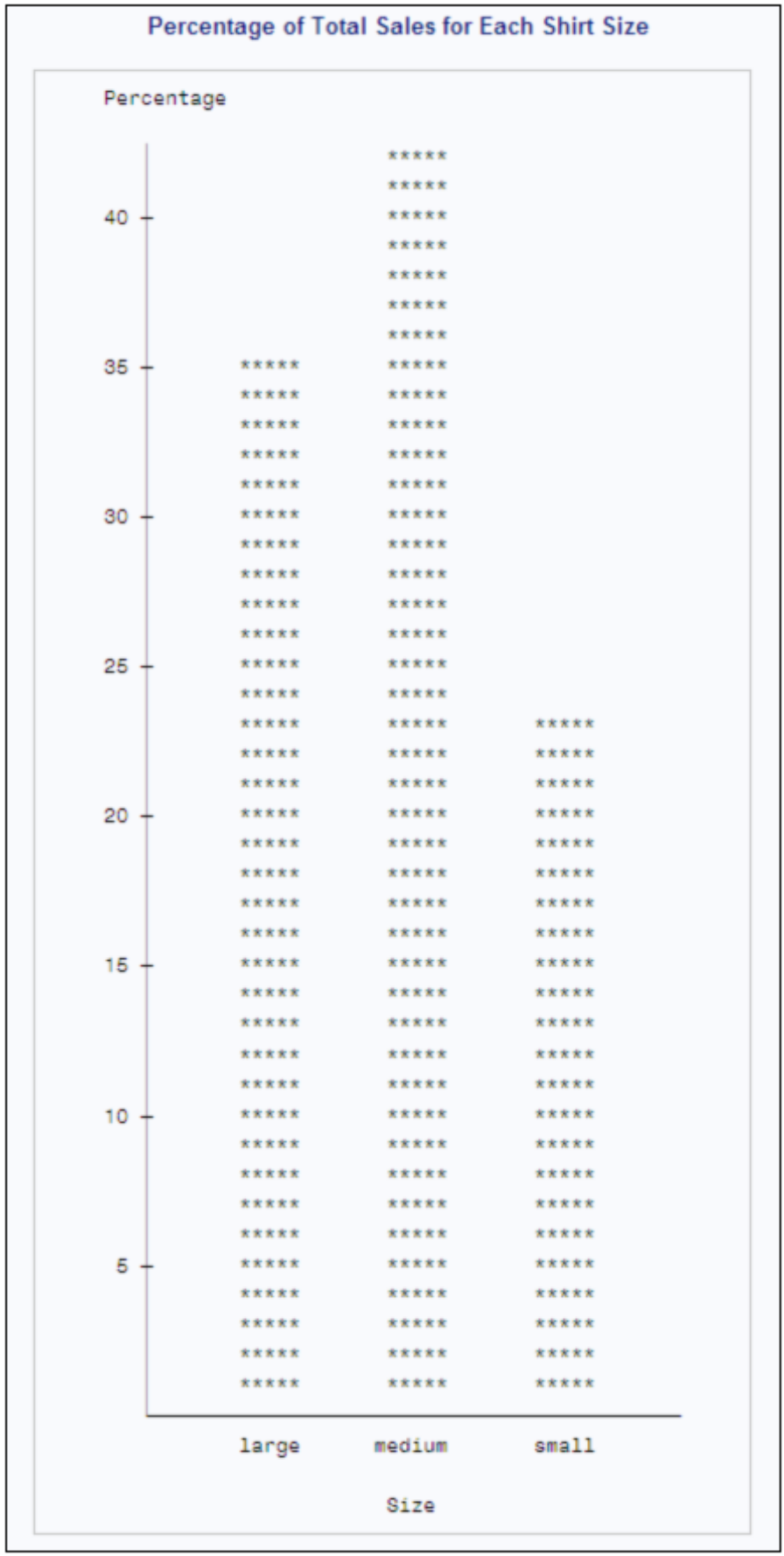
Specify the title.

```
   title 'Percentage of Total Sales for Each Shirt Size';
run;
```

Output: HTML

The following chart shows the percentage of total sales for each shirt size. Of all the shirts sold, about 42.3 percent were medium, 34.6 were large, and 23.1 were small.

Output 11.7 *Percentage of Total Sales for Each Shirt Size*



Example 3: Subdividing the Bars into Categories

Features: VBAR statement options
SUBGROUP=
SUMVAR=

Details

This example does the following:

- produces a vertical bar chart for categories of one variable with bar lengths that represent the values of another variable
- subdivides each bar into categories based on the values of a third variable

Program

```
data piesales;
   input Bakery $ Flavor $ Year Pies_Sold;
   datalines;
Samford  apple      2005  234
Samford  apple      2006  288
Samford  blueberry  2005  103
Samford  blueberry  2006  143
Samford  cherry     2005  173
Samford  cherry     2006  195
Samford  rhubarb    2005   26
Samford  rhubarb    2006   28
Oak      apple      2005  219
Oak      apple      2006  371
Oak      blueberry  2005  174
Oak      blueberry  2006  206
Oak      cherry     2005  226
Oak      cherry     2006  311
Oak      rhubarb    2005   51
Oak      rhubarb    2006   56
Clyde    apple      2005  213
Clyde    apple      2006  415
Clyde    blueberry  2005  177
Clyde    blueberry  2006  201
Clyde    cherry     2005  230
Clyde    cherry     2006  328
Clyde    rhubarb    2005   60
Clyde    rhubarb    2006   59
;
```

```
proc chart data=piesales;
   vbar flavor / subgroup=bakery
                 sumvar=pies_sold;
   title 'Pie Sales by Flavor Subdivided by Bakery Location';
run;
```

Program Description

Create the Piesales data set. Piesales contains the number of each flavor of pie that is sold for two years at three bakeries that are owned by the same company. One bakery is on Samford Avenue, one on Oak Street, and one on Clyde Drive.

```
data piesales;
   input Bakery $ Flavor $ Year Pies_Sold;
   datalines;
Samford  apple      2005  234
Samford  apple      2006  288
Samford  blueberry  2005  103
Samford  blueberry  2006  143
Samford  cherry     2005  173
Samford  cherry     2006  195
Samford  rhubarb    2005   26
Samford  rhubarb    2006   28
Oak      apple      2005  219
Oak      apple      2006  371
Oak      blueberry  2005  174
Oak      blueberry  2006  206
Oak      cherry     2005  226
Oak      cherry     2006  311
Oak      rhubarb    2005   51
Oak      rhubarb    2006   56
Clyde    apple      2005  213
Clyde    apple      2006  415
Clyde    blueberry  2005  177
Clyde    blueberry  2006  201
Clyde    cherry     2005  230
Clyde    cherry     2006  328
Clyde    rhubarb    2005   60
Clyde    rhubarb    2006   59
;
```

Create a vertical bar chart with the bars that are subdivided into categories. The VBAR statement produces a vertical bar chart with one bar for each pie flavor. SUBGROUP= divides each bar into sales for each bakery.

```
proc chart data=piesales;
   vbar flavor / subgroup=bakery
```

Specify the bar length variable. SUMVAR= specifies Pies_Sold as the variable whose values are represented by the lengths of the bars.

```
                 sumvar=pies_sold;
```

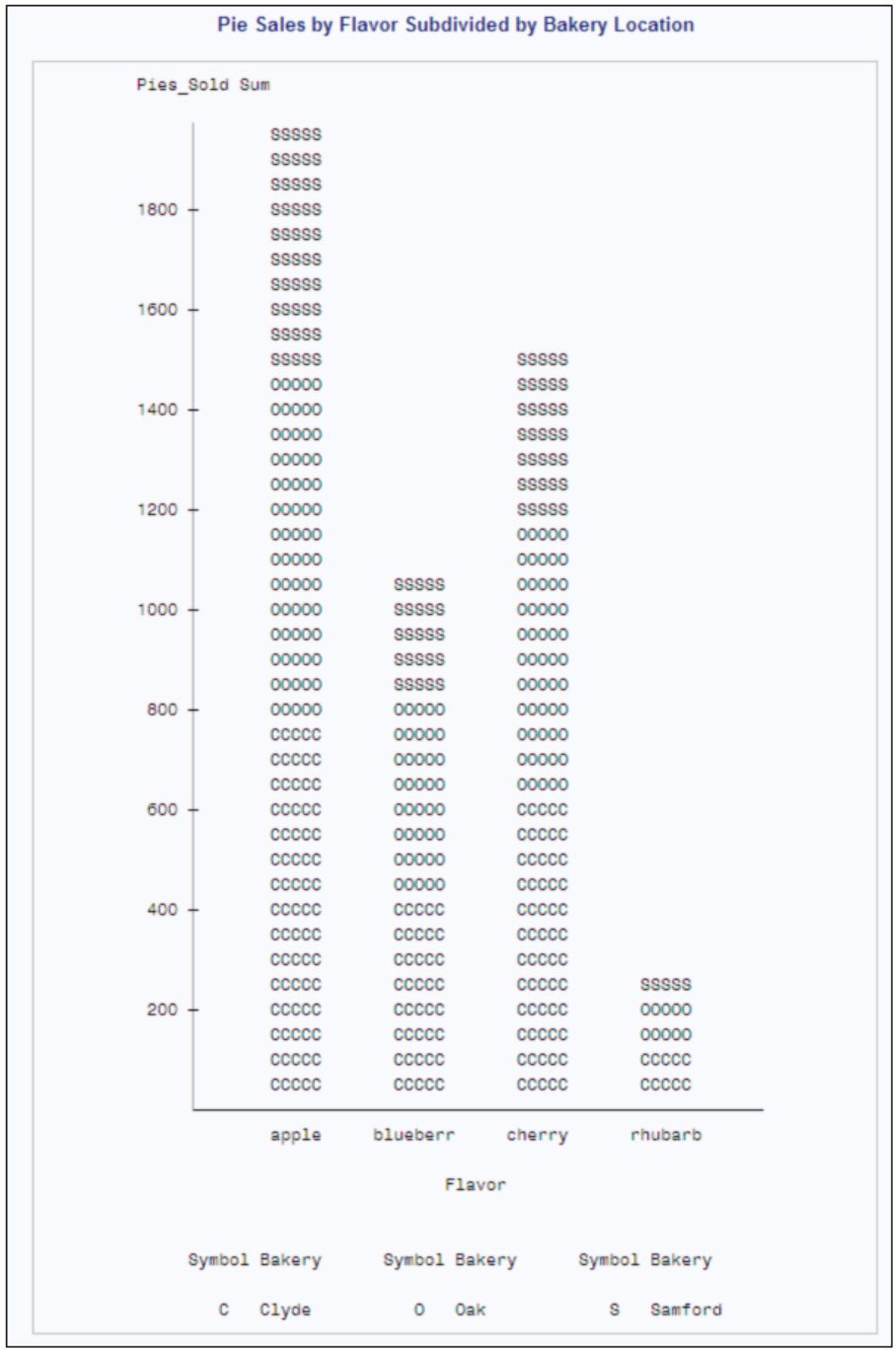
Specify the title.

```
   title 'Pie Sales by Flavor Subdivided by Bakery Location';
run;
```

Output: HTML

In the following output, the bar that represents the sales of apple pies, for example, shows 1,940 total pies across both years and all three bakeries. The symbol for the Samford Avenue bakery represents the 522 pies at the top. The symbol for the Oak Street bakery represents the 690 pies in the middle. The symbol for the Clyde Drive bakery represents the 728 pies at the bottom of the bar for apple pies. By default, the labels along the horizontal axis are truncated to eight characters.

Output 11.8 *Pie Sales by Flavor Subdivided by Bakery Location*



Example 4: Producing Side-by-Side Bar Charts

Features: VBAR statement options
- GROUP=
- REF=
- SUMVAR=

TYPE=

Data set: PIESALES

Details

This example does the following:

- charts the mean values of a variable for the categories of another variable
- creates side-by-side bar charts for the categories of a third variable
- draws reference lines across the charts

Program

```
proc chart data=piesales;
   vbar flavor / group=bakery
                 ref=100 200 300
                 sumvar=pies_sold
                 type=mean;
   title  'Mean Yearly Pie Sales Grouped by Flavor';
   title2 'within Bakery Location';
run;
```

Program Description

Create a side-by-side vertical bar chart. The VBAR statement produces a side-by-side vertical bar chart to compare the sales across values of Bakery, specified by GROUP=. Each Bakery group contains a bar for each Flavor value.

```
proc chart data=piesales;
   vbar flavor / group=bakery
```

Create reference lines. REF= draws reference lines to mark pie sales at 100, 200, and 300.

```
                 ref=100 200 300
```

Specify the bar length variable. SUMVAR= specifies Pies_Sold as the variable that is represented by the lengths of the bars.

```
                 sumvar=pies_sold
```

Specify the statistical variable. TYPE= averages the sales for 2005 and 2006 for each combination of bakery and flavor.

```
                 type=mean;
```

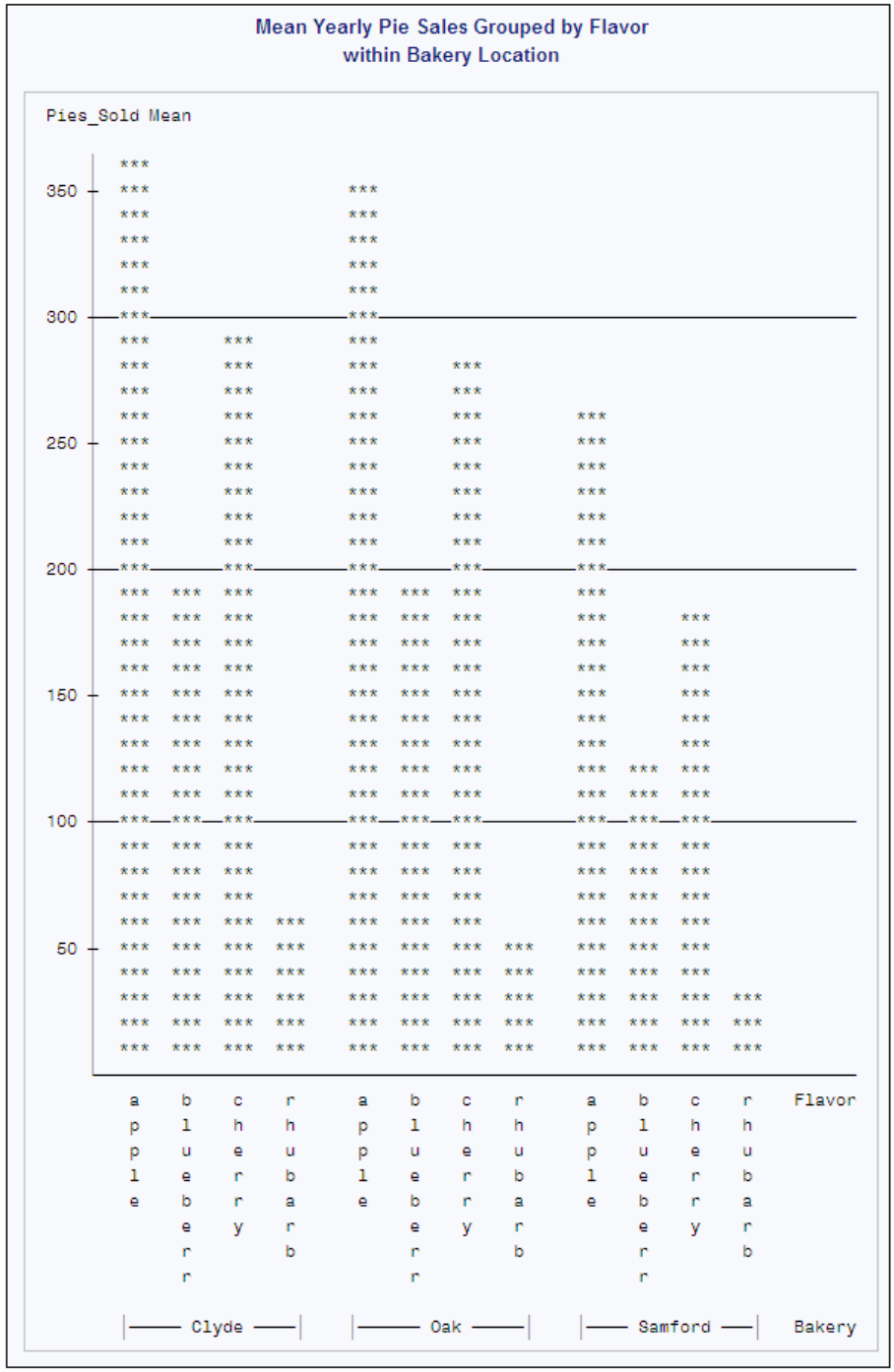
Specify the titles.

```
    title  'Mean Yearly Pie Sales Grouped by Flavor';
    title2 'within Bakery Location';
run;
```

Output: HTML

The following side-by-side bar charts compare the sales of pies by flavor, across bakeries. For example, for apple pie sales, the mean for the Clyde Drive bakery is 364, the mean for the Oak Street bakery is 345, and the mean for the Samford Avenue bakery is 261.

Output 11.9 *Mean Yearly Pie Sales Grouped by Flavor within Bakery Location*



Example 5: Producing a Horizontal Bar Chart for a Subset of the Data

Features: HBAR statement options
GROUP=

SUMVAR=
WHERE= data set option

Data set: PIESALES

Details

This example does the following:

- produces horizontal bar charts only for observations with a common value
- charts the values of a variable for the categories of another variable
- creates side-by-side bar charts for the categories of a third variable

Program

```
proc chart data=piesales(where=(year=2005));
   hbar bakery / group=flavor
   sumvar=pies_sold;
   title '2005 Pie Sales for Each Bakery According to Flavor';
run;
```

Program Description

Specify the variable value limitation for the horizontal bar chart. WHERE= limits the chart to only the 2005 sales totals.

```
proc chart data=piesales(where=(year=2005));
```

Create a side-by-side horizontal bar chart. The HBAR statement produces a side-by-side horizontal bar chart to compare sales across values of Flavor, specified by GROUP=. Each Flavor group contains a bar for each Bakery value.

```
   hbar bakery / group=flavor
```

Specify the bar length variable. SUMVAR= specifies Pies_Sold as the variable whose values are represented by the lengths of the bars.

```
   sumvar=pies_sold;
```

Specify the title.

```
   title '2005 Pie Sales for Each Bakery According to Flavor';
run;
```

Output: HTML

Output 11.10 *2005 Pie Sales for Each Bakery According to Flavor*

2005 Pie Sales for Each Bakery According to Flavor

```
Flavor     Bakery                                   Pies_Sold
                                                          Sum
                     |
apple      Clyde     |*********************      213.0000
           Oak       |**********************     219.0000
           Samford   |***********************    234.0000
                     |
blueberr   Clyde     |******************         177.0000
           Oak       |*****************          174.0000
           Samford   |**********                 103.0000
                     |
cherry     Clyde     |***********************    230.0000
           Oak       |***********************    226.0000
           Samford   |*****************          173.0000
                     |
rhubarb    Clyde     |******                      60.0000
           Oak       |*****                       51.0000
           Samford   |***                         26.0000
                     |
                     -----+----+----+----+---
                         50  100  150  200

                          Pies_Sold Sum
```

Example 6: Producing Block Charts for BY Groups

Features:

BLOCK statement options
- GROUP=
- NOHEADER=
- SUMVAR=
- SYMBOL=

BY statement

PROC SORT

SAS system options
- NOBYLINE
- OVP

TITLE statement
- #BYVAL specification

Data set: PIESALES

Details

This example does the following:

- sorts the data set
- produces a block chart for each BY group
- organizes the blocks into a three-dimensional chart
- prints BY group-specific titles

Program

```
proc sort data=piesales out=sorted_piesales;
   by year;
run;

options nobyline;

proc chart data=sorted_piesales;
   by year;

   block bakery / group=flavor

                  sumvar=pies_sold

                  noheader

                  symbol='OX';

   title  'Pie Sales for Each Bakery and Flavor';
   title2 '#byval(year)';
run;

options byline;
```

Program Description

Sort the input data set Piesales. PROC SORT sorts Piesales by year. Sorting is required to produce a separate chart for each year.

```
proc sort data=piesales out=sorted_piesales;
   by year;
run;
```

Suppress BY lines and allow overprinted characters in the block charts. NOBYLINE suppresses the usual BY lines in the output.

```
options nobyline;
```

Specify the BY group for multiple block charts. The BY statement produces one chart for 2005 sales and one for 2006 sales.

```
proc chart data=sorted_piesales;
   by year;
```

Create a block chart. The BLOCK statement produces a block chart for each year. Each chart contains a grid (Bakery values along the bottom, Flavor values along the side) of cells that contain the blocks.

```
   block bakery / group=flavor
```

Specify the bar length variable. SUMVAR= specifies Pies_Sold as the variable whose values are represented by the lengths of the blocks.

```
                sumvar=pies_sold
```

Suppress the default header line. NOHEADER suppresses the default header line.

```
                noheader
```

Specify the block symbols. SYMBOL= specifies the symbols in the blocks.

```
                symbol='OX';
```

Specify the titles. The #BYVAL specification inserts the year into the second line of the title.

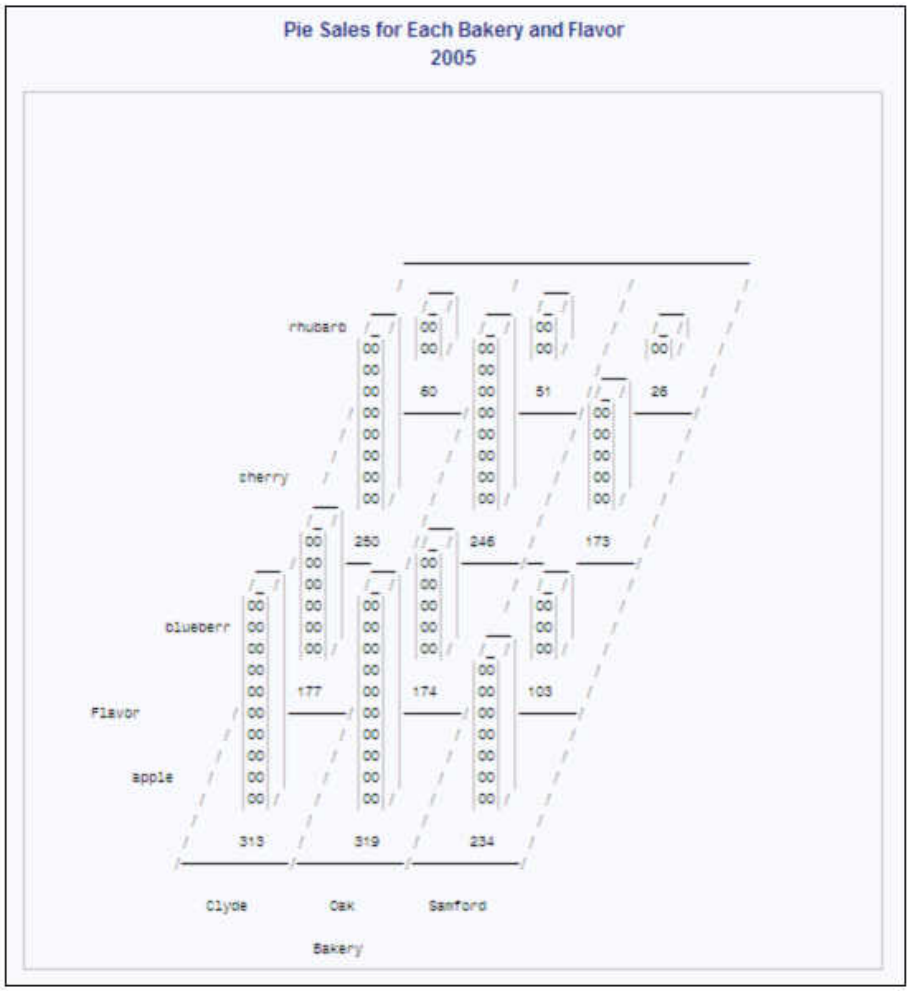
```
   title  'Pie Sales for Each Bakery and Flavor';
   title2 '#byval(year)';
run;
```

Reset the printing of the default BY line. The SAS system option BYLINE resets the printing of the default BY line.

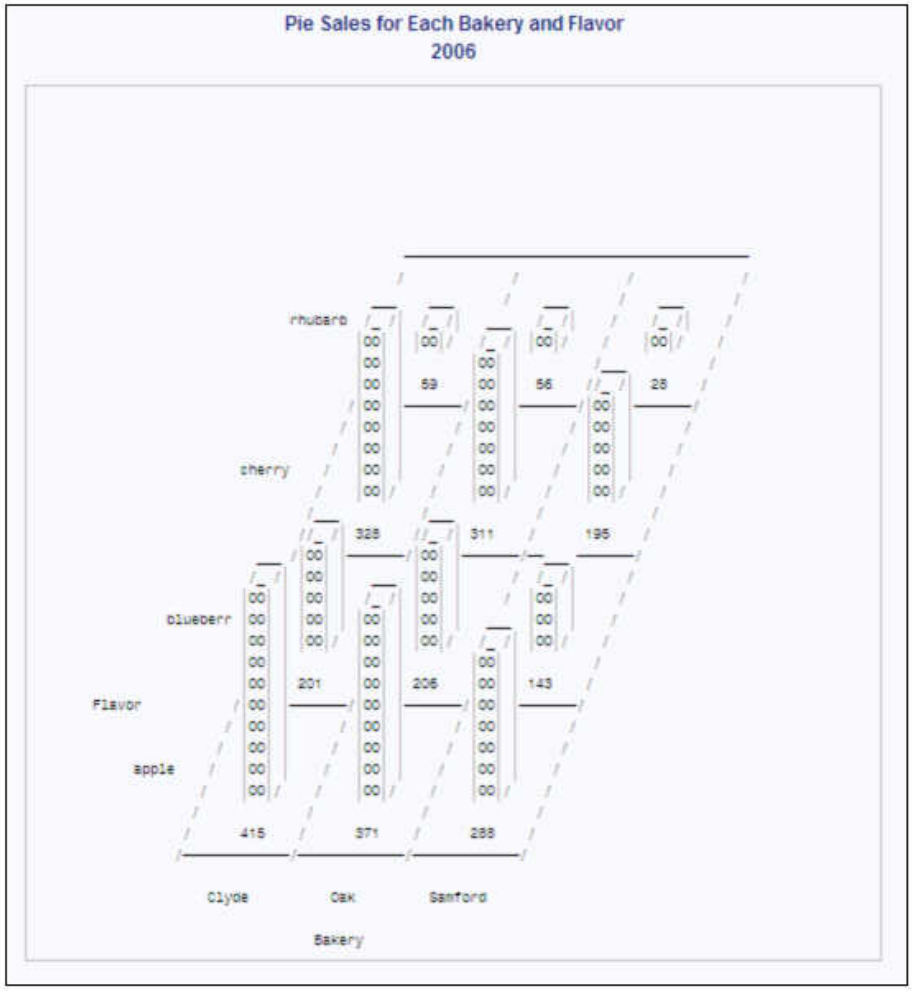
```
options byline;
```

Output: HTML

Output 11.11 *2005 Pie Sales for Each Bakery and Flavor*



Output 11.12 *2006 Pie Sales for Each Bakery and Flavor*



References

Nelder, J.A. 1976. "A Simple Algorithm for Scaling Graphs." *Applied Statistics* 25 (1) London, England: The Royal Statistical Society: 94–96.

Terrell, G.R. and D.W. Scott. 1985. "Oversmoothed Nonparametric Density Estimates." *Journal of the American Statistical Association* 80 (389): 209–214.

12

CIMPORT Procedure

Overview: CIMPORT Procedure

What Does the CIMPORT Procedure Do?

The CIMPORT procedure *imports* a transport file that was created (*exported*) by the CPORT procedure. PROC CIMPORT restores the transport file to its original form as a SAS catalog, SAS data set, or SAS library. *Transport files* are sequential files that each contain a SAS library, a SAS catalog, or a SAS data set in transport format. The transport format that PROC CPORT writes is the same for all environments and for many releases of SAS.

PROC CIMPORT also *converts* SAS files, which means that it changes the format of a SAS file from the SAS format appropriate for one version of SAS to the SAS format appropriate for another version. For example, you can use PROC CPORT and PROC CIMPORT to move files from earlier releases of SAS to more recent releases (for example, from SAS 8 to SAS®9) or between the same versions (for example, from one SAS 9 operating environment to another SAS 9 operating environment). PROC CIMPORT automatically converts the transport file as it imports it.

However, PROC CPORT and PROC CIMPORT do not allow file transport from a later version to an earlier version (known as regressing). For example, transporting is not allowed from SAS® 9 to SAS 8.

Note: PROC CIMPORT and PROC CPORT can be used to back up graphic catalogs. PROC COPY cannot be used to back up graphic catalogs.

PROC CIMPORT produces no output, but it does write notes to the SAS log.

Process for Creating and Reading a Transport File

Here is the process to create a transport file at the source computer and to read it at a target computer:

1. A transport file is created at the source computer using PROC CPORT.
2. The transport file is transferred from the source computer to the target computer.
3. The transport file is read at the target computer using PROC CIMPORT.

   Note: Transport files that are created using PROC CPORT are not interchangeable with transport files that are created using the XPORT engine.

For complete details about the steps to create a transport file (PROC CPORT), to transfer the transport file, and to restore the transport file (PROC CIMPORT), see *Moving and Accessing SAS Files*.

Converting Data to UTF-8 for Loading into CAS

The CAS server supports only UTF-8 encoding. If your SAS Viya session encoding is not UTF-8, then the data that is read to a CAS table must be transcoded to UTF-8 before loading your data into CAS. You can set your SAS Viya session to UTF-8 in order to avoid the need to transcode the data.

In SAS Viya 3.5, PROC CIMPORT provides the EXTENDVAR= and the EXTENDFORMAT = options to prevent truncation and to ensure that the SAS supplied format width is sufficient for the transcoded data.

Note: The formats supported are SAS supplied formats only. User-defined formats are not supported.

For more information about migrating data to UTF-8 encoding, see the following resources.

- "UTF-8 Encoding" in *Migrating Data to UTF-8 for SAS Viya*
- "Data Migration to UTF-8 Encoding" in *An Introduction to SAS Viya Programming*
- "Read External Files" in *Migrating Data to UTF-8 for SAS Viya*

Syntax: CIMPORT Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Tip: Use PROC CIMPORT or PROC CPORT when backing up graphic catalogs. PROC COPY cannot be used to back up graphic catalogs.

See: CIMPORT Procedure under Windows, UNIX, z/OS

For complete details about the steps to create a transport file (PROC CPORT), to transfer the transport file, and to restore the transport file (PROC CIMPORT), see *Moving and Accessing SAS Files*

PROC CIMPORT *destination=libref | <libref.> member-name* <*options*>;

EXCLUDE *SAS file(s) | catalog entry(s)* </ MEMTYPE=*mtype*> </ ENTRYTYPE=*entry-type*>;

SELECT *SAS file(s) | catalog entry(s)* </ MEMTYPE=*mtype*> </ ENTRYTYPE=*entry-type*>;

Statement	Task	Example
PROC CIMPORT	Import a transport file	Ex. 1, Ex. 2, Ex. 3
EXCLUDE	Exclude one or more specified files from the import process	
SELECT	Specify one or more files or entries to import process	Ex. 2

PROC CIMPORT Statement

Imports a transport file.

Examples:

Syntax

PROC CIMPORT *destination=libref* | <*libref.*> *member-name* <*options*>;

Summary of Optional Arguments

COMPRESS=NO | CHAR | BINARY
: Specifies how the resulting CIMPORT data set is to be compressed.

FORCE
: enables access to a locked catalog.

NEW
: creates a new catalog for the imported transport file, and deletes any existing catalog with the same name.

NOEDIT
: imports SAS/AF PROGRAM and SCL entries without Edit capability.

NOSRC
: suppresses the importing of source code for SAS/AF entries that contain compiled SCL code.

SORT
: causes the output data set to be re-sorted if necessary when PROC CIMPORT is used to import a sorted data set.

Control the contents of the transport file

EXTENDFORMAT=YES | NO
: specifies whether to extend the character format width.

EXTENDSN=YES | NO
: specifies whether to extend by 1 byte the length of short numerics (less than 8 bytes) when you import them.

EXTENDVAR=*multiplier* | AUTO
: specifies a multiplier value that expands character variable lengths.

UPCASE
: writes the alphabetic characters in uppercase to the output file.

Identify the input transport file

INFILE=*fileref* | '*filename*'
: specifies a previously defined fileref or the filename of the transport file to read.

TAPE
: reads the input transport file from a tape.

Look at the encoding of the transport file

ENCODINGINFO=ALL | *n*
: specifies the number of data set headers to read in order to output the encoding value of the data set to the log.

ISFILEUTF8=YES | NO
: specifies whether the file is encoded in UTF-8 format.

Select files to import

EET=(*etype(s)*)
: excludes specified entry types from the import process.

ET=(*etype(s)*)
: specifies entry types to import.

MEMTYPE=*mtype*
: specifies that only data sets, only catalogs, or both, be moved when a library is imported.

Required Argument

destination=libref | <libref.>member-name
: identifies the type of file to import and specifies the catalog, SAS data set, or SAS library to import.

destination
: identifies the file or files in the transport file as a single catalog, as a single SAS data set, or as the members of a SAS library. The *destination* argument can be one of the following:

CATALOG | CAT | C

DATA | DS | D

LIBRARY | LIB | L

libref
<libref.> member-name
: specifies the specific catalog, SAS data set, or SAS library as the destination of the transport file. If the *destination* argument is CATALOG or DATA, you can specify both a *libref* and a member name. If the *libref* is omitted, PROC CIMPORT uses the default library as the *libref*, which is usually the WORK library. If the *destination* argument is LIBRARY, specify only a *libref*.

See Refer to "Names in the SAS Language" in *SAS Language Reference: Concepts* for naming conventions that you can use for names and member names.

Optional Arguments

COMPRESS=NO | CHAR | BINARY
: specifies whether the resulting CIMPORT data set is compressed. You can specify the compression type that is being used.

NO
: specifies that the data set produced by CIMPORT is not compressed.

Alias OFF | N

CHAR
specifies that the observations in a newly created SAS data set are compressed (producing variable-length records) by using RLE (Run Length Encoding). RLE compresses observations by reducing repeated runs of the same character (including blanks) to two-byte or three-byte representations.

Alias ON | YES | Y

BINARY
specifies that the observations in a newly created SAS data set are compressed (producing variable-length records) by using RDC (Ross Data Compression). RDC combines run-length encoding and sliding-window compression to compress the file by representing repeated byte patterns more efficiently.

Note: This method is highly effective for compressing medium to large (several hundred bytes or larger) blocks of binary data (character and numeric variables). Because the compression function operates on a single record at a time, the record length needs to be several hundred bytes or larger for effective compression.

See For more information about creating and restoring transport files, see *Moving and Accessing SAS Files*.

Example
```
proc cimport file=transportFile lib=myLib compress=char;
run;
```

EET=(*etype(s)*)
excludes specified entry types from the import process. If the *etype* is a single entry type, then you can omit the parentheses. Separate multiple values with spaces.

Interaction You cannot specify both the EET= option and the ET= option in the same PROC CIMPORT step.

ENCODINGINFO=ALL | *n*
specifies the number of data set headers to read in order to output the encoding value of the data set to the log.

ALL
specifies that all data set headers are read. The encoding value stored for the data set header is output to the SAS log.

n
specifies an integer greater than zero. This value represents the number of data set headers to read. The encoding value stored for the data set header is output to the SAS log.

Range Specify an integer greater than zero. The upper limit is dependent on system contraints. All data is still processed when *n* is larger than the number of data sets in the transport file.

Note If catalogs are encountered in the library during the process of reading the data set headers, they are skipped. Catalog headers do not contain encoding values.

See For more information about creating and restoring transport files, see *Moving and Accessing SAS Files*.

Example
```
proc cimport lib=work file='mixed' encodinginfo=3;
run;
```

```
NOTE: The CPORTed data set ASCII transport file encoding=us-ascii.
NOTE: The CPORTed data set JISDS transport file encoding=wlatin1.
NOTE: The CPORTed data set UTF8 transport file encoding=wlatin1.
NOTE: The CPORTed data set WLATIN1DS transport file encoding=wlatin1.
```

ET=(*etype(s)*)
specifies the entry types to import. If the *etype* is a single entry type, then you can omit the parentheses. Separate multiple values with spaces.

Interaction You cannot specify both the EET= option and the ET= option in the same PROC CIMPORT step.

EXTENDSN=YES | NO
specifies whether to extend by 1 byte the length of short numerics (fewer than 8 bytes) when you import them. You can avoid a loss of precision when you transport a short numeric in IBM format to IEEE format if you extend its length. You cannot extend the length of an 8-byte short numeric.

Default YES

Restriction This option applies only to data sets.

Tip Do not store fractions as short numerics.

EXTENDFORMAT=YES | NO
specifies whether to extend the character format width.

Note: The EXTENDFORMAT= option is used in conjunction with the EXTENDVAR= option.

Alias Y, N

Default YES

Restrictions This option is supported in SAS Viya 3.5 but is not supported in SAS 9.

The EXTENDFORMAT= option is used in conjunction with the EXTENDVAR= option. If you set EXTENDVAR= to specify a larger variable length and then set EXTENDFORMAT= to NO, the text might be truncated.

EXTENDVAR=*multiplier* | AUTO

specifies a multiplier value that expands character variable lengths when you are processing a SAS data file that requires transcoding. The expanded length helps to ensure that character data is not truncated.

multiplier

Specify a multiplier value from 1 to 5 or you can specify AUTO. The lengths for character variables are increased by multiplying the current length by the specified value. The default value is 1. When 1 is used, the variable length is not extended. When AUTO is specified, the multiplier is set automatically.

Auto

AUTO is used to set the *multiplier*. This value is dependant on the encoding of the session and the data set in the transport file. When the file that is specified by INFILE= is in ANSI encoding or has no character encoding ID (CEI) information, a multiplier value of one is used. Otherwise, the extended length is calculated for you.

When the string is truncated, a warning message is generated. The message prompts you to use the EXTENDVAR option.

Default 1. When the default is used, the variable length is not extended.

Restrictions This option is supported in SAS Viya 3.5 but is not supported in SAS 9.

This option applies only to data sets.

This option does not take affect when the NOTRANSCODE attribute is specified for data types for SAS character variables.

PROC CIMPORT does not support VARCHAR.

Note If the ASIS option is specified in PROC CPORT, the EXTENDVAR= option is ignored.

Tip Do not store fractions as short numerics.

ISFILEUTF8=YES | NO

explicitly designates the encoding of a data set that is contained in a transport file as UTF-8. Although data set encodings are recorded (or stamped) in SAS 9.2 transport files, encodings are not stamped in transport files created using SAS releases before 9.2. Therefore, designating the UTF-8 encoding is useful under these conditions:

- The data set in the transport file was created using a SAS release before 9.2.
- The data set is known to be encoded as UTF-8.

The person who restores the transport file in the target environment should have a description of the transport file in advance of the restore operation.

yes

specifies that the data set in the transport file is encoded as UTF-8.

Alias YES, Y, y, TRUE, true, T, t

no
specifies that the data set in the transport file is not encoded as UTF-8. NO is the default.

Alias NO, N, n, FALSE, false, F, f

In order to successfully import a transport file in the target SAS session, you should have this information about the transport file:

- source operating environment. **`Windows`** for example.
- SAS release. **`SAS 9.2`** for example.
- name of the transport file. **`tport.dat`** for example.
- encoding of the character data.**`wlatin1`** for example.
- national language of the character data. For example, American English (or **`en_US`**)

Default NO

Restriction PROC CIMPORT uses this option only if the transport file is not stamped with the encoding of the data set. Encodings were not recorded in SAS releases before 9.2. If an encoding is recorded in the transport file and the ISFILEUTF8= option is specified in PROC CIMPORT, ISFILEUTF8= is ignored.

See "CIMPORT Problems: Importing Transport Files" on page 402

For more information about creating and restoring transport files, see *Moving and Accessing SAS Files*.

FORCE
enables access to a locked catalog. By default, PROC CIMPORT locks the catalog that it is updating to prevent other users from accessing the catalog while it is being updated. The FORCE option overrides this lock, which allows other users to access the catalog while it is being imported, or enables you to import a catalog that is currently being accessed by other users.

CAUTION
The FORCE option can lead to unpredictable results. The FORCE option allows multiple users to access the same catalog entry simultaneously.

INFILE=*fileref* | '*filename*'
specifies a previously defined fileref or the filename of the transport file to read. If you omit the INFILE= option, then PROC CIMPORT attempts to read from a transport file with the fileref SASCAT. If a fileref SASCAT does not exist, then PROC CIMPORT attempts to read from a file named SASCAT.DAT.

Alias FILE=

Example "Example 1: Importing an Entire Library" on page 410

MEMTYPE=*mtype*
specifies that only data sets, only catalogs, or both, be imported from the transport file. Values for *mtype* can be as follows:

ALL	both catalogs and data sets
CATALOG | CAT	catalogs
DATA | DS	SAS data sets

NEW
creates a new catalog to contain the contents of the imported transport file when the destination that you specify has the same name as an existing catalog. NEW deletes any existing catalog with the same name as the one you specify as a destination for the import. If you do not specify NEW, and the destination that you specify has the same name as an existing catalog, PROC CIMPORT appends the imported transport file to the existing catalog.

NOEDIT
imports SAS/AF PROGRAM and SCL entries without Edit capability.

You obtain the same results if you create a new catalog to contain SCL code by using the MERGE statement with the NOEDIT option in the BUILD procedure of SAS/AF software.

Note: The NOEDIT option affects only SAS/AF PROGRAM and SCL entries. It does not affect FSEDIT SCREEN and FSVIEW FORMULA entries.

Alias NEDIT

NOSRC
suppresses the importing of source code for SAS/AF entries that contain compiled SCL code.

You obtain the same results if you create a new catalog to contain SCL code by using the MERGE statement with the NOSOURCE option in the BUILD procedure of SAS/AF software.

Alias NSRC

Interaction PROC CIMPORT ignores the NOSRC option if you use it with an entry type other than FRAME, PROGRAM, or SCL.

SORT
causes the output data set to be re-sorted if necessary when importing a sorted data set using PROC CIMPORT. A re-sort is necessary if the data set to be imported is sorted by one or more character variables and the ordering of character values in the target SAS session is different from that of the source session.

Note: The CIMPORT SORT option has no effect on data sets that do not contain sort information. This applies only to data sets that were sorted previously.

The ordering of character values, or collating sequence, is dependent upon the session encoding and translation tables used by SAS as well as by the options used when invoking the SORT procedure. If necessary, a re-sort is performed during the import, and the data set's sort indicator is preserved.

For more information, see "Collating Sequence" in *SAS National Language Support (NLS): Reference Guide* and Chapter 64, "SORT Procedure," on page 2355.

When PROC CIMPORT re-sorts a data set, the following information is output:

```
NOTE: PROC CIMPORT re-sorted the data set WORK.TEMP because it contained
      character variables in the sort key, and the collating sequence of
      the sort differs from the local host.
```

Example `proc cimport 'transportfile.tpt' lib=library sort; run;`

Example code for z/OS:

```
proc cimport data=file.mwelect inf=CPO sort; run;
```

TAPE

reads the input transport file from a tape.

Default PROC CIMPORT reads from disk.

UPCASE

reads from the transport file and writes the alphabetic characters in uppercase to the output file.

Restriction The UPCASE option is allowed only if SAS is built with a Double-Byte Character Set (DBCS).

Tip PROC CPORT can be used to create a transport file that includes all uppercase characters. See option "OUTTYPE=UPCASE" on page 545 for details.

EXCLUDE Statement

Excludes specified files or entries from the import process.

Interaction: You can use either EXCLUDE statements or SELECT statements in a PROC CIMPORT step, but not both.

Tip: There is no limit to the number of EXCLUDE statements that you can use in one invocation of PROC CIMPORT.

Syntax

EXCLUDE *SAS file(s) | catalog entry(s)* </ MEMTYPE=*mtype*> </ ENTRYTYPE=*entry-type*>;

Required Argument

SAS file(s) | catalog entry(s)
specifies one or more SAS files or one or more catalog entries to be excluded from the import process. Specify SAS filenames if you import a library; specify catalog entry names if you import an individual SAS catalog. Separate multiple filenames or entry names with a space. You can use shortcuts to list many like-named files in the EXCLUDE statement. For more information, see "SAS Data Sets" in *SAS Language Reference: Concepts*.

Optional Arguments

ENTRYTYPE=*entry-type*
specifies a single entry type for one or more catalog entries that are listed in the EXCLUDE statement. See *SAS Language Reference: Concepts* for a complete list of catalog entry types.

Alias ETYPE=, ET=

Restriction ENTRYTYPE= is valid only when you import an individual SAS catalog.

MEMTYPE=*mtype*
specifies a single member type for one or more SAS files listed in the EXCLUDE statement. Values for *mtype* can be

ALL	both catalogs and data sets
CATALOG	catalogs
DATA	SAS data sets

You can also specify the MEMTYPE= option, enclosed in parentheses, immediately after the name of a file. In parentheses, MEMTYPE= identifies the type of the filename that just precedes it. When you use this form of the option, it overrides the MEMTYPE= option that follows the slash in the EXCLUDE statement, but it must match the MEMTYPE= option in the PROC CIMPORT statement.

Alias MTYPE=, MT=

Default ALL

Restriction MEMTYPE= is valid only when you import a SAS library.

SELECT Statement

Specifies individual files or entries to import.

Interaction: You can use either EXCLUDE statements or SELECT statements in a PROC CIMPORT step, but not both.

Tip: There is no limit to the number of SELECT statements that you can use in one invocation of PROC CIMPORT.

Example: "Example 2: Importing Individual Catalog Entries" on page 411

Syntax

SELECT *SAS file(s) | catalog entry(s)* </ MEMTYPE=*mtype*>
</ ENTRYTYPE=*entry-type*>;

Required Argument

SAS file(s) | catalog entry(s)
specifies one or more SAS files or one or more catalog entries to import. Specify SAS filenames if you import a library; specify catalog entry names if you import an individual SAS catalog. Separate multiple filenames or entry names with a space. You can use shortcuts to list many like-named files in the SELECT statement. For more information, see "SAS Data Sets" in *SAS Language Reference: Concepts*.

Optional Arguments

ENTRYTYPE=*entry-type*
specifies a single entry type for one or more catalog entries that are listed in the SELECT statement. See *SAS Language Reference: Concepts* for a complete list of catalog entry types.

Alias ETYPE=, ET=

Restriction ENTRYTYPE= is valid only when you import an individual SAS catalog.

MEMTYPE=*mtype*
specifies a single member type for one or more SAS files listed in the SELECT statement. Valid values are CATALOG or CAT, DATA, or ALL.

You can also specify the MEMTYPE= option, enclosed in parentheses, immediately after the name of a file. In parentheses, MEMTYPE= identifies the type of the filename that just precedes it. When you use this form of the option, it overrides the MEMTYPE= option that follows the slash in the SELECT statement, but it must match the MEMTYPE= option in the PROC CIMPORT statement.

Alias MTYPE=, MT=

Default ALL

Restriction MEMTYPE= is valid only when you import a SAS library.

Usage: CIMPORT Procedure

CIMPORT Problems: Importing Transport Files

About Transport Files and Encodings

The character data in a transport file is created for the following types of encodings:

- the UTF-8 encoding of the SAS session in which the transport file is created.
- the Windows encoding that is associated with the locale of the SAS session in which the transport file is created. However, starting in SAS 9.4M3, PROC CIMPORT supports the ability to import data sets created in non-UTF-8 SAS sessions into UTF-8 SAS sessions.

  Using PROC CIMPORT to import a data set in a UTF-8 session preserves the encoding value of the data set. For example, if a data set with SHIFT-JIS encoding is imported into a UTF-8 session using PROC CIMPORT, PROC CONTENTS shows that the SHIFT-JIS encoding is maintained. However, starting in SAS Viya 3.5, using PROC CIMPORT to import a data set in a UTF-8 session, the UTF-8 encoding is maintained.

  Note: The ENCODINGINFO= option displays the Window's encoding associated with the locale of the SAS Session in which the transport file was created.

- Starting in SAS 9.4, when you use PROC CPORT to create a transport file that is encoded with US-ASCII on an ASCII platform, regardless of the session encoding, the US-ASCII encoding is preserved for that transport file. If you then transport that data set to an ASCII platform using PROC CIMPORT, the US-ASCII encoding for that transport file is preserved and is not d. The data set that is created has the US-ASCII encoding, not the session encoding. For example, if your session encoding is WLATIN1, you use PROC CPORT to create a data set that has an encoding of US-ASCII. The US-ASCII encoding is preserved in the transport file, instead of the WLATIN1 encoding. This preservation also occurs when you use PROC CIMPORT on this data set. The US-ASCII encoding is preserved and is not when you use PROC CIMPORT to transport the data set to an ASCII platform.

Note: The preservation of the US-ASCII encoding occurs only on an ASCII platform, not on z/OS.

- on a z/OS platform, PROC CIMPORT creates data sets using the session encoding.

These examples show how SAS applies an encoding to a transport file:

Table 12.1 *Assignment of Encodings to Transport Files*

Encoding Value of the Transport File	Example of Applying an Encoding in a SAS Invocation	Explanation
utf-8 or us-ascii	sas9 -encoding utf8;	A SAS session is invoked using the UTF-8 encoding. The session encoding is applied to the transport file. Note that starting in SAS 9.4M3, if the data set is US-ASCII, the US-ASCII encoding is preserved, not the session encoding.
wlatin2	sas9 -locale pl_PL;	A SAS session is invoked using the default UNIX encoding, LATIN2, which is associated with the Polish Poland locale.

For a complete list of encodings that are associated with each locale, see Locale Tables in *SAS National Language Support (NLS): Reference Guide*.

In order for a transport file to be imported successfully, the encodings of the source and target SAS sessions must be compatible. Here is an example of compatible source and target SAS sessions:

Table 12.2 *Compatible Encodings*

Source SAS Session			Target SAS Session	
Locale	UNIX SAS Session Encoding	Transport File Encoding	Locale	Windows SAS Session Encoding
es_MX (Spanish Mexico)	latin1	wlatin1	it_IT (Italian Italy)	wlatin1

The encodings of the source and target SAS sessions are compatible because the Windows default encoding for the es_MX locale is WLATIN1 and the encoding of the target SAS session is WLATIN1. For more detailed information about

compatible languages and encodings, see the SAS Press book SAS Encoding: Understanding the Details, by Manfred Kiefer.

However, if the encodings of the source and target SAS sessions are incompatible, a transport file might not be successfully imported. (See the introduction to this section.) Here is an example of incompatible encodings:

Table 12.3 *Incompatible Encodings*

Source SAS Session			Target SAS Session	
Locale	**UNIX SAS Session Encoding**	**Transport File Encoding**	**Locale**	**z/OS Encoding**
cs_CZ (Czech Czechoslovakia)	latin2	wlatin2	de_DE (German Germany)	open_ed-1141

The encodings of the source and target SAS sessions are incompatible because the Windows default encoding for the cs_CZ locale is WLATIN2 and the encoding of the target SAS session is OPEN_ED-1141. A transport file cannot be imported between these locales.

When importing transport files, you can use the ENCODINGINFO= option see the encoding value of the transport file. Otherwise, you are alerted to compatibility problems via warnings and error messages. For more information about the ENCODINGINFO= option, see "ENCODINGINFO=ALL | *n*" on page 394.

Problems with Transport Files Created Using a SAS Release Prior to 9.2

Overview: SAS Releases Prior to 9.2

Transport files that were created by SAS releases before 9.2 are not stamped with encoding values. Therefore, the CIMPORT procedure does not know the identity of the transport file's encoding and cannot report specific warning and error detail. The encoding of the transport file must be inferred when performing recovery actions.

However, using your knowledge about the transport file, you should be able to recover from transport problems. For information that is useful for importing the transport file in the target SAS session, see Tips: for the ISFILEUTF8 option on page 396. For complete details about creating and restoring transport files, see *Moving and Accessing SAS Files*.

Here are the warning and error messages with recovery actions:

- "Error: Transport File Encoding Is Unknown: Use the ISFILEUTF8= Option" on page 405

■ “Warning: Transport File Encoding Is Unknown” on page 405

Error: Transport File Encoding Is Unknown: Use the ISFILEUTF8= Option

The error message provides this information:

- The transport file was created using a SAS release before 9.2.
- Because the encoding is not stamped in the transport file, the encoding is unknown.
- The target SAS session uses the UTF-8 encoding.

Note: In order to perform recovery steps, you must know the encoding of the transport file.

If you know that the transport file is encoded as UTF-8, you can import the file again, and use the ISFILEUTF8=YES option in PROC CIMPORT.

Here is an example of the UTF-8 transport file and UTF-8 target SAS session. The UTF-8 transport file was created using a SAS release before 9.2.

```
filename importin 'transport-file';
libname target 'sas-library';
proc cimport isfileutf8=yes infile=importin library=target
memtype=data;
run;
```

For syntax details, see the ISFILEUTF8= option on page 396.

PROC CIMPORT should succeed.

Warning: Transport File Encoding Is Unknown

The warning message provides this information:

- The transport file was created using a SAS release before 9.2.
- Because the encoding is not stamped in the transport file, the encoding is unknown.

Try to read the character data from the imported data set. If you cannot read the data, you can infer that the locale of the target SAS session is incompatible with the encoding of the transport file.

Note: In order to perform recovery steps, you must know the encoding of the transport file.

For example, the transport file was created in a source SAS session using a SAS release before 9.2. The transport file was also created using a Polish Poland locale. The target SAS session uses a German locale.

1 In the target SAS session, start another SAS session and change the locale to the locale of the source SAS session that created the transport file.

In this example, you start a new SAS session in the Polish Poland locale.

```
sas9 -locale pl_PL;
```

2 Import the file again. Here is an example:

```
filename importin 'transport-file';
libname target 'sas-library';
proc cimport infile=importin library=target memtype=data;
run;
```

PROC CIMPORT should succeed and the data should be readable in the SAS session that uses a Polish_Poland locale.

Problems with Transport Files Created Using SAS Versions 9.2 and Later

Overview

The encoding of the character data is stamped in transport files that are created using SAS versions 9.2 and later. Therefore, the CIMPORT procedure can detect error conditions such as UTF-8 encoded transport files cannot be imported into SAS sessions that do not use the UTF-8 encoding. For example, a UTF-8 transport file cannot be imported into a SAS session that uses the Wlatin2 encoding.

SAS versions 9.2 and later can detect the condition of incompatibility between the encoding of the transport file and the locale of the target SAS session. Because some customers' SAS applications ran successfully using a release prior to SAS 9.2, PROC CIMPORT reports a warning only, but allows the import procedure to continue.

Here are the warning and error messages with recovery actions:

- "Error: Target Session Uses UTF-8: Transport File Is Not UTF-8" on page 406
- "Error: Target Session Does Not Use UTF-8: Transport File Is UTF-8" on page 408
- "Warning: Target Session Does Not Use UTF-8: Transport File Is Not UTF-8" on page 408

Error: Target Session Uses UTF-8: Transport File Is Not UTF-8

This error message should not appear in SAS 9.4M3 and later. The Error message provides the following information:

- The target SAS session uses the UTF-8 encoding.
- The transport file has an identified encoding that is not UTF-8. The encodings of the transport file and the target SAS session are incompatible.

Note: Starting in SAS 9.4M3, PROC CIMPORT supports the ability to import data sets that are created in non-UTF-8 SAS sessions into UTF-8 SAS sessions.

Prior to SAS 9.4M3, transport files are encoded in a Windows encoding that corresponds to the SAS session encoding.

If this error is generated, the encoding of the target SAS session cannot be UTF-8. The locales of the source and target SAS sessions must be identical.

Here is an example of a SAS 9.2 WLATIN2 transport file and UTF-8 target SAS session.

1 To recover, in the target SAS session, start another SAS session and change the locale to the locale that was used in the source SAS session that created the transport file.

   The LOCALE= value is preferred over the ENCODING= value because it sets automatically the default values for the ENCODING=, DFLANG=, DATESTYLE=, and PAPERSIZE= options.

   If you do not know the locale of the source session (or the transport file), you can infer it from the language that is used by the character data in the transport file.

   For example, if you know that Polish is the language, specify the pl_PL (Polish Poland) locale in a new target SAS session. Here are the encoding values that are associated with the pl_PL locale:

   Table 12.4 *LOCALE= Value for the Polish Language*

POSIX Locale	Windows Encoding	UNIX Encoding	z/OS Encoding
.pl_PL (Polish Poland)	wlatin2	latin2	open_ed-870

   Here is an example of specifying the pl_PL locale in a new SAS session:

```
sas9 -locale pl_PL;
```

   For complete details, see Locale Table.

   Note: Verify that you do not have a SAS invocation command that already contains the specification of the UTF-8 encoding. For example: `sas9 -encoding utf8`. If it exists, the UTF-8 encoding would persist regardless of a new locale specification.

2 Import the file again. Here is an example:

```
filename importin 'transport-file';
libname target 'SAS-data-library';
proc cimport infile=importin library=target memtype=data;
run;
```

   PROC CIMPORT should succeed.

Error: Target Session Does Not Use UTF-8: Transport File Is UTF-8

The error message provides this information:

- The target session uses an identified encoding that is not UTF-8.
- The transport file is encoded as UTF-8. The encodings of the transport file and the target SAS session are incompatible.

The encoding of the target SAS session must be changed to UTF-8.

Here is an example of a SAS 9.2 UTF-8 transport file and Wlatin1 target SAS session:

1 To recover, in the target SAS session, start a new SAS session and change the session encoding to UTF-8. Here is an example:

```
sas9 -encoding utf8;
```

2 Import the file again. Here is an example:

```
filename importin 'transport-file';
libname target 'sas-library';
proc cimport infile=importin library=target memtype=data;
run;
```

PROC CIMPORT should succeed.

Warning: Target Session Does Not Use UTF-8: Transport File Is Not UTF-8

The warning message provides this information:

- The target SAS session uses an identified encoding.
- The encoding of the transport file is identified. The encodings of the transport file and the target SAS session are incompatible.

This table shows the locale and encoding values of incompatible source and target SAS sessions. Although the wlatin2 Windows encoding that is assigned to the transport file in the source SAS session is incompatible with the open_ed-1141 encoding of the target SAS session, a warning is displayed and the import continues.

Table 12.5 *Encoding Values for the Czech and German Locales*

SAS Session	POSIX Locale	Windows Encoding	UNIX Encoding	z/OS Encoding
Source SAS Session	cs_CZ (Czech Czechoslovakia)	wlatin2	latin2	open_ed-870

SAS Session	POSIX Locale	Windows Encoding	UNIX Encoding	z/OS Encoding
Target SAS Session	de_DE (German Germany)	wlatin1	latin9	open_ed-1141

The transport file is imported, but the contents of the file are questionable. The message identifies the incompatible encoding formats. To recover, try to read the contents of the imported file. If the file is unreadable, perform these steps:

1 In the target SAS session, start a new SAS session and change the locale (rather than the encoding) to the locale that is used in the source SAS session.

   The LOCALE= value is preferred over the ENCODING= value because it automatically sets the default values for the ENCODING=, DFLANG=, DATESTYLE=, and PAPERSIZE= options.

   If you do not know the locale of the source session (or the transport file), you can infer it from the national language of the transport file.

   For example, if you know that Czech is the national language, specify the **cs_CZ** locale in a new target SAS session.

   Here is an example of specifying the **cs_CZ** locale in a new SAS session:

   ```
   sas9 -locale cs_CZ;
   ```

   The target SAS session and the transport file use compatible encodings. They both use wlatin2.

   For complete details, see the Locale Table in *SAS National Language Support (NLS): Reference Guide*.

2 Import the file again. Here is an example:

   ```
   filename importin 'transport-file';
   libname target 'sas-library';
   proc cimport infile=importin library=target memtype=data;
   run;
   ```

   PROC CIMPORT should succeed.

Problems with Loss of Numeric Precision

PROC CPORT and PROC CIMPORT can lose precision on numeric values that are extremely small and large. Refer to "Loss of Numeric Precision and Magnitude" in *SAS/CONNECT User's Guide* for details.

Examples: CIMPORT Procedure

Example 1: Importing an Entire Library

Features: PROC CIMPORT statement option
INFILE=

Details

This example shows how to use PROC CIMPORT to read from disk a transport file, named TRANFILE, that PROC CPORT created from a SAS library in another operating environment. The transport file was moved to the new operating environment by means of communications software or magnetic medium. PROC CIMPORT imports the transport file to a SAS library, called NEWLIB, in the new operating environment.

Program

```
libname newlib 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;

proc cimport library=newlib infile=tranfile;
run;
```

Program Description

Specify the library name and filename. The LIBNAME statement specifies a LIBNAME for the new SAS library. The FILENAME statement specifies the filename of the transport file that PROC CPORT created and enables you to specify any operating environment options for file characteristics.

```
libname newlib 'sas-library';
filename tranfile 'transport-file';
```

```
host-options-for-file-characteristics;
```

Import the SAS library in the NEWLIB library. PROC CIMPORT imports the SAS library into the library named NEWLIB.

```
proc cimport library=newlib infile=tranfile;
run;
```

Log Examples

Example Code 12.1 *Importing an Entire Library*

```
NOTE: Proc CIMPORT begins to create/update catalog NEWLIB.FINANCE
NOTE: Entry LOAN.FRAME has been imported.
NOTE: Entry LOAN.HELP has been imported.
NOTE: Entry LOAN.KEYS has been imported.
NOTE: Entry LOAN.PMENU has been imported.
NOTE: Entry LOAN.SCL has been imported.
NOTE: Total number of entries processed in catalog NEWLIB.FINANCE: 5

NOTE: Proc CIMPORT begins to create/update catalog NEWLIB.FORMATS
NOTE: Entry REVENUE.FORMAT has been imported.
NOTE: Entry DEPT.FORMATC has been imported.
NOTE: Total number of entries processed in catalog NEWLIB.FORMATS: 2
```

Example 2: Importing Individual Catalog Entries

Features:

PROC CIMPORT statement option
INFILE=

SELECT statement

Details

This example shows how to use PROC CIMPORT to import the individual catalog entries LOAN.PMENU and LOAN.SCL from the transport file TRANS2, which was created from a single SAS catalog.

Program

```
libname newlib 'sas-library';
filename trans2 'transport-file';

host-options-for-file-characteristics;
```

```
proc cimport catalog=newlib.finance infile=trans2;
   select loan.pmenu loan.scl;
run;
```

Program Description

Specify the library name, filename, and operating environment options. The LIBNAME statement specifies a LIBNAME for the new SAS library. The FILENAME statement specifies the filename of the transport file that PROC CPORT created and enables you to specify any operating environment options for file characteristics.

```
libname newlib 'sas-library';
filename trans2 'transport-file';

host-options-for-file-characteristics;
```

Import the specified catalog entries to the new SAS catalog. PROC CIMPORT imports the individual catalog entries from the TRANS2 transport file and stores them in a new SAS catalog called NEWLIB.FINANCE. The SELECT statement selects only the two specified entries from the transport file to be imported into the new catalog.

```
proc cimport catalog=newlib.finance infile=trans2;
   select loan.pmenu loan.scl;
run;
```

Log Examples

Example Code 12.2 *Importing Individual Catalog Entries*

```
NOTE: Proc CIMPORT begins to create/update catalog NEWLIB.FINANCE
NOTE: Entry LOAN.PMENU has been imported.
NOTE: Entry LOAN.SCL has been imported.
NOTE: Total number of entries processed in catalog NEWLIB.FINANCE: 2
```

Example 3: Importing a Single Indexed SAS Data Set

Features: PROC CIMPORT statement option
INFILE=

Details

This example shows how to use PROC CIMPORT to import an indexed SAS data set from a transport file that was created by PROC CPORT from a single SAS data set.

Program

```
libname newdata 'sas-library';
filename trans3 'transport-file';

host-options-for-file-characteristics;

proc cimport data=newdata.times infile=trans3;
run;
```

Program Description

Specify the library name, filename, and operating environment options. The LIBNAME statement specifies a LIBNAME for the new SAS library. The FILENAME statement specifies the filename of the transport file that PROC CPORT created and enables you to specify any operating environment options for file characteristics.

```
libname newdata 'sas-library';
filename trans3 'transport-file';

host-options-for-file-characteristics;
```

Import the SAS data set. PROC CIMPORT imports the single SAS data set that you identify with the DATA= specification in the PROC CIMPORT statement. PROC CPORT exported the data set NEWDATA.TIMES in the transport file TRANS3.

```
proc cimport data=newdata.times infile=trans3;
run;
```

Log Examples

Example Code 12.3 *Importing a Single Indexed SAS Data Set*

```
NOTE: Proc CIMPORT begins to create/update data set NEWDATA.TIMES
NOTE: The data set index x is defined.
NOTE: Data set contains 2 variables and 2 observations.
      Logical record length is 16
```

Example 4: Using PROC CIMPORT to Import a French Data Set into a UTF-8 SAS Session

Features:

PROC CPORT statement option
- DATA=
- FILE=

PROC CIMPORT statement option
- DATA=
- INFILE=
- EXTENDVAR=
- EXTENDFORMAT=

Details

This example shows how to import a French data set into a UTF-8 SAS session. The French data set has an 8-byte character variable 'a' with a character format '$8.'. Using a SAS Viya deployment, we start a French SAS session where we use PROC CPORT to generate a transport file named 'myfile'.

In another SAS Viya window, we start a SAS session that uses UTF-8 encoding. We then import the transport file (non-UTF-8) into a UTF-8 SAS session using PROC CIMPORT. We first show that the imported data set is truncated and then how to extend the variable length using the EXTENDVAR= option to avoid truncation.

Program

Use PROC CPORT to create a transport file using a French data set. From a SAS Viya deployment, bring up a default SAS session using the French language. In the following example, we are using a French data set where the data set has an 8-byte character variable 'a' (the value of 'a' is premiere with an accented e) with a character format set to'$8.'. We use PROC CPORT to create a transport file. In this example, the encoding is wlatin-1, the default.

```
data test;
   a = 'première';
   format a $8.;
run;
proc cport data=test file='myfile';
run;
```

Output 12.1 *French Data Set Used in PROC CPORT File*

Le Système SAS

Obs.	a
1	première

Import the transport file in a UTF-8 SAS session using PROC CIMPORT. From a separate SAS Viya session that is using UTF-8 encoding, import the transport file 'myfile' into the UTF-8 SAS session using PROC CIMPORT. Print the SAS data set and the PROC CONTENTS. Because it takes 2 bytes to store the accented 'e' in UTF-8 encoding, the value premiere needs 9 bytes to display the value. The format is $8. so the value is truncated.

```
proc cimport data=test infile='myfile';
run;
proc print data=test;
run;
proc contents data=test;
run;
```

Output 12.2 *CIMPORT a Non-UTF-8 Transport File to an Encoding Session That Is UTF-8 - Truncated*

Cimport the Transport File Into a UTF-8 SAS Session Showing Truncation

Obs.	a
1	premièr

Cimport the Transport File Into a UTF-8 SAS Session Showing Truncation

La procédure CONTENTS

Nom de la table	WORK.TEST	Observations	1
Type de membre	DATA	Variables	1
Moteur	V9	Index	0
Créée	14/10/2019 16:14:41	Longueur d'observation	8
Dernière modification	14/10/2019 16:14:41	Observations supprimées	0
Protection		Compressée	NON
Type de table		Triée	NON
Libellé			
Représentation des données	WINDOWS_64		
Codage	utf-8 Unicode (UTF-8)		

Informations dépendantes de la machine/de l'hôte	
Taille de la page	65536
Nombre de pages	1
Première page de données	1
Nb max. d'obs. par page	8063
Obs. sur première page de données	1
Nombre de corrections dans la table	0
ExtendObsCounter	YES
Nom du fichier	C:\Users\sasuser\test.sas7bdat
Version de création	V.0305M0
Hôte de création	X64_10PRO
Nom du propriétaire	sasuser
Taille du fichier	128KB
Taille de fichier (octets)	131072

Liste alphabétique des variables et des attributs

#	Variable	Type	Long.	Format
1	a	Texte	8	$8.

Extend the Variable Length to avoid truncation. Because there was truncation, we use the EXTENDVAR= option to extend the variable length and the format width (default for EXTENDFORMAT= is YES).

```
proc cimport data=test infile='myfile' extendvar=1.5;
run;
proc print data=test;
run;
```

```
proc contents data=test;
run;
```

Note that the output data set now contains the entire variable. Also, note in the output of PROC CONTENTS that the variable length and the format width have been extended.

Output 12.3 *CIMPORT a Non-UTF-8 Transport File to an Encoding Session That Is UTF-8 - EXTENDVAR=*

Cimport the Transport File Into a UTF-8 SAS Session Showing NO Truncation

Obs.	a
1	première

Cimport the Transport File Into a UTF-8 SAS Session Showing NO Truncation

La procédure CONTENTS

Nom de la table	WORK.TEST	Observations	1
Type de membre	DATA	Variables	1
Moteur	V9	Index	0
Créée	14/10/2019 16:15:53	Longueur d'observation	12
Dernière modification	14/10/2019 16:15:53	Observations supprimées	0
Protection		Compressée	NON
Type de table		Triée	NON
Libellé			
Représentation des données	WINDOWS_64		
Codage	utf-8 Unicode (UTF-8)		

Informations dépendantes de la machine/de l'hôte	
Taille de la page	65536
Nombre de pages	1
Première page de données	1
Nb max. d'obs. par page	5403
Obs. sur première page de données	1
Nombre de corrections dans la table	0
ExtendObsCounter	YES
Nom du fichier	C:\Users\sasuser\test.sas7bdat
Version de création	V.0305M0
Hôte de création	X64_10PRO
Nom du propriétaire	sasuser
Taille du fichier	128KB
Taille de fichier (octets)	131072

Liste alphabétique des variables et des attributs				
#	Variable	Type	Long.	Format
1	a	Texte	12	$12.

13

COMPARE Procedure

Overview: COMPARE Procedure

What Does the COMPARE Procedure Do?

The COMPARE procedure compares the contents of two SAS data sets, selected variables in different data sets, or variables within the same data set.

PROC COMPARE compares two data sets: the base data set and the comparison data set. The procedure determines matching variables and matching observations. Matching variables are variables with the same name or variables that you pair by using the VAR and WITH statements. Matching variables must be of the same type. Matching observations are observations that have the same values for all ID variables that you specify or, if you do not use the ID statement, that occur in the same position in the data sets. If you match observations by ID variables, then both data sets must be sorted by all ID variables.

What Information Does PROC COMPARE Provide?

PROC COMPARE generates the following information about the two data sets that are being compared:

- whether matching variables have different values
- whether one data set has more observations than the other
- what variables the two data sets have in common
- how many variables are in one data set but not in the other
- whether matching variables have different formats, labels, or types
- a comparison of the values of matching observations

Note: You can create a view that has two columns with the same variable name. If duplicate variable names exist in the view, PROC COMPARE cannot determine which column in the base data set should be compared to the compare data set. PROC COMPARE issues an error if it finds duplicate variable names.

Further, PROC COMPARE creates two types of output data sets that give detailed information about the differences between observations of variables that it is comparing.

The following example compares the data sets Proclib.One and Proclib.Two, which contain similar data about students:

```
data proclib.one(label='First Data Set');
   input student year $ state $ gr1 gr2;
   label year='Year of Birth';
   format gr1 4.1;
   datalines;
1000 1990 NC 85 87
1042 1991 MS 90 92
1095 1989 TN 78 92
1187 1990 MA 87 94
;

data proclib.two(label='Second Data Set');
   input student $ year $ state $ gr1
         gr2 major $;
   label state='Home State';
   format gr1 5.2;
   datalines;
1000 1990 NC 85 87 Math
1042 1991 MS 90 92 History
1095 1989 TN 78 92 Physics
1187 1990 MA 87 94 Music
1204 1991 NC 82 96 English
;
```

PROC COMPARE does not produce information about values that are the same in each comparison data set. It produces information about values that are different, not the same.

PROC COMPARE does not produce a data set that contains observations that are in one of the comparison data sets but not in the other, or that are in both comparison data sets. The options for the COMPARE statement can produce much of this information, but they do not produce a data set. If you want to produce a data set that contains this information, use a DATA step that contains a MERGE statement. Here is an example of a DATA step that uses a MERGE statement to create a data set:

```
data inone intwo inboth;
   merge a (in=ina) b(in=inb);
   by byvar;
      if ina and not inb then output inone;
      if inb and not ina then output intwo;
      if ina and inb then output inboth;
run;
```

Concepts: COMPARE Procedure

Comparisons Using PROC COMPARE

PROC COMPARE first compares the following:

- data set attributes (set by the data set options TYPE= and LABEL=).
- variables. PROC COMPARE checks each variable in one data set to determine whether it matches a variable in the other data set.
- attributes (type, length, labels, formats, and informats) of matching variables.
- observations. PROC COMPARE checks each observation in one data set to determine whether it matches an observation in the other data set. PROC COMPARE either matches observations by their position in the data sets or by the values of the ID variable.

After making these comparisons, PROC COMPARE compares the values in the parts of the data sets that match. PROC COMPARE either compares the data by the position of observations or by the values of an ID variable.

A Comparison by Position of Observations

The following figure shows two data sets. The data inside the shaded boxes shows the part of the data sets that the procedure compares. Assume that variables with the same names have the same type.

Figure 13.1 Comparison by the Positions of Observations

Data Set ONE

Obs	idnum	name	year	state	grade1	grade2
1	1000	Emily	1990	NC	85.0	87
2	1042	Dan	1991	MS	90.0	92
3	1095	Julia	1989	TN	78.0	92
4	1187	Robin	1990	MA	87.0	94

Data Set TWO

Obs	idnum	name	year	state	grade1	grade2	major
1	1000	Emily	1990	NC	85.00	87	Math
2	1042	Dan	1991	MS	90.00	92	History
3	1095	Julia	1989	TN	78.00	92	Physics
4	1187	Robin	1990	MA	87.00	94	Music
5	1204	Keith	1991	NC	82.00	96	English
6	1198	Ted	1990	PA	84.00	93	Music
7	1054	Lisa	1989	GA	81.00	94	French

When you use PROC COMPARE to compare data set TWO with data set ONE, the procedure compares the first observation in data set ONE with the first observation in data set TWO, and it compares the second observation in the first data set with the second observation in the second data set, and so on. In each observation that it compares, the procedure compares the values of the idnum, name, year, state, grade1, and grade2.

The procedure does not report on the value of the last three observations or the variable major in data set TWO because there is nothing to compare them with in data set ONE.

A Comparison with an ID Variable

In a simple comparison, PROC COMPARE uses the observation number to determine which observations to compare. When you use an ID variable, PROC COMPARE uses the values of the ID variable to determine which observations to compare. ID variables should have unique values and must have the same type.

For the two data sets shown in the following figure, assume that IDNUM is an ID variable and that IDNUM has the same type in both data sets. The procedure compares the observations that have the same value for IDNUM. The data inside the shaded boxes shows the part of the data sets that the procedure compares.

Figure 13.2 Comparison by the Value of the ID Variable

Data Set ONE

Obs	idnum	name	year	state	grade1	grade2
1	1000	Emily	1990	NC	85.0	87
2	1042	Dan	1991	MS	90.0	92
3	1095	Julia	1989	TN	78.0	92
4	1187	Robin	1990	MA	87.0	94

Data Set TWO

Obs	idnum	name	year	state	grade1	grade2	major
1	1000	Emily	1990	NC	85.00	87	Math
2	1042	Dan	1991	MS	90.00	92	History
3	1095	Julia	1989	TN	78.00	92	Physics
4	1187	Robin	1990	MA	87.00	94	Music
5	1204	Keith	1991	NC	82.00	96	English
6	1198	Ted	1990	PA	84.00	93	Music
7	1054	Lisa	1989	GA	81.00	94	French

The data sets contain five matching variables: name, year, state, grade1, and grade2. They also contain four matching observations: the observations with values of `1000`, `1042`, `1095`, and `1187` for idnum.

Data set TWO contains three observations (idnum=`1204`, idnum=`1198`, and idnum=`1054`) for which data set ONE contains no matching observations. Similarly, no variable in data set ONE matches the variable “major” in data set TWO.

See “Example 5: Comparing Observations with an ID Variable” on page 476 for an example that uses an ID variable.

The Equality Criterion

Using the CRITERION= Option

The COMPARE procedure judges numeric values unequal if the magnitude of their difference, as measured according to the METHOD= option, is greater than the value of the CRITERION= option. PROC COMPARE provides four methods for applying CRITERION=:

- The EXACT method tests for exact equality.

- The ABSOLUTE method compares the absolute difference to the value specified by CRITERION=.
- The RELATIVE method compares the absolute relative difference to the value specified by CRITERION=.
- The PERCENT method compares the absolute percent difference to the value specified by CRITERION=.

For a numeric variable compared, let *x* be its value in the base data set and let *y* be its value in the comparison data set. If both *x* and *y* are nonmissing, then the values are judged unequal according to the value of METHOD= and the value of CRITERION= (γ) as follows:

- If METHOD=EXACT, then the values are unequal if *y* does not equal *x*.
- If METHOD=ABSOLUTE, then the values are unequal if

  $$\mathrm{ABS}(y - x) > \gamma$$

- If METHOD=RELATIVE, then the values are unequal if

  $$\mathrm{ABS}(y - x)/((\mathrm{ABS}(x) + \mathrm{ABS}(y))/2 + \delta) > \gamma$$

  The values are equal if *x*=*y*=0.
- If METHOD=PERCENT, then the values are unequal if

  $$100(\mathrm{ABS}(y - x)/\mathrm{ABS}(x)) > \gamma \quad \text{for} \quad x \neq 0$$

  or

  $$y \neq 0 \quad \text{for} \quad \mathrm{x} = 0$$

If *x* or *y* is missing, then the comparison depends on the NOMISSING option. If the NOMISSING option is in effect, then a missing value will always be judged equal to anything. Otherwise, a missing value is judged equal only to a missing value of the same type (that is, .=., .^=.A, .A=.A, .A^=.B, and so on).

If the value that is specified for CRITERION= is negative, then the actual criterion that is used, γ, is equal to the absolute value of the specified criterion multiplied by a very small number, ε (epsilon), that depends on the numerical precision of the computer. This number ε is defined as the smallest positive floating-point value such that, using machine arithmetic, 1−ε<1<1+ε. Round-off or truncation error in floating-point computations is typically a few orders of magnitude larger than ε. CRITERION=−1000 often provides a reasonable test of the equality of computed results at the machine level of precision.

The value δ added to the denominator in the RELATIVE method is specified in parentheses after the method name: METHOD=RELATIVE(δ). If not specified in METHOD=, then δ defaults to 0. The value of δ can be used to control the behavior of the error measure when both *x* and *y* are very close to 0. If δ is not given and *x* and *y* are very close to 0, then any error produces a large relative error (in the limit, 2).

Specifying a value for δ avoids this extreme sensitivity of the RELATIVE method for small values. If you specify METHOD=RELATIVE(δ) CRITERION=γ when both *x* and *y* are much smaller than δ in absolute value, then the comparison is as if you had specified METHOD=ABSOLUTE CRITERION=δγ. However, when either *x* or *y* is much larger than δ in absolute value, the comparison is like METHOD=RELATIVE

CRITERION=γ. For moderate values of *x* and *y*, METHOD=RELATIVE(δ) CRITERION=γ is, in effect, a compromise between METHOD=ABSOLUTE CRITERION=δ γ and METHOD=RELATIVE CRITERION=γ.

For character variables, if one value is longer than the other, then the shorter value is padded with blanks for the comparison. Nonblank character values are judged equal only if they agree at each character. If the NOMISSING option is in effect, then blank character values are judged equal to anything.

Definition of Difference and Percent Difference

In the reports of value comparisons and in the OUT= data set, PROC COMPARE displays difference and percent difference values for the numbers compared. These quantities are defined using the value from the base data set as the reference value. For a numeric variable compared, let *x* be its value in the base data set and let *y* be its value in the comparison data set. If *x* and *y* are both nonmissing, then the difference and percent difference are defined as follows:

- Difference = $y - x$
- Percent Difference = $(y - x)/x * 100 \quad \text{for} \quad x \neq 0$
- Percent Difference = missing for $x = 0$.

How PROC COMPARE Handles Variable Formats

PROC COMPARE compares unformatted values. If you have two matching variables that are formatted differently, then PROC COMPARE lists the formats of the variables. If non-matching values are found in the comparison section of the output, then the formatted values are displayed in the values comparison section.

Syntax: COMPARE Procedure

Restriction: You must use the VAR statement when you use the WITH statement.

Tips: Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

You can use the LABEL, ATTRIB, FORMAT, and WHERE statements. For more information, see “Statements with the Same Function in Multiple Procedures” on page 73.

Ensure that the LINESIZE option in the OPTIONS statement specifies an adequate length to display the label information for the data sets.

If problems occur with the length of CHAR variables when you compare two unequal data sets in CAS, you might need to change the value of the

NCHARMULTIPLIER option of the LIBNAME statement. For more information, see "NCHARMULTIPLIER= LIBNAME Statement Option" in *SAS Cloud Analytic Services: User's Guide* and "CAS LIBNAME Statement" in *SAS Cloud Analytic Services: User's Guide*.

PROC COMPARE <*options*>;

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

ID <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

VAR *variable(s)*;

WITH *variable(s)*;

Statement	Task	Example
PROC COMPARE	Compare the contents of SAS data sets, or compare two variables	Ex. 1, Ex. 2, Ex. 4, Ex. 6, Ex. 7
BY	Produce a separate comparison for each BY group	
ID	Identify variables to use to match observations	Ex. 5
VAR	Restrict the comparison to values of specific variables	Ex. 2, Ex. 3, Ex. 4
WITH	Compare variables of different names	Ex. 2, Ex. 3, Ex. 4
WITH	Compare two variables in the same data set	Ex. 4

PROC COMPARE Statement

Compares the contents of two SAS data sets, selected variables in different data sets, or variables within the same data set.

Restriction: If you omit COMPARE=, then you must use the WITH and VAR statements.

Tips: Ensure that the LINESIZE option in the OPTIONS statement specifies an adequate length to display the label information for the data sets.

If problems occur with the length of CHAR variables when you compare two unequal data sets in CAS, you might need to change the value of the NCHARMULTIPLIER option of the LIBNAME statement. For more information, see "NCHARMULTIPLIER= LIBNAME Statement Option" in *SAS Cloud Analytic Services: User's Guide* and "CAS LIBNAME Statement" in *SAS Cloud Analytic Services: User's Guide*.

You can use data set options with the BASE= and COMPARE= options.

Examples:

"Example 1: Producing a Complete Report of the Differences" on page 463
"Example 2: Comparing Variables in Different Data Sets" on page 470
"Example 4: Comparing Variables That Are in the Same Data Set" on page 474
"Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)" on page 482
"Example 7: Creating an Output Data Set of Statistics (OUTSTATS=)" on page 486

Syntax

PROC COMPARE <*options*>;

Summary of Optional Arguments

Control the details in the default report

ALLOBS
: includes the values for all matching observations.

ALLSTATS
: prints a table of summary statistics for all pairs of matching variables.

ALLVARS
: includes in the report the values and differences for all matching variables.

BRIEFSUMMARY
: prints only a short comparison summary.

FUZZ=*number*
: changes the report for numbers between 0 and 1.

MAXPRINT=*total* | (*per-variable, total*)
: restricts the number of differences to be printed.

NODATE
: suppresses the printing of creation and last-modified dates.

NOPRINT
: suppresses all printed output.

NOSUMMARY
: suppresses the data set, variable, observation, and values comparison summary reports.

NOVALUES
: suppresses the report of the value comparison results.

PRINTALL
: produces a complete listing of values and differences.

STATS
: prints a table of summary statistics for all pairs of matching numeric variables that are judged unequal.

TRANSPOSE

prints the reports of value differences by observation instead of by variable.

Control the listing of variables and observations

LISTALL
: lists all variables and observations that are found in only one data set.

LISTBASE
: lists all variables and observations found only in the base data set.

LISTBASEOBS
: lists all observations found only in the base data set.

LISTBASEVAR
: lists all variables found in only the base data set.

LISTCOMP
: lists all variables and observations found only in the comparison data set.

LISTCOMPOBS
: lists all observations found only in the comparison data set.

LISTCOMPVAR
: lists all variables found only in the comparison data set.

LISTEQUALVAR
: lists variables whose values are judged equal.

LISTOBS
: lists all observations found in only one data set.

LISTVAR
: list all variables found in only one data set.

Control the output data set

OUT=*SAS-data-set*
: creates an output data set.

OUTALL
: writes an observation for each observation in the BASE= and COMPARE= data sets.

OUTBASE
: writes an observation for each observation in the base data set.

OUTCOMP
: writes an observation for each observation in the comparison data set

OUTDIF
: writes an observation to the output data set for each pair of matching observations.

OUTNOEQUAL
: suppresses the writing of observations when all values are equal.

OUTPERCENT
: writes an observation to the output data set for each pair of matching observations.

Create an output data set that contains summary statistics

OUTSTATS=*SAS-data-set*
: writes summary statistics for all pairs of matching variables to the specified *SAS-data-set*.

Display a warning message in the SAS log

WARNING
: displays a warning message in the SAS log when differences are found.

Display an error message in the SAS log

ERROR
: displays an error message in the SAS log when differences are found.

Specify how the values are compared

CRITERION=γ
: specifies the criterion for judging the equality of numeric values.

METHOD=ABSOLUTE | EXACT | PERCENT | RELATIVE<(δ)>
: specifies the method for judging the equality of numeric values.

NOMISSBASE
: judges a missing value in the base data set equal to any value.

NOMISSCOMP
: judges a missing value in the comparison data set equal to any value.

NOMISSING
: judges missing values in both the base and comparison data sets equal to any value.

Specify the data sets to compare

BASE=*SAS-data-set*
: specifies the data set to use as the base data set.

COMPARE=*SAS-data-set*
: specifies the data set to use as the comparison data set.

Write notes to the SAS log

NOTE
: displays notes in the SAS log that describe the results of the comparison.

Optional Arguments

ALLOBS

includes in the report of value comparison results the values and, for numeric variables, the differences for all matching observations, even if they are judged equal.

Default
: If you omit ALLOBS, then PROC COMPARE prints values only for observations that are judged unequal.

Interaction
: When used with the TRANSPOSE option, ALLOBS invokes the ALLVARS option and displays the values for all matching observations and variables.

ALLSTATS

prints a table of summary statistics for all pairs of matching variables.

See "Table of Summary Statistics" on page 456 for information about the statistics produced

ALLVARS
includes in the report of value comparison results the values and, for numeric variables, the differences for all pairs of matching variables, even if they are judged equal.

Default If you omit ALLVARS, then PROC COMPARE prints values only for variables that are judged unequal.

Interaction When used with the TRANSPOSE option, ALLVARS displays unequal values in context with the values for other matching variables. If you omit the TRANSPOSE option, then ALLVARS invokes the ALLOBS option and displays the values for all matching observations and variables.

BASE=*SAS-data-set*
specifies the data set to use as the base data set.

Alias DATA=

Default the most recently created SAS data set

Tip You can use the WHERE= data set option with the BASE= option to limit the observations that are available for comparison.

BRIEFSUMMARY
produces a short comparison summary and suppresses the four default summary reports (data set summary report, variables summary report, observation summary report, and values comparison summary report).

Alias BRIEF

Tip By default, a listing of value differences accompanies the summary reports. To suppress this listing, use the NOVALUES option.

Example "Example 4: Comparing Variables That Are in the Same Data Set" on page 474

COMPARE=*SAS-data-set*
specifies the data set to use as the comparison data set.

Alias COMP=, C=

Default If you omit COMPARE=, then the comparison data set is the same as the base data set, and PROC COMPARE compares variables within the data set.

Restriction If you omit COMPARE=, then you must use the WITH and VAR statements.

Tip You can use the WHERE= data set option with COMPARE= to limit the observations that are available for comparison.

CRITERION=γ
specifies the criterion for judging the equality of numeric values. Normally, the value of γ (gamma) is positive. In that case, the number itself becomes the

equality criterion. If you use a negative value for γ, then PROC COMPARE uses an equality criterion proportional to the precision of the computer on which SAS is running.

Default 0.00001

See "The Equality Criterion" on page 424

ERROR
displays an error message in the SAS log when differences are found.

Interaction This option overrides the WARNING option.

FUZZ=*number*
alters the values comparison results for numbers less than *number*. PROC COMPARE prints the following:

- 0 for any variable value that is less than *number*
- a blank for difference or percent difference if it is less than *number*
- 0 for any summary statistic that is less than *number*

Default 0

Range 0 - 1

Tip A report that contains many trivial differences is easier to read in this form.

LISTALL
lists all variables and observations that are found in only one data set.

Alias LIST

Interaction using LISTALL is equivalent to using the following four options: LISTBASEOBS, LISTCOMPOBS, LISTBASEVAR, and LISTCOMPVAR.

LISTBASE
lists all observations and variables that are found in the base data set but not in the comparison data set.

Interaction Using LISTBASE is equivalent to using the LISTBASEOBS and LISTBASEVAR options.

LISTBASEOBS
lists all observations that are found in the base data set but not in the comparison data set.

LISTBASEVAR
lists all variables that are found in the base data set but not in the comparison data set.

LISTCOMP
lists all observations and variables that are found in the comparison data set but not in the base data set.

Interaction Using LISTCOMP is equivalent to using the LISTCOMPOBS and LISTCOMPVAR options.

LISTCOMPOBS
lists all observations that are found in the comparison data set but not in the base data set.

LISTCOMPVAR
lists all variables that are found in the comparison data set but not in the base data set.

LISTEQUALVAR
prints a list of variables whose values are judged equal at all observations in addition to the default list of variables whose values are judged unequal.

LISTOBS
lists all observations that are found in only one data set.

Interaction Using LISTOBS is equivalent to using the LISTBASEOBS and LISTCOMPOBS options.

LISTVAR
lists all variables that are found in only one data set.

Interaction Using LISTVAR is equivalent to using both the LISTBASEVAR and LISTCOMPVAR options.

MAXPRINT=*total* | (*per-variable, total*)
specifies the maximum number of differences to be printed, where

total
is the maximum total number of differences to be printed. The default value is 500 unless you use the ALLOBS option (or both the ALLVAR and TRANSPOSE options). In that case, the default is 32000.

per-variable
is the maximum number of differences to be printed for each variable within a BY group. The default value is 50 unless you use the ALLOBS option (or both the ALLVAR and TRANSPOSE options). In that case, the default is 1000.

The MAXPRINT= option prevents the output from becoming extremely large when data sets differ greatly.

METHOD=ABSOLUTE | EXACT | PERCENT | RELATIVE<(δ)>
specifies the method for judging the equality of numeric values. The constant δ (delta) is a number between 0 and 1 that specifies a value to add to the denominator when calculating the equality measure. By default, δ is 0.

Unless you use the CRITERION= option, the default method is EXACT. If you use the CRITERION= option, then the default method is RELATIVE(ϕ), where ϕ (phi) is a small number that depends on the numerical precision of the computer on which SAS is running and on the value of CRITERION=.

See "The Equality Criterion" on page 424

NODATE
suppresses the display in the data set summary report of the creation dates and the last modified dates of the base and comparison data sets.

NOMISSBASE
(By default, a missing value is equal only to a missing value of the same kind, that is .=., .^=.A, .A=.A, .A^=.B, and so on.)

You can use this option to determine the changes that would be made to the observations in the comparison data set if it were used as the master data set and the base data set were used as the transaction data set in a DATA step UPDATE statement. For information about the UPDATE statement, see "UPDATE" in *SAS DATA Step Statements: Reference*.

NOMISSCOMP
judges a missing value in the comparison data set equal to any value. (By default, a missing value is equal only to a missing value of the same kind, that is .=., .^=.A, .A=.A, .A^=.B, and so on.)

You can use this option to determine the changes that would be made to the observations in the base data set if it were used as the master data set and the comparison data set were used as the transaction data set in a DATA step UPDATE statement. For information about the UPDATE statement, see "UPDATE" in *SAS DATA Step Statements: Reference*.

NOMISSING
judges missing values in both the base and comparison data sets equal to any value. By default, a missing value is equal only to a missing value of the same kind, that is .=., .^=.A, .A=.A, .A^=.B, and so on.

Alias NOMISS

Interaction Using NOMISSING is equivalent to using both NOMISSBASE and NOMISSCOMP.

NOPRINT
suppresses all printed output.

Tip You might want to use this option when you are creating one or more output data sets.

Example "Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)" on page 482

NOSUMMARY
suppresses the data set, variable, observation, and values comparison summary reports.

Tip NOSUMMARY produces no output if there are no differences in the matching values.

Example "Example 2: Comparing Variables in Different Data Sets" on page 470

NOTE
displays notes in the SAS log that describe the results of the comparison, if differences were found.

NOVALUES
suppresses the report of the value comparison results.

Example Overview: COMPARE Procedure on page 420

OUT=*SAS-data-set*
names the output data set. If *SAS-data-set* does not exist, then PROC COMPARE creates it. *SAS-data-set* contains the differences between matching variables.

See "Output Data Set (OUT=)" on page 460

Example "Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)" on page 482

OUTALL
writes an observation to the output data set for each observation in the base data set and for each observation in the comparison data set. The option also writes observations to the output data set that contains the differences and percent differences between the values in matching observations.

Tip Using OUTALL is equivalent to using the following four options: OUTBASE, OUTCOMP, OUTDIF, and OUTPERCENT.

See "Output Data Set (OUT=)" on page 460

OUTBASE
writes an observation to the output data set for each observation in the base data set, creating observations in which _TYPE_=BASE.

See "Output Data Set (OUT=)" on page 460

Example "Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)" on page 482

OUTCOMP
writes an observation to the output data set for each observation in the comparison data set, creating observations in which _TYPE_=COMP.

See "Output Data Set (OUT=)" on page 460

Example "Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)" on page 482

OUTDIF
writes an observation to the output data set for each pair of matching observations. The values in the observation include values for the differences between the values in the pair of observations. The value of _TYPE_ in each observation is DIF.

Default The OUTDIF option is the default unless you specify the OUTBASE, OUTCOMP, or OUTPERCENT option. If you use any of these options, then you must specify the OUTDIF option to create _TYPE_=DIF observations in the output data set.

See "Output Data Set (OUT=)" on page 460

Example "Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)" on page 482

OUTNOEQUAL
suppresses the writing of an observation to the output data set when all values in the observation are judged equal. In addition, in observations containing values for some variables judged equal and others judged unequal, the OUTNOEQUAL option uses the special missing value ".E" to represent differences and percent differences for variables judged equal.

See "Output Data Set (OUT=)" on page 460

Example "Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)" on page 482

OUTPERCENT
writes an observation to the output data set for each pair of matching observations. The values in the observation include values for the percent differences between the values in the pair of observations. The value of _TYPE_ in each observation is PERCENT.

See "Output Data Set (OUT=)" on page 460

OUTSTATS=*SAS-data-set*
writes summary statistics for all pairs of matching variables to the specified *SAS-data-set*.

Tip If you want to print a table of statistics in the procedure output, then use the STATS, ALLSTATS, or PRINTALL option.

See "Output Statistics Data Set (OUTSTATS=)" on page 462

"Table of Summary Statistics" on page 456

Example "Example 7: Creating an Output Data Set of Statistics (OUTSTATS=)" on page 486

PRINTALL
invokes the following options: ALLVARS, ALLOBS, ALLSTATS, LISTALL, and WARNING.

Example "Example 1: Producing a Complete Report of the Differences" on page 463

STATS
prints a table of summary statistics for all pairs of matching numeric variables that are judged unequal.

See "Table of Summary Statistics" on page 456 for information about the statistics produced.

TRANSPOSE
prints the reports of value differences by observation instead of by variable.

Interaction If you also use the NOVALUES option, then the TRANSPOSE option lists only the *names* of the variables whose values are judged unequal for each observation, not the values and differences.

See "Comparison Results for Observations (Using the TRANSPOSE Option)" on page 458.

WARNING
displays a warning message in the SAS log when differences are found.

Interaction The ERROR option overrides the WARNING option.

BY Statement

Produces a separate comparison for each BY group.

See: "BY" on page 74

Syntax

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, then the observations in the data set must be sorted by all the variables that you specify. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the observations are sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The observations are grouped in another way (for example, chronological order).

Note The requirement for ordering observations according to the values of BY variables is suspended for BY-group processing when you use the

NOTSORTED option. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

Details

BY Processing with PROC COMPARE

To use a BY statement with PROC COMPARE, you must sort both the base and comparison data sets by the BY variables. The nature of the comparison depends on whether all BY variables are in the comparison data set and, if they are, whether their attributes match the ones of the BY variables in the base data set. The following table shows how PROC COMPARE behaves under different circumstances:

Table 13.1 *Behavior of PROC COMPARE under Different Circumstances*

Condition	Behavior of PROC COMPARE
All BY variables are in the comparison data set and all attributes match exactly	Compares corresponding BY groups
None of the BY variables are in the comparison data set	Compares each BY group in the base data set with the entire comparison data set
Some BY variables are not in the comparison data set	Writes an error message to the SAS log and terminates
Some BY variables have different types in the two data sets	Writes an error message to the SAS log and terminates

Note: Identical BY values might not compare as equal if they are formatted differently.

ID Statement

Lists variables to use to match observations.

See: "A Comparison with an ID Variable" on page 423

Example: "Example 5: Comparing Observations with an ID Variable" on page 476

Syntax

ID <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to match observations. You can specify more than one variable, but the data set must be sorted by the variable or variables that you specify. These variables are *ID variables*. ID variables also identify observations on the printed reports and in the output data set.

Optional Arguments

DESCENDING
specifies that the data set is sorted in descending order by the variable that immediately follows the word DESCENDING in the ID statement.

If you use the DESCENDING option, then you must sort the data sets. SAS does not use an index to process an ID statement with the DESCENDING option. Further, the use of DESCENDING for ID variables must correspond to the use of the DESCENDING option in the BY statement in the PROC SORT step that was used to sort the data sets.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The data are grouped in another way (for example, chronological order).

See "Comparing Unsorted Data" on page 440

Details

Requirements for ID Variables

- ID variables must be in the BASE= data set or PROC COMPARE stops processing.
- If an ID variable is not in the COMPARE= data set, then PROC COMPARE writes a warning message to the SAS log and does not use that variable to match observations in the comparison data set (but does write it to the OUT= data set).
- ID variables must be of the same type in both data sets.
- You should sort both data sets by the common ID variables (within the BY variables, if any) unless you specify the NOTSORTED option.

Comparing Unsorted Data

If you do not want to sort the data set by the ID variables, then you can use the NOTSORTED option. When you specify the NOTSORTED option, or if the ID statement is omitted, PROC COMPARE matches the observations one-to-one. That is, PROC COMPARE matches the first observation in the base data set with the first observation in the comparison data set, the second with the second, and so on. If you use NOTSORTED, and the ID values of corresponding observations are not the same, then PROC COMPARE prints an error message and stops processing.

If the data sets are not sorted by the common ID variables and if you do not specify the NOTSORTED option, then PROC COMPARE writes a warning message to the SAS log and continues to process the data sets as if you had specified NOTSORTED.

Avoiding Duplicate ID Values

The observations in each data set should be uniquely labeled by the values of the ID variables. If PROC COMPARE finds two successive observations with the same ID values in a data set, then it does the following:

- prints the warning `Duplicate Observations` for the first occurrence for that data set
- prints the total number of duplicate observations found in the data set in the observation summary report
- uses the duplicate observations in the base data set and the comparison data set to compare the observations on a one-to-one basis

When the data sets are not sorted, PROC COMPARE detects only those duplicate observations that occur in succession.

VAR Statement

Restricts the comparison of the values of variables to the ones named in the VAR statement.

Examples: "Example 2: Comparing Variables in Different Data Sets" on page 470
"Example 3: Comparing a Variable Multiple Times" on page 472
"Example 4: Comparing Variables That Are in the Same Data Set" on page 474

Syntax

VAR *variable(s)*;

Required Argument

variable(s)
one or more variables that appear in the BASE= and COMPARE= data sets or only in the BASE= data set.

Details

- If you do not use the VAR statement, then PROC COMPARE compares the values of all matching variables except the ones that appear in BY and ID statements.
- If a variable in the VAR statement does not exist in the COMPARE= data set, then PROC COMPARE writes a warning message to the SAS log and ignores the variable.
- If a variable in the VAR statement does not exist in the BASE= data set, then PROC COMPARE stops processing and writes an error message to the SAS log.
- The VAR statement restricts only the comparison of values of matching variables. PROC COMPARE still reports on the total number of matching variables and compares their attributes. However, it produces neither error nor warning messages about these variables.

WITH Statement

Compares variables in the base data set with variables that have different names in the comparison data set, and compares different variables that are in the same data set.

Restriction: You must use the VAR statement when you use the WITH statement.

Examples: "Example 2: Comparing Variables in Different Data Sets" on page 470
"Example 3: Comparing a Variable Multiple Times" on page 472
"Example 4: Comparing Variables That Are in the Same Data Set" on page 474

Syntax

WITH *variable(s)*;

Required Argument

variable(s)
one or more variables to compare with variables in the VAR statement.

Details

Comparing Selected Variables

If you want to compare variables in the base data set with variables that have different names in the comparison data set, then specify the names of the variables in the base data set in the VAR statement and specify the names of the matching variables in the WITH statement. The first variable that you list in the WITH

statement corresponds to the first variable that you list in the VAR statement, the second with the second, and so on. If the WITH statement list is shorter than the VAR statement list, then PROC COMPARE assumes that the extra variables in the VAR statement have the same names in the comparison data set as they do in the base data set. If the WITH statement list is longer than the VAR statement list, then PROC COMPARE ignores the extra variables.

A variable name can appear any number of times in the VAR statement or the WITH statement. By selecting VAR and WITH statement lists, you can compare the variables in any permutation.

If you omit the COMPARE= option in the PROC COMPARE statement, then you must use the WITH statement. In this case, PROC COMPARE compares the values of variables with different names in the BASE= data set.

Usage: COMPARE Procedure

Customizing PROC COMPARE Output

PROC COMPARE produces lengthy output. You can use one or more options to determine the types of comparisons to make and the degree of detail in the report. For example, in the following PROC COMPARE step, the NOVALUES option suppresses the part of the output that shows the differences in the values of matching variables:

```
options nodate pageno=1 linesize=80 pagesize=40;

title 'The SAS System';

proc compare base=proclib.one
             compare=proclib.two novalues;
run;
```

Output 13.1 *Part One of Comparison of WORK.ONE and WORK.TWO*

The SAS System

```
                        The COMPARE Procedure
                  Comparison of WORK.ONE with WORK.TWO
                             (Method=EXACT)

                          Data Set Summary

Dataset            Created          Modified  NVar    NObs  Label

WORK.ONE   16MAR11:16:43:16  16MAR11:16:43:16     5       4  First Data Set
WORK.TWO   16MAR11:16:43:16  16MAR11:16:43:16     6       5  Second Data Set


                          Variables Summary

            Number of Variables in Common: 5.
            Number of Variables in WORK.TWO but not in WORK.ONE: 1.
            Number of Variables with Conflicting Types: 1.
            Number of Variables with Differing Attributes: 3.
```

```
            Listing of Common Variables with Conflicting Types

                     Variable  Dataset   Type  Length

                     student   WORK.ONE  Num        8
                               WORK.TWO  Char       8


             Listing of Common Variables with Differing Attributes

          Variable  Dataset   Type  Length  Format  Label

          year      WORK.ONE  Char       8          Year of Birth
                    WORK.TWO  Char       8
          state     WORK.ONE  Char       8
                    WORK.TWO  Char       8          Home State
```

Output 13.2 *Part Two of Comparison of WORK.ONE and WORK.TWO*

The SAS System

```
                        The COMPARE Procedure
                  Comparison of WORK.ONE with WORK.TWO
                             (Method=EXACT)

          Listing of Common Variables with Differing Attributes

        Variable  Dataset   Type  Length  Format  Label

        gr1       WORK.ONE  Num        8  4.1
                  WORK.TWO  Num        8  5.2
```

```
                          Observation Summary

                     Observation      Base  Compare

                     First Obs           1        1
                     First Unequal       1        1
                     Last  Unequal       4        4
                     Last  Match         4        4
                     Last  Obs           .        5

Number of Observations in Common: 4.
Number of Observations in WORK.TWO but not in WORK.ONE: 1.
Total Number of Observations Read from WORK.ONE: 4.
Total Number of Observations Read from WORK.TWO: 5.

Number of Observations with Some Compared Variables Unequal: 4.
Number of Observations with All Compared Variables Equal: 0.
```

Output 13.3 *Part Three of Comparison of WORK.ONE and WORK.TWO*

The SAS System

```
                        The COMPARE Procedure
                  Comparison of WORK.ONE with WORK.TWO
                             (Method=EXACT)

                      Values Comparison Summary

Number of Variables Compared with All Observations Equal: 1.
Number of Variables Compared with Some Observations Unequal: 3.
Total Number of Values which Compare Unequal: 6.
Maximum Difference: 20.


                   Variables with Unequal Values

       Variable  Type  Len   Compare Label  Ndif   MaxDif

       state     CHAR    8   Home State        2
       gr1       NUM     8                     2    1.000
       gr2       NUM     8                     2   20.000
```

"Procedure Output" on page 449 shows the default output for these two data sets. "Example 1: Producing a Complete Report of the Differences" on page 463 shows the complete output for these two data sets.

Results: COMPARE Procedure

Results Reporting

PROC COMPARE reports the results of its comparisons in the following ways:

- the SAS log
- return codes stored in the automatic macro SYSINFO
- procedure output
- output data sets

SAS Log

When you use the WARNING, PRINTALL, or ERROR option, PROC COMPARE writes a description of the differences to the SAS log.

Macro Return Codes (SYSINFO)

PROC COMPARE stores a return code in the automatic macro variable SYSINFO. The value of the return code provides information about the result of the comparison. By checking the value of SYSINFO after PROC COMPARE has run and before any other step begins, SAS macros can use the results of a PROC COMPARE step to determine what action to take or what parts of a SAS program to execute.

The following table is a key for interpreting the SYSINFO return code from PROC COMPARE. For each of the conditions listed, the associated value is added to the return code if the condition is true. Thus, the SYSINFO return code is the sum of the codes listed in the following table for the applicable conditions:

Table 13.2 *Macro Return Codes*

Bit	Condition	Code	Hexadecimal	Description
1	DSLABEL	1	0001X	Data set labels differ
2	DSTYPE	2	0002X	Data set types differ
3	INFORMAT	4	0004X	Variable has different informat
4	FORMAT	8	0008X	Variable has different format
5	LENGTH	16	0010X	Variable has different length
6	LABEL	32	0020X	Variable has different label
7	BASEOBS	64	0040X	Base data set has observation not in comparison
8	COMPOBS	128	0080X	Comparison data set has observation not in base
9	BASEBY	256	0100X	Base data set has BY group not in comparison
10	COMPBY	512	0200X	Comparison data set has BY group not in base

Bit	Condition	Code	Hexadecimal	Description
11	BASEVAR	1024	0400X	Base data set has variable not in comparison
12	COMPVAR	2048	0800X	Comparison data set has variable not in base
13	VALUE	4096	1000X	A value comparison was unequal
14	TYPE	8192	2000X	Conflicting variable types
15	BYVAR	16384	4000X	BY variables do not match
16	ERROR	32768	8000X	Fatal error: comparison not done

These codes are ordered and scaled to enable a simple check of the degree to which the data sets differ. For example, if you want to check that two data sets contain the same variables, observations, and values, but you do not care about differences in labels, formats, and so on, then use the following statements:

```
proc compare base=SAS-data-set
             compare=SAS-data-set;
run;

%if &sysinfo >= 64 %then
   %do;
      handle error;
   %end;
```

Each time you include SYSINFO in your code, the value for each subsequent instance of SYSINFO is added to the previous value. The final value for SYSINFO is the cumulative value for all of the instances of SYSINFO in the code. For example, if you run the following example code, the first instance of SYSINFO produces a return code of 32, and the second instance produces a return code of 4096. The two values are added together to produce the final return code of 4128.

```
   /*diff label -- RC is 32*/
   data class1;
      set sashelp.class;
      label sex='Gender';
   run;

   data class2;
      set sashelp.class;
   run;

   proc compare base=class1 comp=class2;
   run;

   %let rc=&sysinfo
   %put 'RC' &rc

   /*diff label and value -- RC is 4128*/
   data class1;
```

```
      set sashelp.class;
      label sex='Gender';
   run;
   data class2;
      set sashelp.class;
      if name="Jeffrey" then name="Jeff";
   run;

   proc compare base=class1 comp=class2;
   run;

   %let rc=&sysinfo
   %put 'RC' &rc
```

You can examine individual bits in the SYSINFO value by using DATA step bit-testing features to check for specific conditions. For example, to check for the presence of observations in the base data set that are not in the comparison data set, use the following statements:

```
proc compare base=SAS-data-set
             compare=SAS-data-set;
run;

%let rc=&sysinfo;
data _null_;
   /* Test for data set label */
   if &rc = '1'b then
      put '<<<< Data sets have different labels';
/* Test for data set types */
   if &rc = '1.'b then
      put '<<<< Data set types differ';
/* Test for label */
   if &rc = '1.....'b then
      put '<<<< Variable has different label';
/* Test for base observation */
if &rc = '1......'b then
      put '<<<< Base data set has observation not in comparison data set';
/* Test for length */
   if &rc = '1....'b then
      put '<<<< Variable has different lengths between the base data set
      and the comparison data set';
/* Variable in base data set not in compare data set */
   if &rc ='1..........'b then
      put '<<<< Variable in base data set not found in comparison data set';
/* Comparison data set has variable not in base data set */
   if &rc = '1...........'b then
      put '<<<< Comparison data set has variable not contained in the
      base data set';
/* Test for values */
   if &rc = '1............'b then
      put '<<<< A value comparison was unequal';
/* Conflicting variable types */
   if &rc ='1............'b then
      put '<<<< Conflicting variable types between the two data sets
      being compared';
run;
```

PROC COMPARE must run before you check SYSINFO and you must obtain the SYSINFO value before another SAS step starts because every SAS step resets SYSINFO.

Procedure Output

Procedure Output Overview

The following sections show and describe the default output of the two data sets shown in Overview: COMPARE Procedure on page 420. Because PROC COMPARE produces lengthy output, the output is presented in seven pieces.

```
options nodate pageno=1 linesize=80 pagesize=60;
proc compare base=proclib.one compare=proclib.two;
  run;
```

Data Set Summary

This report lists the attributes of the data sets that are being compared. These attributes include the following:

- the data set names
- the data set types, if any
- the data set labels, if any
- the dates created and last modified
- the number of variables in each data set
- the number of observations in each data set

To view the Data Set Summary, see Output 13.65 on page 451.

Note: The COMPARE procedure omits data set labels if the line size is too small for them.

Variables Summary

This report compares the variables in the two data sets. The first part of the report lists the following:

- the number of variables the data sets have in common

- the number of variables in the base data set that are not in the comparison data set and vice versa
- the number of variables in both data sets that have different types
- the number of variables that differ on other attributes (length, label, format, or informat)
- the number of BY, ID, VAR, and WITH variables specified for the comparison

The second part of the report lists matching variables with different attributes and shows how the attributes differ. (The COMPARE procedure omits variable labels if the line size is too small for them.)

The following output shows the Data Set Summary and the Variables Summary.

Output 13.4 *Partial Output Showing the Data Set Summary and Variables Summary*

The SAS System

```
                        The COMPARE Procedure
                  Comparison of WORK.ONE with WORK.TWO
                             (Method=EXACT)

                          Data Set Summary

Dataset            Created          Modified  NVar    NObs  Label

WORK.ONE  18MAR11:11:22:21  18MAR11:11:22:21     5       4  First Data Set
WORK.TWO  18MAR11:11:22:22  18MAR11:11:22:22     6       5  Second Data Set


                          Variables Summary

            Number of Variables in Common: 5.
            Number of Variables in WORK.TWO but not in WORK.ONE: 1.
            Number of Variables with Conflicting Types: 1.
            Number of Variables with Differing Attributes: 3.
```

```
            Listing of Common Variables with Conflicting Types

                      Variable  Dataset   Type  Length

                      student   WORK.ONE  Num        8
                                WORK.TWO  Char       8


           Listing of Common Variables with Differing Attributes

          Variable  Dataset   Type  Length  Format  Label

          year      WORK.ONE  Char       8          Year of Birth
                    WORK.TWO  Char       8
          state     WORK.ONE  Char       8
                    WORK.TWO  Char       8          Home State
          gr1       WORK.ONE  Num        8  4.1
                    WORK.TWO  Num        8  5.2
```

Observation Summary

This report provides information about observations in the base and comparison data sets. First of all, the report identifies the first and last observation in each data set, the first and last matching observations, and the first and last different observations. Then, the report lists the following:

- the number of observations that the data sets have in common

- the number of observations in the base data set that are not in the comparison data set and vice versa
- the total number of observations in each data set
- the number of matching observations for which PROC COMPARE judged some variables unequal
- the number of matching observations for which PROC COMPARE judged all variables equal

The following output shows the Observation Summary.

Output 13.5 *Partial Output Showing the Observation Summary*

```
                        Observation Summary

                    Observation      Base  Compare

                    First Obs           1        1
                    First Unequal       1        1
                    Last  Unequal       4        4
                    Last  Match         4        4
                    Last  Obs           .        5

Number of Observations in Common: 4.
Number of Observations in WORK.TWO but not in WORK.ONE: 1.
Total Number of Observations Read from WORK.ONE: 4.
Total Number of Observations Read from WORK.TWO: 5.

Number of Observations with Some Compared Variables Unequal: 4.
Number of Observations with All Compared Variables Equal: 0.
```

Values Comparison Summary

This report first lists the following:

- the number of variables compared with all observations equal
- the number of variables compared with some observations unequal
- the number of variables with differences involving missing values, if any
- the total number of values judged unequal
- the maximum difference measure between unequal values for all pairs of matching variables (for differences not involving missing values)

In addition, for the variables for which some matching observations have unequal values, the report lists the following:

- the name of the variable
- other variable attributes
- the number of times PROC COMPARE judged the variable unequal

- the maximum difference measure found between values (for differences not involving missing values)
- the number of differences caused by comparison with missing values, if any

The following output shows the Values Comparison Summary.

Output 13.6 *Partial Output Showing the Values Comparison Summary*

The SAS System

```
                        The COMPARE Procedure
                Comparison of WORK.ONE with WORK.TWO
                            (Method=EXACT)

                     Values Comparison Summary

Number of Variables Compared with All Observations Equal: 1.
Number of Variables Compared with Some Observations Unequal: 3.
Total Number of Values which Compare Unequal: 6.
Maximum Difference: 20.


                  Variables with Unequal Values

Variable  Type  Len   Compare Label  Ndif   MaxDif

state     CHAR    8   Home State        2
gr1       NUM     8                     2    1.000
gr2       NUM     8                     2   20.000
```

Value Comparison Results

This report consists of a table for each pair of matching variables judged unequal at one or more observations.

Note:

- When it is comparing character values, PROC COMPARE displays only the first 20 characters. When you use the TRANSPOSE option, PROC COMPARE displays only the first 12 characters.

  If you are comparing character values, in the output PROC COMPARE displays a plus sign at the end of a character string that is longer than 20 characters. If you specify the TRANSPOSE option PROC COMPARE displays a plus sign in the output at the end of a character string that is longer than 12 characters. In both instances, the plus sign appears in the table-cell border above the character string. Here is an example.

```
                The COMPARE Procedure
            Comparison of WORK.X with WORK.Y
                   (Method=EXACT)

          Value Comparison Results for Variables

__________________________________________________________
          ||  Base Value            Compare Value
      Obs ||  x                      x
 ________ ||  ___________________+  ___________________+
          ||
        1 ||  12345678901234567890  12345678901234567890
__________________________________________________________
```

Note: The plus sign is displayed at the end of the border above the character string.

- If you do not specify an adequate value for the LINESIZE option, SAS might write a warning that indicates the LINESIZE value is too small to print all of the ID variables in the value comparison reports. PROC COMPARE reserves space for the value section based on the formatted width of the data values. The rest of the space is available for ID values. The character ID values use the width that is specified by their format, and numeric variables use approximately 10 spaces.

Each table shows the following:

- the number of the observation or, if you use the ID statement, the values of the ID variables
- the value of the variable in the base data set
- the value of the variable in the comparison data set
- the difference between these two values (numeric variables only)
- the percent difference between these two values (numeric variables only)

The following output shows the Value Comparison Results for Variables.

Output 13.7 *Partial Output Showing the Value Comparison Results for Variables*

Value Comparison Results for Variables

Obs	Home State Base Value state	Compare Value state
2	MD	MA
4	MA	MD

Obs	Base gr1	Compare gr1	Diff.	% Diff
1	85.0	84.00	-1.0000	-1.1765
3	78.0	79.00	1.0000	1.2821

Obs	Base gr2	Compare gr2	Diff.	% Diff
3	72.0000	73.0000	1.0000	1.3889
4	94.0000	74.0000	-20.0000	-21.2766

You can suppress the value comparison results with the NOVALUES option. If you use both the NOVALUES and TRANSPOSE options, then PROC COMPARE lists for each observation the names of the variables with values judged unequal but does not display the values and differences.

The display limits of PROC COMPARE and the TRANSPOSE option apply only to the printed output generated by PROC COMPARE. To see the entire value, you have to use the following options to create an output data set with PROC COMPARE:

- OUT= specifies the name of the output data set.
- OUTNOEQUAL suppresses writing observations where all variables match.
- OUTBASE and OUTCOMP include the observations from the BASE= and COMPARE= data sets.
- NOPRINT suppresses the default printed reports.

The following example produces a Differences data set and then runs PROC PRINT.

```
data x;
a='aaaaaaaaaaaaaaaaaaaaa';
```

```
data y;
a='aaaaaaaaaaaaaaaaaaaab';
run;
proc compare base=x comp=y out=dif outbase outcomp outdif outnoequal;
run;
proc print data=dif;
run;
```

Figure 13.3 *Differences Data Set*

The SAS System

Obs	_TYPE_	_OBS_	a
1	BASE	1	aaaaaaaaaaaaaaaaaaaaa
2	COMPARE	1	aaaaaaaaaaaaaaaaaaaab
3	DIF	1	X

Table of Summary Statistics

If you use the STATS, ALLSTATS, or PRINTALL option, then the Value Comparison Results for Variables section contains summary statistics for the numeric variables that are being compared. The STATS option generates these statistics for only the numeric variables whose values are judged unequal. The ALLSTATS and PRINTALL options generate these statistics for all numeric variables, even if all values are judged equal. Here is the formula that is used to generate the statistics for the ALLSTATS section.

```
(ystat-xstat)/x*100
```

Note: In all cases PROC COMPARE calculates the summary statistics based on all matching observations that do not contain missing values, not just on those containing unequal values.

The following output shows the following summary statistics for base data set values, comparison data set values, differences, and percent differences:

N
: the number of nonmissing values.

  Note: The value of the N statistic is always the count of nonmissing observations for all four of the columns in the output. The Diff and %Diff columns do not perform any calculations on the N statistic.

MEAN
: the mean, or average, of the values.

STD
: the standard deviation.

MAX
the maximum value.

MIN
the minimum value.

MISSDIFF
the number of missing values in either a base or compare data set.

STDERR
the standard error of the mean.

T
the T ratio (MEAN/STDERR).

PROB> | T |
the probability of a greater absolute T value if the true population mean is 0.

NDIF
the number of matching observations judged unequal, and the percent of the matching observations that were judged unequal.

DIFMEANS
the difference between the mean of the base values and the mean of the comparison values. This line contains three numbers. The first is the mean expressed as a percentage of the base values mean. The second is the mean expressed as a percentage of the comparison values mean. The third is the difference in the two means (the comparison mean minus the base mean).

R
the correlation of the base and comparison values for matching observations that are nonmissing in both data sets.

RSQ
the square of the correlation of the base and comparison values for matching observations that are nonmissing in both data sets.

The following output is from the ALLSTATS option using the two data sets shown in Overview: COMPARE Procedure on page 420.:

```
options nodate pageno=1
   linesize=80 pagesize=60;
proc compare base=proclib.one
     compare=proclib.two allstats;
   title 'Comparing Two Data Sets: Default Report';
run;
```

Output 13.8 *Partial Output Showing Value Comparison Results for Variables*

Value Comparison Results for Variables

Obs	Home State Base Value state	Compare Value state
2	MD	MA
4	MA	MD

Obs	Base gr1	Compare gr1	Diff.	% Diff
1	85.0	84.00	-1.0000	-1.1765
3	78.0	79.00	1.0000	1.2821
N	4	4	4	4
Mean	85.5000	85.5000	0	0.0264
Std	5.8023	5.4467	0.8165	1.0042
Max	92.0000	92.0000	1.0000	1.2821
Min	78.0000	79.0000	-1.0000	-1.1765
StdErr	2.9011	2.7234	0.4082	0.5021
t	29.4711	31.3951	0.0000	0.0526
Prob>|t|	<.0001	<.0001	1.0000	0.9614
Ndif	2	50.000%		
DifMeans	0.000%	0.000%	0	
r, rsq	0.991	0.983		

Note: If you use a wide line size with PRINTALL, then PROC COMPARE prints the value comparison result for character variables next to the result for numeric variables. In that case, PROC COMPARE calculates only NDIF for the character variables.

Comparison Results for Observations (Using the TRANSPOSE Option)

The TRANSPOSE option prints the comparison results by observation instead of by variable. The comparison results precede the observation summary report. By

default, the source of the values for each row of the table is indicated by the following label:

```
_OBS_1=number-1  _OBS_2=number-2
```

where *number-1* is the number of the observation in the base data set for which the value of the variable is shown, and *number-2* is the number of the observation in the comparison data set.

The following output shows the differences in PROCLIB.ONE and PROCLIB.TWO by observation instead of by variable.

```
options nodate pageno=1
   linesize=80 pagesize=60;
proc compare base=proclib.one
     compare=proclib.two transpose;
   title 'Comparing Two Data Sets: Default Report';
run;
```

Output 13.9 *Partial Output Showing Comparison Results for Observations*

Comparing Two Data Sets: Default Report

```
                        The COMPARE Procedure
                  Comparison of WORK.ONE with WORK.TWO
                              (Method=EXACT)

                  Comparison Results for Observations

_OBS_1=3 _OBS_2=3:
Variable    Base Value       Compare         Diff.        % Diff
     gr1          78.0         79.00      1.000000      1.282051
     gr2     72.000000     73.000000      1.000000      1.388889

_OBS_1=4 _OBS_2=4:
Variable    Base Value       Compare         Diff.        % Diff
     gr2     94.000000     74.000000    -20.000000    -21.276596
   state            MA            MD
```

If you use an ID statement, then the identifying label has the following form:

```
ID-1=ID-value-1 ... ID-n=ID-value-n
```

where *ID* is the name of an ID variable and *ID-value* is the value of the ID variable.

Note: When you use the TRANSPOSE option, PROC COMPARE prints only the first 12 characters of the value.

ODS Table Names

The COMPARE procedure assigns a name to each table that it creates. You can use these names to reference the table when using the Output Delivery System (ODS)

to select tables and create output data sets. For more information, see *SAS Output Delivery System: User's Guide*.

Table 13.3 *ODS Tables Produced by the COMPARE Procedure*

Table Name	Description	Conditions When Table Is Generated
CompareData sets	Information about the data set or data sets	By default, unless NOSUMMARY or NOVALUES option is specified
CompareDetails (Comparison Results for Observations)	A listing of observations that the base data set and the compare data set do not have in common	If PRINTALL option is specified
CompareDetails (ID variable notes and warnings)	A listing of notes and warnings concerning duplicate ID variable values	If ID statement is specified and duplicate ID variable values exist in either data set
CompareDifferences	A report of variable value differences	By default unless NOVALUES option is specified
CompareSummary	Summary report of observations, values, and variables with unequal values	By default
CompareVariables	A listing of differences in variable types or attributes between the base data set and the compare data set	By default, unless the variables are identical or the NOSUMMARY option is specified

Note: The ODS output tables contain the same information as that written to the Output window. These tables do not contain any additional information, and they do not provide a different format for the information. The ODS output tables might be of some use to you, but it depends on the task that you are performing. For an example of the format produced in the Output window, see the outputs in "Customizing PROC COMPARE Output" on page 442.

Output Data Set (OUT=)

By default, the OUT= data set contains an observation for each pair of matching observations. The OUT= data set contains the following variables from the data sets you are comparing:

- all variables named in the BY statement

- all variables named in the ID statement
- all matching variables or, if you use the VAR statement, all variables listed in the VAR statement

In addition, the data set contains two variables created by PROC COMPARE to identify the source of the values for the matching variables: _TYPE_ and _OBS_.

TYPE
is a character variable of length 8. Its value indicates the source of the values for the matching (or VAR) variables in that observation. (For ID and BY variables, which are not compared, the values are the values from the original data sets.) _TYPE_ has the label `Type of Observation`. The four possible values of this variable are as follows:

BASE
the values in this observation are from an observation in the base data set. PROC COMPARE writes this type of observation to the OUT= data set when you specify the OUTBASE option.

COMPARE
the values in this observation are from an observation in the comparison data set. PROC COMPARE writes this type of observation to the OUT= data set when you specify the OUTCOMP option.

DIF
the values in this observation are the differences between the values in the base and comparison data sets.

For character variables, PROC COMPARE uses a period (.) to represent equal characters and an X to represent unequal characters.

For numeric variables, an E means that there is no difference. Otherwise, the numeric difference is shown.

PROC COMPARE writes this type of observation to the OUT= data set by default. However, if you request any other type of observation with the OUTBASE, OUTCOMP, or OUTPERCENT option, then you must specify the OUTDIF option to generate observations of this type in the OUT= data set.

For an example output that shows the use of the period, X, and E to represent equal and different values, see "Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)" on page 482.

PERCENT
the values in this observation are the percent differences between the values in the base and comparison data sets. For character variables the values in observations of type PERCENT are the same as the values in observations of type DIF.

OBS
is a numeric variable that contains a number further identifying the source of the OUT= observations.

For observations with _TYPE_ equal to BASE, _OBS_ is the number of the observation in the base data set from which the values of the VAR variables were copied. Similarly, for observations with _TYPE_ equal to COMPARE, _OBS_ is the number of the observation in the comparison data set from which the values of the VAR variables were copied.

For observations with _TYPE_ equal to DIF or PERCENT, _OBS_ is a sequence number that counts the matching observations in the BY group.

OBS has the label `Observation Number`.

The COMPARE procedure takes variable names and attributes for the OUT= data set from the base data set except for the length of the VAR variable. The COMPARE procedure uses the longer length for the VAR variable regardless of which data set contains that length is from. This behavior has two important repercussions:

- If you use the VAR and WITH statements, then the names of the variables in the OUT= data set come from the VAR statement. Thus, observations with _TYPE_ equal to `BASE` contain the values of the VAR variables, whereas observations with _TYPE_ equal to `COMPARE` contain the values of the WITH variables.
- If you include a variable more than once in the VAR statement in order to compare it with more than one variable, then PROC COMPARE can include only the first comparison in the OUT= data set because each variable must have a unique name. Other comparisons produce warning messages.

For an example of the OUT= option, see "Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)" on page 482.

Output Statistics Data Set (OUTSTATS=)

When you use the OUTSTATS= option, PROC COMPARE calculates the same summary statistics as the ALLSTATS option for each pair of numeric variables that are compared. For more information, see "Table of Summary Statistics" on page 456). The OUTSTATS= data set contains an observation for each summary statistic for each pair of variables. The data set also contains the BY variables used in the comparison and several variables created by PROC COMPARE:

VAR
is a character variable that contains the name of the variable from the base data set for which the statistic in the observation was calculated.

WITH
is a character variable that contains the name of the variable from the comparison data set for which the statistic in the observation was calculated. The _WITH_ variable is not included in the OUTSTATS= data set unless you use the WITH statement.

TYPE
is a character variable that contains the name of the statistic contained in the observation. Values of the _TYPE_ variable are `N`, `MEAN`, `STD`, `MIN`, `MAX`, `STDERR`, `T`, `PROBT`, `NDIF`, `DIFMEANS`, and `R`, `RSQ`.

BASE
is a numeric variable that contains the value of the statistic calculated from the values of the variable named by _VAR_ in the observations in the base data set with matching observations in the comparison data set.

COMP
is a numeric variable that contains the value of the statistic calculated from the values of the variable named by the _VAR_ variable (or by the _WITH_ variable if you use the WITH statement) in the observations in the comparison data set with matching observations in the base data set.

DIF
is a numeric variable that contains the value of the statistic calculated from the differences of the values of the variable named by the _VAR_ variable in the base data set and the matching variable (named by the _VAR_ or _WITH_ variable) in the comparison data set.

PCTDIF
is a numeric variable that contains the value of the statistic calculated from the percent differences of the values of the variable named by the _VAR_ variable in the base data set and the matching variable (named by the _VAR_ or _WITH_ variable) in the comparison data set.

Note: For both types of output data sets, PROC COMPARE assigns one of the following data set labels:

```
Comparison of base-SAS-data-set
with comparison-SAS-data-set

Comparison of variables in base-SAS-data-set
```

Labels are limited to 40 characters.

See "Example 7: Creating an Output Data Set of Statistics (OUTSTATS=)" on page 486 for an example of an OUTSTATS= data set.

Examples: COMPARE Procedure

Example 1: Producing a Complete Report of the Differences

Features: PROC COMPARE statement options
BASE=
PRINTALL
COMPARE=

Data set: Proclib.One, Proclib.Two

Details

This example shows the most complete report that PROC COMPARE produces as procedure output.

Program

```
libname proclib 'SAS-library';

options nodate pageno=1 linesize=80 pagesize=40;

proc compare base=proclib.one compare=proclib.two printall;
   title 'Comparing Two Data Sets: Full Report';
run;
```

Program Description

Declare the PROCLIB SAS library.

```
libname proclib 'SAS-library';
```

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Create a complete report of the differences between two data sets. BASE= and COMPARE= specify the data sets to compare. PRINTALL prints a full report of the differences.

```
proc compare base=proclib.one compare=proclib.two printall;
   title 'Comparing Two Data Sets: Full Report';
run;
```

Output: HTML

A > in the output marks information that is in the full report but not in the default report. The additional information includes a listing of variables found in one data set but not the other, a listing of observations found in one data set but not the other, a listing of variables with all equal values, and summary statistics. For an explanation of the statistics, see “Table of Summary Statistics” on page 456.

Output 13.10 *Part One of Comparing Two Data Sets: Full Report*

Comparing Two Data Sets: Full Report

```
                        The COMPARE Procedure
                    Comparison of WORK.ONE with WORK.TWO
                              (Method=EXACT)

                           Data Set Summary

Dataset            Created          Modified  NVar    NObs  Label

WORK.ONE   16MAR11:17:52:15  16MAR11:17:52:15     5       4  First Data Set
WORK.TWO   16MAR11:17:52:15  16MAR11:17:52:15     6       5  Second Data Set


                           Variables Summary

              Number of Variables in Common: 5.
              Number of Variables in WORK.TWO but not in WORK.ONE: 1.
              Number of Variables with Conflicting Types: 1.
              Number of Variables with Differing Attributes: 3.
```

```
            Listing of Variables in WORK.TWO but not in WORK.ONE

                          Variable  Type  Length

                          major     Char       8


             Listing of Common Variables with Conflicting Types

                     Variable  Dataset   Type  Length

                     student   WORK.ONE  Num        8
                               WORK.TWO  Char       8
```

Output 13.11 *Part Two of Comparing Two Data Sets: Full Report*

Comparing Two Data Sets: Full Report

```
                        The COMPARE Procedure
                  Comparison of WORK.ONE with WORK.TWO
                             (Method=EXACT)

          Listing of Common Variables with Differing Attributes

        Variable  Dataset   Type  Length  Format  Label

        year      WORK.ONE  Char       8          Year of Birth
                  WORK.TWO  Char       8
        state     WORK.ONE  Char       8
                  WORK.TWO  Char       8          Home State
        gr1       WORK.ONE  Num        8  4.1
                  WORK.TWO  Num        8  5.2
```

```
                  Comparison Results for Observations

      Observation 5 in WORK.TWO not found in WORK.ONE.
```

```
                       Observation Summary

                   Observation      Base  Compare

                   First Obs           1        1
                   First Unequal       1        1
                   Last  Unequal       4        4
                   Last  Match         4        4
                   Last  Obs           .        5

      Number of Observations in Common: 4.
      Number of Observations in WORK.TWO but not in WORK.ONE: 1.
      Total Number of Observations Read from WORK.ONE: 4.
      Total Number of Observations Read from WORK.TWO: 5.

      Number of Observations with Some Compared Variables Unequal: 4.
      Number of Observations with All Compared Variables Equal: 0.
```

Output 13.12 *Part Three of Comparing Two Data Sets: Full Report*

Comparing Two Data Sets: Full Report

```
                        The COMPARE Procedure
                  Comparison of WORK.ONE with WORK.TWO
                             (Method=EXACT)

                      Values Comparison Summary

Number of Variables Compared with All Observations Equal: 1.
Number of Variables Compared with Some Observations Unequal: 3.
Total Number of Values which Compare Unequal: 6.
Maximum Difference: 20.


                   Variables with All Equal Values

               Variable  Type  Len   Label

               year      CHAR    8   Year of Birth

                   Variables with Unequal Values

         Variable  Type  Len   Compare Label  Ndif   MaxDif

         state     CHAR    8   Home State        2
         gr1       NUM     8                     2    1.000
         gr2       NUM     8                     2   20.000
```

Output 13.13 *Part Four of Comparing Two Data Sets: Full Report*

Comparing Two Data Sets: Full Report

The COMPARE Procedure
Comparison of WORK.ONE with WORK.TWO
(Method=EXACT)

Value Comparison Results for Variables

Obs	Year of Birth Base Value year	Compare Value year
1	1970	1970
2	1971	1971
3	1969	1969
4	1970	1970

Obs	Home State Base Value state	Compare Value state
1	NC	NC
2	MD	MA
3	PA	PA
4	MA	MD

Output 13.14 *Part Five of Comparing Two Data Sets: Full Report*

Comparing Two Data Sets: Full Report

The COMPARE Procedure
Comparison of WORK.ONE with WORK.TWO
(Method=EXACT)

Value Comparison Results for Variables

Obs	Base gr1	Compare gr1	Diff.	% Diff
1	85.0	84.00	-1.0000	-1.1765
2	92.0	92.00	0	0
3	78.0	79.00	1.0000	1.2821
4	87.0	87.00	0	0
N	4	4	4	4
Mean	85.5000	85.5000	0	0.0264
Std	5.8023	5.4467	0.8165	1.0042
Max	92.0000	92.0000	1.0000	1.2821
Min	78.0000	79.0000	-1.0000	-1.1765
StdErr	2.9011	2.7234	0.4082	0.5021
t	29.4711	31.3951	0.0000	0.0526
Prob>|t|	<.0001	<.0001	1.0000	0.9614
Ndif	2	50.000%		
DifMeans	0.000%	0.000%	0	
r, rsq	0.991	0.983		

Output 13.15 *Part Six of Comparing Two Data Sets: Full Report*

Comparing Two Data Sets: Full Report

The COMPARE Procedure
Comparison of WORK.ONE with WORK.TWO
(Method=EXACT)

Value Comparison Results for Variables

Obs	Base gr2	Compare gr2	Diff.	% Diff
1	87.0000	87.0000	0	0
2	92.0000	92.0000	0	0
3	72.0000	73.0000	1.0000	1.3889
4	94.0000	74.0000	-20.0000	-21.2766
N	4	4	4	4
Mean	86.2500	81.5000	-4.7500	-4.9719
Std	9.9457	9.4692	10.1776	10.8895
Max	94.0000	92.0000	1.0000	1.3889
Min	72.0000	73.0000	-20.0000	-21.2766
StdErr	4.9728	4.7346	5.0888	5.4447
t	17.3442	17.2136	-0.9334	-0.9132
Prob>|t|	0.0004	0.0004	0.4195	0.4285
Ndif	2	50.000%		
DifMeans	-5.507%	-5.828%	-4.7500	
r, rsq	0.451	0.204		

Example 2: Comparing Variables in Different Data Sets

Features: PROC COMPARE statement option NOSUMMARY
VAR statement
WITH statement

Data set: Proclib.One, Proclib.Two

Details

This example compares a variable from the base data set with a variable in the comparison data set. All summary reports are suppressed.

Program

```
libname proclib 'SAS-library';

options nodate pageno=1 linesize=80 pagesize=40;

proc compare base=proclib.one compare=proclib.two nosummary;

   var gr1;
   with gr2;
   title 'Comparison of Variables in Different Data Sets';
run;
```

Program Description

Declare the PROCLIB SAS library.

```
libname proclib 'SAS-library';
```

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Suppress all summary reports of the differences between two data sets. BASE= specifies the base data set and COMPARE= specifies the comparison data set. NOSUMMARY suppresses all summary reports.

```
proc compare base=proclib.one compare=proclib.two nosummary;
```

Specify one variable from the base data set to compare with one variable from the comparison data set. The VAR and WITH statements specify the variables to compare. This example compares GR1 from the base data set with GR2 from the comparison data set.

```
   var gr1;
   with gr2;
   title 'Comparison of Variables in Different Data Sets';
run;
```

Output: HTML

Output 13.16 *Comparison of Variables in Different Data Sets*

Comparison of Variables in Different Data Sets

```
                        The COMPARE Procedure
                    Comparison of WORK.ONE with WORK.TWO
                              (Method=EXACT)

NOTE: Data set WORK.TWO contains 1 observations not in WORK.ONE.
NOTE: Values of the following 1 variables compare unequal: gr1^=gr2
```

Value Comparison Results for Variables

Obs	Base gr1	Compare gr2	Diff.	% Diff
1	85.0	87.0000	2.0000	2.3529
3	78.0	73.0000	-5.0000	-6.4103
4	87.0	74.0000	-13.0000	-14.9425

Example 3: Comparing a Variable Multiple Times

Features: VAR statement
WITH statement

Data set: Proclib.One, Proclib.Two

Details

This example compares one variable from the base data set with two variables in the comparison data set.

Program

```
libname proclib 'SAS-library';
options nodate pageno=1 linesize=80 pagesize=40;
```

```
proc compare base=proclib.one compare=proclib.two nosummary;
   var gr1 gr1;
   with gr1 gr2;
   title 'Comparison of One Variable with Two Variables';
run;
```

Program Description

Declare the PROCLIB SAS library.

```
libname proclib 'SAS-library';
```

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Suppress all summary reports of the differences between two data sets. BASE= specifies the base data set and COMPARE= specifies the comparison data set. NOSUMMARY suppresses all summary reports.

```
proc compare base=proclib.one compare=proclib.two nosummary;
```

Specify one variable from the base data set to compare with two variables from the comparison data set. The VAR and WITH statements specify the variables to compare. This example compares GR1 from the base data set with GR1 and GR2 from the comparison data set.

```
   var gr1 gr1;
   with gr1 gr2;
   title 'Comparison of One Variable with Two Variables';
run;
```

Output: HTML

The Value Comparison Results section shows the result of the comparison.

Output 13.17 *Comparison of One Variable with Two Variables*

Comparison of One Variable with Two Variables

```
                        The COMPARE Procedure
                   Comparison of WORK.ONE with WORK.TWO
                              (Method=EXACT)

NOTE: Data set WORK.TWO contains 1 observations not in WORK.ONE.
NOTE: Values of the following 2 variables compare unequal: gr1^=gr1 gr1^=gr2
```

Value Comparison Results for Variables

Obs	Base gr1	Compare gr1	Diff.	% Diff
1	85.0	84.00	-1.0000	-1.1765
3	78.0	79.00	1.0000	1.2821

Obs	Base gr1	Compare gr2	Diff.	% Diff
1	85.0	87.0000	2.0000	2.3529
3	78.0	73.0000	-5.0000	-6.4103
4	87.0	74.0000	-13.0000	-14.9425

Example 4: Comparing Variables That Are in the Same Data Set

Features: PROC COMPARE statement options
- ALLSTATS
- BRIEFSUMMARY

VAR statement

WITH statement

Data set: Proclib.One

Details

This example shows that PROC COMPARE can compare two variables that are in the same data set.

Program

```
libname proclib 'SAS-library';

options nodate pageno=1 linesize=80 pagesize=40;

proc compare base=proclib.one allstats briefsummary;

   var gr1;
   with gr2;
   title 'Comparison of Variables in the Same Data Set';
run;
```

Program Description

Declare the Proclib SAS library.

```
libname proclib 'SAS-library';
```

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Create a short summary report of the differences within one data set. ALLSTATS prints summary statistics. BRIEFSUMMARY prints only a short comparison summary.

```
proc compare base=proclib.one allstats briefsummary;
```

Specify two variables from the base data set to compare. The VAR and WITH statements specify the variables in the base data set to compare. This example compares GR1 with GR2. Because there is no comparison data set, the variables GR1 and GR2 must be in the base data set.

```
   var gr1;
   with gr2;
   title 'Comparison of Variables in the Same Data Set';
run;
```

Output: HTML

Output 13.18 *Comparison of One Variable with Two Variables*

Comparison of One Variable with Two Variables

```
                        The COMPARE Procedure
                    Comparisons of variables in WORK.ONE
                              (Method=EXACT)

NOTE: Values of the following 1 variables compare unequal: gr1^=gr2
```

Value Comparison Results for Variables

Obs	Base gr1	Compare gr2	Diff.	% Diff
1	85.0	87.0000	2.0000	2.3529
3	78.0	72.0000	-6.0000	-7.6923
4	87.0	94.0000	7.0000	8.0460
N	4	4	4	4
Mean	85.5000	86.2500	0.7500	0.6767
Std	5.8023	9.9457	5.3774	6.5221
Max	92.0000	94.0000	7.0000	8.0460
Min	78.0000	72.0000	-6.0000	-7.6923
StdErr	2.9011	4.9728	2.6887	3.2611
t	29.4711	17.3442	0.2789	0.2075
Prob>|t|	<.0001	0.0004	0.7984	0.8489
Ndif	3	75.000%		
DifMeans	0.877%	0.870%	0.7500	
r, rsq	0.898	0.807		

Example 5: Comparing Observations with an ID Variable

Features: ID statement

Data sets: Proclib.Emp95
Proclib.Emp96

Details

In this example, PROC COMPARE compares only the observations that have matching values for the ID variable.

Program

```
libname proclib 'SAS-library';

options nodate pageno=1 linesize=80 pagesize=40;

data proclib.emp95;
   input #1 idnum $4. @6 name $15.
         #2 address $42.
         #3 salary 6.;
   datalines;
2388 James Schmidt
100 Apt. C Blount St. SW Raleigh NC 27693
92100
2457 Fred Williams
99 West Lane  Garner NC 27509
33190
... more data lines...
3888 Kim Siu
5662 Magnolia Blvd Southeast Cary NC 27513
77558
;

data proclib.emp96;
   input #1 idnum $4. @6 name $15.
         #2 address $42.
         #3 salary 6.;
   datalines;
2388 James Schmidt
100 Apt. C Blount St. SW Raleigh NC 27693
92100
2457 Fred Williams
99 West Lane  Garner NC 27509
33190
...more data lines...
6544 Roger Monday
3004 Crepe Myrtle Court Raleigh NC 27604
47007
;

proc sort data=proclib.emp95 out=emp95_byidnum;

 by idnum;
run;

proc sort data=proclib.emp96 out=emp96_byidnum;
```

```
   by idnum;
run;

proc compare base=emp95_byidnum compare=emp96_byidnum;
   id idnum;
   title 'Comparing Observations that Have Matching IDNUMs';
run;
```

Program Description

Declare the PROCLIB SAS library.

```
libname proclib 'SAS-library';
```

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Create the Proclib.Emp95 and Proclib.Emp96 data sets. Proclib.Emp95 and Proclib.Emp96 contain employee data. IDNUM works well as an ID variable because it has unique values. The first DATA step creates Proclib.Emp95. The second DATA step creates Proclib.Emp96.

```
data proclib.emp95;
   input #1 idnum $4. @6 name $15.
         #2 address $42.
         #3 salary 6.;
   datalines;
2388 James Schmidt
100 Apt. C Blount St. SW Raleigh NC 27693
92100
2457 Fred Williams
99 West Lane  Garner NC 27509
33190
... more data lines...
3888 Kim Siu
5662 Magnolia Blvd Southeast Cary NC 27513
77558
;

data proclib.emp96;
   input #1 idnum $4. @6 name $15.
         #2 address $42.
         #3 salary 6.;
   datalines;
2388 James Schmidt
100 Apt. C Blount St. SW Raleigh NC 27693
92100
2457 Fred Williams
99 West Lane  Garner NC 27509
33190
...more data lines...
6544 Roger Monday
```

```
3004 Crepe Myrtle Court Raleigh NC 27604
47007
;
```

Sort the data sets by the ID variable. Both data sets must be sorted by the variable that will be used as the ID variable in the PROC COMPARE step. OUT= specifies the location of the sorted data.

```
proc sort data=proclib.emp95 out=emp95_byidnum;

 by idnum;
run;

proc sort data=proclib.emp96 out=emp96_byidnum;
   by idnum;
run;
```

Create a summary report that compares observations with matching values for the ID variable. The ID statement specifies IDNUM as the ID variable.

```
proc compare base=emp95_byidnum compare=emp96_byidnum;
   id idnum;
   title 'Comparing Observations that Have Matching IDNUMs';
run;
```

Output: HTML

PROC COMPARE identifies specific observations by the value of IDNUM. In the `Value Comparison Results for Variables` section, PROC COMPARE prints the nonmatching addresses and nonmatching salaries. For salaries, PROC COMPARE computes the numerical difference and the percent difference. Because ADDRESS is a character variable, PROC COMPARE displays only the first 20 characters. For addresses where the observation has an IDNUM of `0987`, `2776`, or `3888`, the differences occur after the 20th character and the differences do not appear in the output. The plus sign in the output indicates that the full value is not shown. To see the entire value, create an output data set. See "Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)" on page 482.

Output 13.19 *Part One of Comparing Observations That Have Matching IDNUMs*

Comparing Observations that Have Matching IDNUMs

```
                        The COMPARE Procedure
          Comparison of WORK.EMP95_BYIDNUM with WORK.EMP96_BYIDNUM
                                (Method=EXACT)

                             Data Set Summary

Dataset                       Created          Modified  NVar    NObs

WORK.EMP95_BYIDNUM   17MAR11:08:58:10  17MAR11:08:58:10     4      10
WORK.EMP96_BYIDNUM   17MAR11:08:58:10  17MAR11:08:58:10     4      12


                             Variables Summary

                    Number of Variables in Common: 4.
                    Number of ID Variables: 1.
```

```
                             Observation Summary

                  Observation      Base  Compare  ID

                  First Obs           1        1  idnum=0987
                  First Unequal       1        1  idnum=0987
                  Last  Unequal      10       12  idnum=9857
                  Last  Obs          10       12  idnum=9857

Number of Observations in Common: 10.
Number of Observations in WORK.EMP96_BYIDNUM but not in WORK.EMP95_BYIDNUM: 2.
Total Number of Observations Read from WORK.EMP95_BYIDNUM: 10.
Total Number of Observations Read from WORK.EMP96_BYIDNUM: 12.

Number of Observations with Some Compared Variables Unequal: 5.
Number of Observations with All Compared Variables Equal: 5.
```

Output 13.20 *Part Two of Comparing Observations That Have Matching IDNUMs*

Comparing Observations that Have Matching IDNUMs

```
                    The COMPARE Procedure
      Comparison of WORK.EMP95_BYIDNUM with WORK.EMP96_BYIDNUM
                          (Method=EXACT)

                    Values Comparison Summary

Number of Variables Compared with All Observations Equal: 1.
Number of Variables Compared with Some Observations Unequal: 2.
Total Number of Values which Compare Unequal: 8.
Maximum Difference: 2400.


                  Variables with Unequal Values

              Variable  Type  Len  Ndif   MaxDif

              address   CHAR   42     4
              salary    NUM     8     4     2400
```

```
           Value Comparison Results for Variables

_____________________________________________________
       ||  Base Value           Compare Value
idnum  ||  address                address
_____  ||  ___________________+  ___________________+
       ||
0987   ||  2344 Persimmons Bran  2344 Persimmons Bran
2776   ||  12988 Wellington Far  12988 Wellington Far
3888   ||  5662 Magnolia Blvd S  5662 Magnolia Blvd S
9857   ||  1000 Taft Ave. Morri  100 Taft Ave. Morris
_____________________________________________________
```

Output 13.21 Part Three of Comparing Observations That Have Matching IDNUMs

Comparing Observations that Have Matching IDNUMs

```
                        The COMPARE Procedure
       Comparison of WORK.EMP95_BYIDNUM with WORK.EMP96_BYIDNUM
                           (Method=EXACT)

                 Value Comparison Results for Variables

       _______________________________________________________
                ||       Base    Compare
        idnum   ||     salary     salary      Diff.     % Diff
        _____   ||  _________  _________  _________  _________
                ||
        0987    ||      44010      45110       1100     2.4994
        3286    ||      87734      89834       2100     2.3936
        3888    ||      77558      79958       2400     3.0945
        9857    ||      38756      40456       1700     4.3864
       _______________________________________________________
```

Example 6: Comparing Values of Observations Using an Output Data Set (OUT=)

Features: PROC COMPARE statement options
- NOPRINT
- OUT=
- OUTBASE
- OUTCOMP
- OUTDIF
- OUTNOEQUAL

PRINT procedure

Data sets: Proclib.Emp95
Proclib.Emp96

Details

This example creates and prints an output data set that shows the differences between matching observations.

In "Example 5: Comparing Observations with an ID Variable" on page 476, the output does not show the differences past the 20th character. The output data set in this example shows the full values. Further, it shows the observations that occur in only one of the data sets.

Program

```
libname proclib 'SAS-library';

options nodate pageno=1 linesize=120 pagesize=40;

proc sort data=proclib.emp95 out=emp95_byidnum;

 by idnum;
run;

proc sort data=proclib.emp96 out=emp96_byidnum;
   by idnum;
run;

proc compare base=emp95_byidnum compare=emp96_byidnum

             out=result outnoequal outbase outcomp outdif
     noprint;

   id idnum;
run;

proc print data=result noobs;
   by idnum;
   id idnum;
   title 'The Output Data Set RESULT';
run;
```

Program Description

Declare the PROCLIB SAS library.

```
libname proclib 'SAS-library';
```

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=120 pagesize=40;
```

Sort the data sets by the ID variable. Both data sets must be sorted by the variable that will be used as the ID variable in the PROC COMPARE step. OUT= specifies the location of the sorted data.

```
proc sort data=proclib.emp95 out=emp95_byidnum;

 by idnum;
run;

proc sort data=proclib.emp96 out=emp96_byidnum;
   by idnum;
run;
```

Specify the data sets to compare. BASE= and COMPARE= specify the data sets to compare.

```
proc compare base=emp95_byidnum compare=emp96_byidnum
```

Create the Result output data set and include all unequal observations and their differences. OUT= names and creates the output data set. NOPRINT suppresses the printing of the procedure output. OUTNOEQUAL includes only observations that are judged unequal. OUTBASE writes an observation to the output data set for each observation in the base data set. OUTCOMP writes an observation to the output data set for each observation in the comparison data set. OUTDIF writes an observation to the output data set that contains the differences between the two observations.

```
                out=result outnoequal outbase outcomp outdif
      noprint;
```

Specify the ID variable. The ID statement specifies IDNUM as the ID variable.

```
   id idnum;
run;
```

Print the Result output data set and use the BY and ID statements with the ID variable. PROC PRINT prints the output data set. Using the BY and ID statements with the same variable makes the output easy to read. See the PRINT procedure for more information about this technique.

```
proc print data=result noobs;
   by idnum;
   id idnum;
   title 'The Output Data Set RESULT';
run;
```

Output: HTML

The differences for character variables are noted with an X or a period (.). An X shows that the characters do not match. A period shows that the characters do match. For numeric variables, an E means that there is no difference. Otherwise, the numeric difference is shown. By default, the output data set shows that two observations in the comparison data set have no matching observation in the base data set. You do not have to use an option to make those observations appear in the output data set.

Output 13.22 *Part One of the Output Data Set RESULT*

The Output Data Set RESULT

idnum	_TYPE_	_OBS_	name	address	salary
0987	BASE	1	Dolly Lunford	2344 Persimmons Branch Apex NC 27505	44010
	COMPARE	1	Dolly Lunford	2344 Persimmons Branch Trail Apex NC 27505	45110
	DIF	1	.....	.....XXXXX.XXXXXXXXXXXXX	1100

idnum	_TYPE_	_OBS_	name	address	salary
2776	BASE	5	Robert Jones	12988 Wellington Farms Ave. Cary NC 27512	29025
	COMPARE	5	Robert Jones	12988 Wellington Farms Ave. Cary NC 27511	29025
	DIF	5	.....	.....X.	E

idnum	_TYPE_	_OBS_	name	address	salary
3278	COMPARE	6	Mary Cravens	211 N. Cypress St. Cary NC 27512	35362

idnum	_TYPE_	_OBS_	name	address	salary
3286	BASE	6	Hoa Nguyen	2818 Long St. Cary NC 27513	87734
	COMPARE	7	Hoa Nguyen	2818 Long St. Cary NC 27513	89834
	DIF	6	.....	.....	2100

Output 13.23 *Part Two of the Output Data Set RESULT*

idnum	_TYPE_	_OBS_	name	address	salary
3888	BASE	7	Kim Siu	5662 Magnolia Blvd Southeast Cary NC 27513	77558
	COMPARE	8	Kim Siu	5662 Magnolia Blvd Southwest Cary NC 27513	79958
	DIF	7	.....	.....XX.....	2400

idnum	_TYPE_	_OBS_	name	address	salary
6544	COMPARE	9	Roger Monday	3004 Crepe Myrtle Court Raleigh NC 27604	47007

idnum	_TYPE_	_OBS_	name	address	salary
9857	BASE	10	Kathy Krupski	1000 Taft Ave. Morrisville NC 27508	38756
	COMPARE	12	Kathy Krupski	100 Taft Ave. Morrisville NC 27508	40456
	DIF	10	.....	...XXXXXXXXXXXXX.XXXXX.XXXXXXXXXX.....	1700

Example 7: Creating an Output Data Set of Statistics (OUTSTATS=)

Features: PROC COMPARE statement options
NOPRINT
OUTSTATS=

Data sets: Proclib.Emp95
Proclib.Emp96

Details

This example creates an output data set that contains summary statistics for the numeric variables that are compared.

Program

```
libname proclib 'SAS-library';

options nodate pageno=1 linesize=80 pagesize=40;

proc sort data=proclib.emp95 out=emp95_byidnum;
   by idnum;
run;

proc sort data=proclib.emp96 out=emp96_byidnum;
   by idnum;
run;

proc compare base=emp95_byidnum compare=emp96_byidnum
             outstats=diffstat noprint;
   id idnum;
run;

proc print data=diffstat noobs;
   title 'The DIFFSTAT Data Set';
run;
```

Program Description

Declare the Proclib SAS library.

```
libname proclib 'SAS-library';
```

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Sort the data sets by the ID variable. Both data sets must be sorted by the variable that will be used as the ID variable in the PROC COMPARE step. OUT= specifies the location of the sorted data.

```
proc sort data=proclib.emp95 out=emp95_byidnum;
   by idnum;
run;

proc sort data=proclib.emp96 out=emp96_byidnum;
   by idnum;
run;
```

Create the output data set of statistics and compare observations that have matching values for the ID variable. BASE= and COMPARE= specify the data sets to compare. OUTSTATS= creates the output data set Diffstat.Noprint and suppresses the procedure output. The ID statement specifies IDNUM as the ID variable. PROC COMPARE uses the values of IDNUM to match observations.

```
proc compare base=emp95_byidnum compare=emp96_byidnum
             outstats=diffstat noprint;
   id idnum;
run;
```

Print the output data set Diffstat. PROC PRINT prints the output data set Diffstat.

```
proc print data=diffstat noobs;
   title 'The DIFFSTAT Data Set';
run;
```

Output: HTML

The variables are described in "Output Statistics Data Set (OUTSTATS=)" on page 462.

Output 13.24 *The Diffstat Data Set*

The DIFFSTAT Data Set

VAR	_TYPE_	_BASE_	_COMP_	_DIF_	_PCTDIF_
salary	N	10.00	10.00	10.00	10.0000
salary	MEAN	52359.00	53089.00	730.00	1.2374
salary	STD	24143.84	24631.01	996.72	1.6826
salary	MAX	92100.00	92100.00	2400.00	4.3864
salary	MIN	29025.00	29025.00	0.00	0.0000
salary	STDERR	7634.95	7789.01	315.19	0.5321
salary	T	6.86	6.82	2.32	2.3255
salary	PROBT	0.00	0.00	0.05	0.0451
salary	NDIF	4.00	40.00	.	.
salary	DIFMEANS	1.39	1.38	730.00	.
salary	R,RSQ	1.00	1.00	.	.

14

CONTENTS Procedure

Overview: CONTENTS Procedure

What Does the CONTENTS Procedure Do?

The CONTENTS procedure shows the contents of a SAS data set and prints the directory of the SAS library.

Generally, the CONTENTS procedure functions the same as the CONTENTS statement in the DATASETS procedure. The differences between the CONTENTS procedure and the CONTENTS statement in PROC DATASETS are as follows:

- The default for *libref* in the DATA= option in PROC CONTENTS is Work. For the CONTENTS statement, the default is the libref of the procedure input library.

- PROC CONTENTS can read sequential files. The CONTENTS statement cannot.

Concepts: CONTENTS Procedure

Concepts: CONTENTS Procedure

See Concepts for the CONTENTS Statement on page 603.

PROC CONTENTS reports metadata about the table and the metadata about the variables. The CAS engine is the only engine supporting VARCHAR. If there is a VARCHAR data type in the table, PROC CONTENTS shows the Length in bytes and characters as well as maximum bytes used.

Just like with Base engine data sets, the top portion of PROC CONTENTS reports the information about the table. The Encoding shows the encoding of the CAS table. The same for the Data Representation.

The bottom portion of PROC CONTENTS (related to the variable metadata reports) is the metadata that is represented in the SAS session. Based on what type of transcoding that might or might not be needed to go from the CAS UTF–8 encoding to the SAS session encoding, The variable byte length used in the SAS session may differ from the byte length in the CAS table depending on the encoding of the SAS session.

Output 14.1 *Output of Mycas.French2 with VARCHAR*

Data Set Name	MYCAS.FRENCH2	Observations	11
Member Type	DATA	Variables	2
Engine	CAS	Indexes	0
Created	08/16/2017 18:05:10	Observation Length	40
Last Modified	08/16/2017 18:05:10	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information	
Data Limit	100MB
Caslib	CASUSER,
Scope	Session

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len		Max Bytes Used
			Bytes	Chars	
1	nterm	Varchar	80	20	19
2	term	Char	19		

The following PROC CONTENTS shows the output from the Hadoop engine.

Output 14.2 *PROC CONTENTS for the Hadoop Engine*

The CONTENTS Procedure

Data Set Name	X.CLASS	Observations	.
Member Type	DATA	Variables	5
Engine	HADOOP	Indexes	0
Created	.	Observation Length	0
Last Modified	.	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	Default		
Encoding	Default		

Engine/Host Dependent Information	
Table Type	MANAGED_TABLE
Location	hdfs://hdp26p1/apps/hive/warehouse/accesstesting.db/class
SerDe Library	org.apache.hadoop.hive.serde2.lazy.LazySimpleSerDe
Input Format	org.apache.hadoop.mapred.TextInputFormat
Output Format	org.apache.hadoop.hive.ql.io.HiveIgnoreKeyTextOutputFormat

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat	Label
3	age	Num	8			age
4	height	Num	8			height
1	name	Char	8	$8.	$8.	name
2	sex	Char	1	$1.	$1.	sex
5	weight	Num	8			weight

CAUTION

Do not confuse the GENNUM variable value in CONTENTS' OUT= data set with the GEN variable value from DICTIONARY tables. GENNUM from a CONTENTS procedure or statement refers to a specific generation of a data set. GEN from DICTIONARY tables refers to the total number of generations for a data set. Each SAS procedure is designed and architected to deliver specific information. The output from DICTIONARY.TABLES and PROC CONTENTS are not interchangeable.

Syntax: CONTENTS Procedure

Restrictions: You cannot use the WHERE option to affect the output because PROC CONTENTS does not process any observations.

When a SAS data file reaches the maximum observation count, SAS procedures that return an observation count (such as the PRINT procedure or the CONTENTS procedure) return a missing value, which is represented by a period (.), for the number of observations. For more information, see "Understanding the Observation Count in a SAS Data File" in *SAS Language Reference: Concepts*.

When using a SAS/ACCESS LIBNAME engine to access a database, some of the information that is available in the header of a SAS data set is not available. Procedures like CONTENTS and DATASETS don't query the system tables so indexes, integrity constraints, number of observations, and so on will not be displayed. For more information, see "Differences in the DATASETS Procedure Output When Using SAS/ACCESS LIBNAME Engines" on page 572.

Note: The ATTRIB statement does not affect the PROC CONTENTS output. PROC CONTENTS reports the labels, informats, and formats on the actual member.

Tips: Complete documentation for the CONTENTS procedure is in CONTENTS Statement on page 603. The links in the table below are to the DATASETS procedure documentation, which explains these options.

When using PROC CONTENTS, you can use data set options with the DATA=, OUT=, and OUT2= options.

The ORDER= option does not affect the order of the OUT= and OUT2= data sets.

See: CONTENTS Procedure under Windows, UNIX, z/OS

PROC CONTENTS <*options*>;

Statement	Task	Example
CONTENTS	List the contents of one or more SAS data sets and print the directory of the SAS library	Ex. 1, Ex. 2, Ex. 3, Ex. 4

PROC CONTENTS Statement

Describes the contents of one or more SAS data sets and prints the directory of the SAS library.

Restriction: You cannot use the WHERE option to affect the output because PROC CONTENTS does not process any observations.

Notes: The ATTRIB statement does not affect the CONTENTS statement output. CONTENTS reports the labels, informats, and formats on the actual member.

When using the CONTENTS statement with SAS/ACCESS LIBNAME engines, "Differences in the DATASETS Procedure Output When Using SAS/ACCESS LIBNAME Engines" on page 572.

Tip: You can use data set options with the DATA=, OUT=, and OUT2= options. You can use any global statements as well.

Example: "Example 1: Describing a SAS Data Set" on page 501.

Syntax

PROC CONTENTS<*options*>

Optional Arguments

CENTILES
prints centiles information for indexed variables.

The following additional fields are printed in the default report of PROC CONTENTS when the CENTILES option is selected and an index exists on the data set. Note that the additional fields depend on whether the index is simple or complex.

#	number of the index on the data set.
Index	name of the index.
Update Centiles	percentage of the data values that must be changed before the CENTILES for the indexed variables are automatically updated.
Current Update Percentage	percentage of index updated since CENTILES were refreshed.
# of Unique Values	number of unique indexed values.
Variables	names of the variables used to make up the index. Centile information is listed below the variables.

DATA=*SAS-file-specification*
specifies an entire library or a specific SAS data set within a library. *SAS-file-specification* can take one of the following forms:

<libref.>SAS-data-set
names one SAS data set to process. The default for libref is the libref of the procedure input library. For example, to obtain the contents of the SAS data set HtWt from the procedure input library, use the following CONTENTS statement:

```
contents data=HtWt;
```

To obtain the contents of a specific version from a generation group, use the GENNUM= data set option as shown in the following CONTENTS statement:

```
contents data=HtWt(gennum=3);
```

<*libref.*>_ALL_
gives you information about all SAS data sets that have the type or types specified by the MEMTYPE= option. *libref* refers to the SAS library. The default for libref is the libref of the procedure input library.

- If you are using the _ALL_ keyword, you need Read access to all read-protected SAS data sets in the SAS library.
- DATA=_ALL_ automatically prints a listing of the SAS files that are contained in the SAS library. Note that for SAS views, all librefs that are associated with the views must be assigned in the current session in order for them to be processed for the listing.

Default most recently created data set in your job or session, from any SAS library.

Tip If you specify a read-protected data set in the DATA= option but do not give the Read password, by default the procedure looks in the PROC DATASETS statement for the Read password. However, if you do not specify the DATA= option and the default data set (last one created in the session) is Read protected, the procedure does not look in the PROC DATASETS statement for the Read password.

Example "Example 5: Describing a SAS Data Set" on page 707

DETAILS | NODETAILS
includes information in the output about the number of observations, number of variables, number of indexes, and data set labels. DETAILS includes these additional columns of information in the output, but only if DIRECTORY is also specified.

Default If neither DETAILS nor NODETAILS is specified, the defaults are as follows: for the CONTENTS procedure, the default is the system option setting, which is NODETAILS; for the CONTENTS statement, the default is whatever is specified in the PROC DATASETS statement, which also defaults to the system option setting.

See a description of the additional columns in the Optional Argument section of PROC DATASETS Statement on page 579

DIRECTORY
prints a list of all SAS files in the specified SAS library. If DETAILS is also specified, using DIRECTORY causes the additional columns described in DETAILS | NODETAILS on page 495 to be printed.

ENCRYPTKEY=*key-value*
specifies the key value for AES encryption.

See "Appending AES-Encrypted Data Sets" on page 592

FMTLEN
prints the length of the informat or format. If you do not specify a length for the informat or format when you associate it with a variable, the length does not appear in the output of the CONTENTS statement unless you use the FMTLEN

option. The length also appears in the FORMATL or INFORML variable in the output data set.

MEMTYPE=(*member-type(s)*)
restricts processing to one or more member types. The CONTENTS statement produces output only for member types DATA, VIEW, and ALL, which includes DATA and VIEW.

MEMTYPE= in the CONTENTS statement differs from MEMTYPE= in most of the other statements in the DATASETS procedure in the following ways:

- A slash does not precede the option.
- You cannot enclose the MEMTYPE= option in parentheses to limit its effect to only the SAS file immediately preceding it.

MEMTYPE= results in a directory of the library in which the DATA= member is located. However, MEMTYPE= does not limit the types of members whose contents are displayed unless the _ALL_ keyword is used in the DATA= option. For example, the following statements produce the contents of only the SAS data sets with the member type DATA:

```
proc datasets memtype=data;
   contents data=_all_;
run;
```

Aliases MTYPE=

MT=

Default DATA

NODS
suppresses printing the contents of individual files when you specify _ALL_ in the DATA= option. The CONTENTS statement prints only the SAS library directory. You cannot use the NODS option when you specify only one SAS data set in the DATA= option.

NODETAILS
See “DETAILS|NODETAILS” on page 495.

NOPRINT
suppresses printing the output of the CONTENTS statement.

ORDER=COLLATE | CASECOLLATE | IGNORECASE | VARNUM

COLLATE	prints a list of variables in alphabetical order beginning with uppercase and then lowercase names.
CASECOLLATE	prints a list of variables in alphabetical order even if they include mixed-case names and numerics.
IGNORECASE	prints a list of variables in alphabetical order ignoring the case of the letters.
VARNUM	is the same as the VARNUM option.

Note The ORDER= option does not affect the order of the OUT= and OUT2= data sets.

See "VARNUM" on page 497

Example See "Example 4: Using the ORDER= Option" on page 515 to compare the default and the four options for ORDER=.

OUT=*SAS-data-set*
names an output SAS data set.

Tip OUT= does not suppress the printed output from the statement. If you want to suppress the printed output, you must use the NOPRINT option.

See "The OUT= Data Set" on page 683 for a description of the variables in the OUT= data set.

OUT2=*SAS-data-set*
names the output data set to contain information about indexes and integrity constraints.

Note When you use the OUT2=*PermanentLibrary*_ALL_ option within PROC CONTENTS or PROC DATASETS with the CONTENTS statement, you must also set the REPLACE=YES data set option or the REPLACE system option.

Tips If UPDATECENTILES was not specified in the index definition, then the default value of 5 is used in the re-create variable of the OUT2 data set.

OUT2= does not suppress the printed output from the statement. To suppress the printed output, use the NOPRINT option.

See "The OUT2= Data Set" on page 689 for a description of the variables in the OUT2= data set.

SHORT
prints only the list of variable names, the index information, and the sort information for the SAS data set.

Restriction If the list of variables is more than 32,767 characters, the list is truncated and a WARNING is written to the SAS log. To get a complete list of the variables, request an alphabetical listing of the variables.

VARNUM
prints a list of the variable names in the order of their logical position in the data set. By default, the CONTENTS statement lists the variables alphabetically. The physical position of the variable in the data set is engine-dependent.

Details

Using the CONTENTS Procedure Instead of the CONTENTS Statement

The only difference between the CONTENTS procedure and the CONTENTS statement in PROC DATASETS is the default for libref in the DATA= option. For PROC CONTENTS, the default is Work. For the CONTENTS statement, the default is the libref of the procedure input library.

Printing Variables

The CONTENTS statement prints an alphabetical listing of the variables by default, except for variables in the form of a numbered range list. Numbered range lists, such as x1–x100, are printed in incrementing order, that is, x1–x100. For more information, see "Alphabetic List of Variables and Attributes" on page 678.

Note: If a label is changed after a view is created from a data set with variable labels, the CONTENTS or DATASETS procedure output shows the original labels. The view must be recompiled in order for the CONTENTS or DATASETS procedure output to reflect the new variable labels.

Displaying the ICU Revision Number

The CONTENTS statement prints the International Components for Unicode (ICU) revision number when you use the SORT procedure for a linguistic sort on a data set. For more information about linguistic sorting, see Chapter 64, "SORT Procedure," on page 2355.

Library Contents and AES Encryption

When requesting the contents of all data files in a library, use the _ALL_ option. If the library contains data files that are AES -encrypted, the ENCRYPTKEY= data set option must be used to access the data files. Here is an example using the ENCRYPTKEY= option:

```
proc contents data=MyLib._all_ (encryptkey=key-value);
run;
```

If the key value does not match the key value for a particular data file in the library, then you will be prompted to enter the correct key value.

For more information about AES encryption, see "AES Encryption" in *SAS Programmer's Guide: Essentials*. For more information about the ENCRYPTKEY= data set option, see "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*.

Observation Length, Alignment, and Padding for a SAS Data Set

There are three different cases for alignment.

- Observations within a SAS data set are aligned on double-byte boundaries whenever possible. As a result, 8-byte and 4-byte numeric variables are positioned at 8-byte boundaries at the front of the data set. They are followed by character variables in the order in which they are encountered. If the data set contains only 4-byte numeric data, the alignment is based on 4-byte boundaries. Since numeric doubles can be operated upon directly rather than being moved and aligned before doing comparisons or increments, the boundaries cause better performance.

  Since there are many observations contained within a given disk data page buffer, there might be padding between observations. The padding is to let each observation be aligned on a double-byte boundary. See the following example:

```
data a;
   length aa 7 bb 6 cc $10 dd 8 ee 3;
   aa = 1;
   bb = 2;
   cc = 'abc';
   dd = 3;
   ee = 4;
   ff = 5;
   output;
run;

proc contents data=a out=a1;
run;

proc print data=a1(keep=name length varnum npos);
run;
```

Figure 14.1 *Observation Length*

The CONTENTS Procedure

Data Set Name	WORK.A	**Observations**	1
Member Type	DATA	**Variables**	6
Engine	V9	**Indexes**	0
Created	08/16/2016 12:08:25	**Observation Length**	48
Last Modified	08/16/2016 12:08:25	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	WINDOWS_64		
Encoding	wlatin1 Western (Windows)		

PROC CONTENTS shows an observation length of 48. PROC PRINT displays the internal layout of the variables within the observation where NPOS is the zero-based offset for each variable.

Figure 14.2 *Observation and Variable Boundaries*

Obs	NAME	LENGTH	VARNUM	NPOS
1	aa	7	1	16
2	bb	6	2	23
3	cc	10	3	32
4	dd	8	4	0
5	ee	3	5	29
6	ff	8	6	8

Variables DD and FF, the only true numeric doubles, are at offsets 0 and 8, respectively, so they are automatically aligned. The rest of the observation contains the remaining numeric variables and then character variables.

The last physical variable in this layout is CC with an offset of 32 and a length of 10. This gives you an internal length of 42, even though PROC CONTENTS reports the observation length as 48. The difference is the 6 bytes of padding so that the next observation is aligned on a double-byte boundary within the disk page buffer.

- No alignment is done when the observation does not contain 8-byte numeric variables as demonstrated in the next example, which gives you an observation length of 7 and no padding between observations within disk page buffers:

```
data b;
   length aa 6 cc $1;
   aa = 1;
   cc = 'x';
   output;
run;

proc contents data=b out=b1;
run;

proc print data=b1(keep=name length varnum npos);
run;
```

Figure 14.3 *Variables and Attributes*

Obs	NAME	LENGTH	VARNUM	NPOS
1	aa	6	1	0
2	cc	1	2	6

- Observations for compressed data sets are not aligned within the disk page buffer, but the same algorithm is used for positioning the variables within the observations. Compressed observations must be uncompressed and moved into a work buffer. The 8-byte numeric values will be aligned and ready for use immediately after uncompressing. The observation length in the PROC CONTENTS output might be larger due to operating system-specific overhead.

Usage: CONTENTS Procedure

Using PROC CONTENTS

For information on using PROC CONTENTS with SAS data sets, see "CONTENTS Statement" on page 603.

For more information, see Chapter 5, "CAS Processing of Base Procedures," on page 93.

Examples: CONTENTS Procedure

Example 1: Describing a SAS Data Set

Features: PROC CONTENTS statement options
DATA=
OUT=
OPTIONS statement
TITLE statement

Details

This example shows the output from the CONTENTS procedure for the Group data set. The output shows the modifications made to the Group data set in "Example 4: Modifying SAS Data Sets" on page 704 and the contents of the Grpout data set.

Program

```
options pagesize=40 linesize=80 nodate pageno=1;

LIBNAME health 'SAS-library';

proc datasets library=health nolist;
run;

proc contents data=health.group (read=green) out=health.grpout;
   title  'The Contents of the GROUP Data Set';
run;

proc contents data=health.grpout;
   title  'The Contents of the GRPOUT Data Set';
run;
```

Program Description

Set the system options. The PAGESIZE= option specifies the number of lines that compose a page of the SAS log and SAS output. The LINESIZE= option specifies the line size for the SAS log and for the SAS procedure output. The NODATE option specifies that the date and the time are not printed. The PAGENO= option specifies a beginning page number for the next page of output.

```
options pagesize=40 linesize=80 nodate pageno=1;
```

Set your libref.

```
LIBNAME health 'SAS-library';
```

Specify Health as the procedure input library, and suppress the directory listing.

```
proc datasets library=health nolist;
run;
```

Create the output data set Grpout from the data set Group. Specify Group as the data set to describe, give Read access to the Group data set, and create the output data set Grpout.

```
proc contents data=health.group (read=green) out=health.grpout;
   title  'The Contents of the GROUP Data Set';
run;
```

Display the contents of the Grpout data set.

```
proc contents data=health.grpout;
   title  'The Contents of the GRPOUT Data Set';
run;
```

Output Examples

Output 14.3 *Contents of the Group Data Set*

The Contents of the GROUP Data Set

The DATASETS Procedure

Data Set Name	HEALTH.GROUP	**Observations**	148
Member Type	DATA	**Variables**	11
Engine	V9	**Indexes**	0
Created	09/03/2014 10:35:02	**Observation Length**	96
Last Modified	09/03/2014 10:35:02	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	8192
Number of Data Set Pages	3
First Data Page	1
Max Obs per Page	84
Obs in First Data Page	63
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\procdatasets\health\group.sas7bdat
Release Created	9.0401M3
Host Created	W32_7PRO
Owner Name	BUILTIN\Administrators
File Size	32KB
File Size (bytes)	32768

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Informat
9	BIRTH	Num	8		
4	CITY	Char	15		
3	FNAME	Char	15		
10	HIRED	Num	8	DATE7.	DATE7.
11	HPHONE	Char	12		
1	IDNUM	Char	4		
7	JOBCODE	Char	4		
2	LNAME	Char	15		
8	SALARY	Num	8	COMMA8.	
6	SEX	Char	2		
5	STATE	Char	3		

Output 14.4 *Contents of the Grpout Data Set*

The Contents of the GRPOUT Data Set

The CONTENTS Procedure

Data Set Name	HEALTH.GRPOUT	**Observations**	11
Member Type	DATA	**Variables**	41
Engine	V9	**Indexes**	0
Created	08/17/2016 09:21:07	**Observation Length**	888
Last Modified	08/17/2016 09:21:07	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	YES
Label			
Data Representation	WINDOWS_64		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	73728
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	82
Obs in First Data Page	11
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\\procdatasets\health\grpout.sas7bdat
Release Created	9.0401M4
Host Created	X64_7PRO
Owner Name	BUILTIN\Administrators
File Size	144KB
File Size (bytes)	147456

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Label
32	CHARSET	Char	8		Host Character Set
33	COLLATE	Char	8		Collating Sequence
28	COMPRESS	Char	8		Compression Routine
20	CRDATE	Num	8	DATETIME16.	Create Date
22	DELOBS	Num	8		Deleted Observations in Data Set
36	ENCRYPT	Char	8		Encryption Routine
19	ENGINE	Char	8		Engine Name
27	FLAGS	Char	3		Update Flags (Protect Contribute Add)
10	FORMAT	Char	32		Variable Format
12	FORMATD	Num	8		Number of Format Decimals
11	FORMATL	Num	8		Format Length
38	GENMAX	Num	8		Maximum Number of Generations
40	GENNEXT	Num	8		Next Generation Number
39	GENNUM	Num	8		Generation Number
25	IDXCOUNT	Num	8		Number of Indexes for Data Set
23	IDXUSAGE	Char	9		Use of Variable in Indexes
13	INFORMAT	Char	32		Variable Informat
15	INFORMD	Num	8		Number of Informat Decimals
14	INFORML	Num	8		Informat Length
16	JUST	Num	8		Justification
9	LABEL	Char	256		Variable Label
7	LENGTH	Num	8		Variable Length

1	LIBNAME	Char	8		Library Name
3	MEMLABEL	Char	256		Data Set Label
2	MEMNAME	Char	32		Library Member Name
24	MEMTYPE	Char	8		Library Member Type
21	MODATE	Num	8	DATETIME16.	Last Modified Date
5	NAME	Char	32		Variable Name
18	NOBS	Num	8		Observations in Data Set
34	NODUPKEY	Char	3		Sort Option: No Duplicate Keys
35	NODUPREC	Char	3		Sort Option: No Duplicate Records
17	NPOS	Num	8		Position in Buffer
37	POINTOBS	Char	3		Point to Observations
26	PROTECT	Char	3		Password Protection (Read Write Alter)
29	REUSE	Char	3		Reuse Space
30	SORTED	Num	8		Sorted and/or Validated
31	SORTEDBY	Num	8		Position of Variable in Sortedby Clause
41	TRANSCOD	Char	3		Character Variables Transcoded
6	TYPE	Num	8		Variable Type
4	TYPEMEM	Char	8		Special Data Set Type (From TYPE=)
8	VARNUM	Num	8		Variable Number

Sort Information	
Sortedby	LIBNAME MEMNAME
Validated	YES
Character Set	ANSI

Example 2: Using the DIRECTORY Option

Features:

PROC CONTENTS statement options
- DATA=
- DIRECTORY
- OUT=

OPTIONS statement

TITLE statement

Details

This example shows the output from the CONTENTS procedure for the Group data set using the DIRECTORY option. This option prints a list of all SAS files that are in the specified SAS library.

Program

```
options pagesize=40 linesize=80 nodate pageno=1;

LIBNAME health 'SAS-library';

proc datasets library=health nolist;
run;

proc contents data=health.group (read=green) directory;
title 'Contents Using the DIRECTORY Option';
run;
```

Program Description

Set the system options. The PAGESIZE= option specifies the number of lines that compose a page of the SAS log and the SAS output. The LINESIZE= option specifies the line size for the SAS log and for the SAS procedure output. The NODATE option specifies that the date and the time are not printed. The PAGENO= option specifies a beginning page number for the next page of output.

```
options pagesize=40 linesize=80 nodate pageno=1;
```

Set your libref.

```
LIBNAME health 'SAS-library';
```

Specify Health as the procedure input library, and suppress the directory listing.

```
proc datasets library=health nolist;
run;
```

Specify Group as the data set to describe, and give Read access to the Group data set. Use the DIRECTORY option to print a listing of all the data sets that are in the HEALTH library.

```
proc contents data=health.group (read=green) directory;
title 'Contents Using the DIRECTORY Option';
run;
```

Output Examples

Output 14.5 *Using the DIRECTORY Option - Section 1*

Contents Using the DIRECTORY Option

The CONTENTS Procedure

Directory	
Libref	HEALTH
Engine	V9
Physical Name	c:\\procdatasets\health
Filename	c:\\procdatasets\health
Owner Name	BUILTIN\Administrators
File Size	16KB
File Size (bytes)	16384

#	Name	Member Type	File Size	Last Modified
1	BODYFAT	DATA	8KB	09/03/2014 10:35:01
2	CONFOUND	DATA	8KB	09/03/2014 10:35:01
3	CORONARY	DATA	8KB	09/03/2014 10:35:01
4	FORMATS	CATALOG	17KB	11/16/2011 13:53:09
5	GROUP	DATA	32KB	09/03/2014 10:35:02
6	GRPOUT	DATA	144KB	08/17/2016 09:21:07
7	GRPOUT1	DATA	144KB	08/06/2015 09:54:32
8	INFANT	DATA	17KB	09/12/2007 10:57:52
9	MLSCL	DATA	8KB	09/03/2014 10:35:02
10	NAMES	DATA	8KB	09/03/2014 10:35:02
11	OXYGEN	DATA	16KB	09/03/2014 10:35:02
12	PERSONL	DATA	32KB	09/03/2014 10:35:02
13	PHARM	DATA	8KB	09/03/2014 10:35:02
14	POINTS	DATA	8KB	09/03/2014 10:35:02
15	POSTDRUG	CATALOG	61KB	11/16/2011 13:53:08
16	PRENAT	DATA	24KB	09/03/2014 10:35:02
17	RESULTS	DATA	8KB	09/03/2014 10:35:03

18	SLEEP	DATA	12KB	09/03/2014 10:35:03
19	SPDATA	VIEW	5KB	03/24/2005 13:12:22
20	SYNDROME	DATA	16KB	09/03/2014 10:35:03
21	TENSION	DATA	8KB	09/03/2014 10:35:03
22	TRAIN	DATA	8KB	09/03/2014 10:35:03
23	VISION	DATA	8KB	09/03/2014 10:35:03
24	WEIGHT	DATA	24KB	09/03/2014 10:35:03
25	WGHT	DATA	24KB	09/03/2014 10:35:03

Contents Using the DIRECTORY Option

The CONTENTS Procedure

Data Set Name	HEALTH.GROUP	Observations	148
Member Type	DATA	Variables	11
Engine	V9	Indexes	0
Created	09/03/2014 10:35:02	Observation Length	96
Last Modified	09/03/2014 10:35:02	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	8192
Number of Data Set Pages	3
First Data Page	1
Max Obs per Page	84
Obs in First Data Page	63
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\\procdatasets\health\group.sas7bdat
Release Created	9.0401M3
Host Created	W32_7PRO
Owner Name	BUILTIN\Administrators
File Size	32KB
File Size (bytes)	32768

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Informat
9	BIRTH	Num	8		
4	CITY	Char	15		
3	FNAME	Char	15		
10	HIRED	Num	8	DATE7.	DATE7.
11	HPHONE	Char	12		
1	IDNUM	Char	4		
7	JOBCODE	Char	4		
2	LNAME	Char	15		
8	SALARY	Num	8	COMMA8.	
6	SEX	Char	2		
5	STATE	Char	3		

Example 3: Using the DIRECTORY and DETAILS Options

Features:

PROC CONTENTS statement options
- DATA=
- DETAILS
- DIRECTORY
- OUT=

OPTIONS statement

TITLE statement

Details

This example shows the output from the CONTENTS procedure for the Group data set using the DIRECTORY option. This option prints a list of all SAS files that are in the specified SAS library. The DETAILS option includes information in the output about the number of observations, number of variables, number of indexes, and data set labels.

Program

```
options pagesize=40 linesize=80 nodate pageno=1;

LIBNAME health 'SAS-library';

proc datasets library=health nolist;
run;

proc contents data=health.groupdirectory details;
title 'Contents Using the DIRECTORY and DETAILS Options';
run;
```

Program Description

Set the system options. The PAGESIZE= option specifies the number of lines that compose a page of the SAS log and the SAS output. The LINESIZE= option specifies the line size for the SAS log and for the SAS procedure output. The NODATE option specifies that the date and the time are not printed. The PAGENO= option specifies a beginning page number for the next page of output.

```
options pagesize=40 linesize=80 nodate pageno=1;
```

Set your libref.

```
LIBNAME health 'SAS-library';
```

Specify Health as the procedure input library, and suppress the directory listing.

```
proc datasets library=health nolist;
run;
```

Specify Group as the data set. Use the DIRECTORY option to print a listing of all the data sets that are in the HEALTH library. Use the DETAILS options for additional columns of information in the Group output.

```
proc contents data=health.groupdirectory details;
title 'Contents Using the DIRECTORY and DETAILS Options';
run;
```

Output Examples

Output 14.6 *Using the DIRECTORY and DETAILS Options*

Contents Using the DIRECTORY and DETAILS Options

The CONTENTS Procedure

Directory	
Libref	HEALTH
Engine	V9
Physical Name	c:\\procdatasets\health
Filename	c:\\procdatasets\health
Owner Name	BUILTIN\Administrators
File Size	16KB
File Size (bytes)	16384

#	Name	Member Type	Obs, Entries or Indexes	Vars	Label	File Size	Last Modified
1	BODYFAT	DATA	1	2		8KB	09/03/2014 10:35:01
2	CONFOUND	DATA	8	4		8KB	09/03/2014 10:35:01
3	CORONARY	DATA	39	4		8KB	09/03/2014 10:35:01
4	FORMATS	CATALOG	.	0		17KB	11/16/2011 13:53:09
5	GROUP	DATA	148	11		32KB	09/03/2014 10:35:02
6	GRPOUT	DATA	11	41		144KB	08/17/2016 09:21:07
7	GRPOUT1	DATA	11	41		144KB	08/06/2015 09:54:32
8	INFANT	DATA	149	6		17KB	09/12/2007 10:57:52
9	MLSCL	DATA	32	4	Multiple Sclerosis Data	8KB	09/03/2014 10:35:02
10	NAMES	DATA	7	4		8KB	09/03/2014 10:35:02
11	OXYGEN	DATA	31	7		16KB	09/03/2014 10:35:02
12	PERSONL	DATA	148	11		32KB	09/03/2014 10:35:02
13	PHARM	DATA	6	3	Sugar Study	8KB	09/03/2014 10:35:02
14	POINTS	DATA	6	6		8KB	09/03/2014 10:35:02
15	POSTDRUG	CATALOG	.	0		61KB	11/16/2011 13:53:08

15	POSTDRUG	CATALOG	.	0		61KB	11/16/2011 13:53:08
16	PRENAT	DATA	149	6		24KB	09/03/2014 10:35:02
17	RESULTS	DATA	10	5		8KB	09/03/2014 10:35:03
18	SLEEP	DATA	108	6		12KB	09/03/2014 10:35:03
19	SPDATA	VIEW	.	2		5KB	03/24/2005 13:12:22
20	SYNDROME	DATA	46	8		16KB	09/03/2014 10:35:03
21	TENSION	DATA	4	3		8KB	09/03/2014 10:35:03
22	TRAIN	DATA	7	2		8KB	09/03/2014 10:35:03
23	VISION	DATA	16	3		8KB	09/03/2014 10:35:03
24	WEIGHT	DATA	83	13	California Results	24KB	09/03/2014 10:35:03
25	WGHT	DATA	83	13		24KB	09/03/2014 10:35:03

Contents Using the DIRECTORY and DETAILS Options

The CONTENTS Procedure

Data Set Name	HEALTH.GROUP	**Observations**	148
Member Type	DATA	**Variables**	11
Engine	V9	**Indexes**	0
Created	09/03/2014 10:35:02	**Observation Length**	96
Last Modified	09/03/2014 10:35:02	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	8192
Number of Data Set Pages	3
First Data Page	1
Max Obs per Page	84
Obs in First Data Page	63
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\\procdatasets\health\group.sas7bdat
Release Created	9.0401M3
Host Created	W32_7PRO
Owner Name	BUILTIN\Administrators
File Size	32KB
File Size (bytes)	32768

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Informat
9	BIRTH	Num	8		
4	CITY	Char	15		
3	FNAME	Char	15		
10	HIRED	Num	8	DATE7.	DATE7.
11	HPHONE	Char	12		
1	IDNUM	Char	4		
7	JOBCODE	Char	4		
2	LNAME	Char	15		
8	SALARY	Num	8	COMMA8.	
6	SEX	Char	2		
5	STATE	Char	3		

Example 4: Using the ORDER= Option

Features:

PROC CONTENTS statement options
- DATA=
- ORDER=
- OUT=

OPTIONS statement

TITLE statement

Details

This example shows the output from the CONTENTS procedure for the Grpout data set using the ORDER= option, which prints a list of variables in different orders.

Program

```
options pagesize=40 linesize=80 nodate pageno=1;

LIBNAME health 'SAS-library';

proc contents data=health.grpout order=collate;
title 'Contents Using the ORDER= Option';
run;

proc contents data=health.grpout order=varnum;
title 'Contents Using the ORDER= Option';
run;
```

Program Description

Set the system options. The PAGESIZE= option specifies the number of lines that compose a page of the SAS log and the SAS output. The LINESIZE= option specifies the line size for the SAS log and for the SAS procedure output. The NODATE option specifies that the date and the time are not printed. The PAGENO= option specifies a beginning page number for the next page of output.

```
options pagesize=40 linesize=80 nodate pageno=1;
```

Set your libref.

```
LIBNAME health 'SAS-library';
```

Specify the Grpout data set. Use the ORDER=COLLATE option to print a listing of all variables in alphabetical order.

```
proc contents data=health.grpout order=collate;
title 'Contents Using the ORDER= Option';
run;
```

Specify the Grpout data set. Use the ORDER=VARNUM option to print a listing of all variables in number order.

```
proc contents data=health.grpout order=varnum;
title 'Contents Using the ORDER= Option';
run;
```

Output Examples

Output 14.7 *Using the ORDER=COLLATE Option*

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Label
32	CHARSET	Char	8		Host Character Set
33	COLLATE	Char	8		Collating Sequence
28	COMPRESS	Char	8		Compression Routine
20	CRDATE	Num	8	DATETIME16.	Create Date
22	DELOBS	Num	8		Deleted Observations in Data Set
36	ENCRYPT	Char	8		Encryption Routine
19	ENGINE	Char	8		Engine Name
27	FLAGS	Char	3		Update Flags (Protect Contribute Add)
10	FORMAT	Char	32		Variable Format
12	FORMATD	Num	8		Number of Format Decimals
11	FORMATL	Num	8		Format Length
38	GENMAX	Num	8		Maximum Number of Generations
40	GENNEXT	Num	8		Next Generation Number
39	GENNUM	Num	8		Generation Number
25	IDXCOUNT	Num	8		Number of Indexes for Data Set
23	IDXUSAGE	Char	9		Use of Variable in Indexes
13	INFORMAT	Char	32		Variable Informat
15	INFORMD	Num	8		Number of Informat Decimals
14	INFORML	Num	8		Informat Length
16	JUST	Num	8		Justification

9	LABEL	Char	256		Variable Label
7	LENGTH	Num	8		Variable Length
1	LIBNAME	Char	8		Library Name
3	MEMLABEL	Char	256		Data Set Label
2	MEMNAME	Char	32		Library Member Name
24	MEMTYPE	Char	8		Library Member Type
21	MODATE	Num	8	DATETIME16.	Last Modified Date
5	NAME	Char	32		Variable Name
18	NOBS	Num	8		Observations in Data Set
34	NODUPKEY	Char	3		Sort Option: No Duplicate Keys
35	NODUPREC	Char	3		Sort Option: No Duplicate Records
17	NPOS	Num	8		Position in Buffer
37	POINTOBS	Char	3		Point to Observations
26	PROTECT	Char	3		Password Protection (Read Write Alter)
29	REUSE	Char	3		Reuse Space
30	SORTED	Num	8		Sorted and/or Validated
31	SORTEDBY	Num	8		Position of Variable in Sortedby Clause
41	TRANSCOD	Char	3		Character Variables Transcoded
6	TYPE	Num	8		Variable Type
4	TYPEMEM	Char	8		Special Data Set Type (From TYPE=)
8	VARNUM	Num	8		Variable Number

Output 14.8 *Using the ORDER=VARNUM Option*

Variables in Creation Order					
#	Variable	Type	Len	Format	Label
1	LIBNAME	Char	8		Library Name
2	MEMNAME	Char	32		Library Member Name
3	MEMLABEL	Char	256		Data Set Label
4	TYPEMEM	Char	8		Special Data Set Type (From TYPE=)
5	NAME	Char	32		Variable Name
6	TYPE	Num	8		Variable Type
7	LENGTH	Num	8		Variable Length
8	VARNUM	Num	8		Variable Number
9	LABEL	Char	256		Variable Label
10	FORMAT	Char	32		Variable Format
11	FORMATL	Num	8		Format Length
12	FORMATD	Num	8		Number of Format Decimals
13	INFORMAT	Char	32		Variable Informat
14	INFORML	Num	8		Informat Length
15	INFORMD	Num	8		Number of Informat Decimals
16	JUST	Num	8		Justification
17	NPOS	Num	8		Position in Buffer
18	NOBS	Num	8		Observations in Data Set
19	ENGINE	Char	8		Engine Name
20	CRDATE	Num	8	DATETIME16.	Create Date

21	MODATE	Num	8	DATETIME16.	Last Modified Date
22	DELOBS	Num	8		Deleted Observations in Data Set
23	IDXUSAGE	Char	9		Use of Variable in Indexes
24	MEMTYPE	Char	8		Library Member Type
25	IDXCOUNT	Num	8		Number of Indexes for Data Set
26	PROTECT	Char	3		Password Protection (Read Write Alter)
27	FLAGS	Char	3		Update Flags (Protect Contribute Add)
28	COMPRESS	Char	8		Compression Routine
29	REUSE	Char	3		Reuse Space
30	SORTED	Num	8		Sorted and/or Validated
31	SORTEDBY	Num	8		Position of Variable in Sortedby Clause
32	CHARSET	Char	8		Host Character Set
33	COLLATE	Char	8		Collating Sequence
34	NODUPKEY	Char	3		Sort Option: No Duplicate Keys
35	NODUPREC	Char	3		Sort Option: No Duplicate Records
36	ENCRYPT	Char	8		Encryption Routine
37	POINTOBS	Char	3		Point to Observations
38	GENMAX	Num	8		Maximum Number of Generations
39	GENNUM	Num	8		Generation Number
40	GENNEXT	Num	8		Next Generation Number
41	TRANSCOD	Char	3		Character Variables Transcoded

15

COPY Procedure

Overview: COPY Procedure

What Does the COPY Procedure Do?

The COPY procedure copies one or more tables from one SAS library to another.

Generally, the COPY procedure functions the same as the COPY statement in the DATASETS procedure. The differences are as follows:

- The IN= argument is required with PROC COPY. In the COPY statement, IN= is optional. If IN= is omitted, the default value is the libref of the procedure input library.

- PROC DATASETS cannot work with libraries that allow only sequential data access.
- The COPY statement honors the NOWARN option but PROC COPY does not.

Note: The MIGRATE procedure is available specifically for migrating a SAS library from a previous release to the most recent release. For migration, PROC MIGRATE offers benefits that PROC COPY does not. For more information, see MIGRATE Procedure on page 1559.

With the ACCEL option, PROC COPY executes a CAS action to copy a CAS table from one caslib to another caslib in the same CAS session.

Syntax: COPY Procedure

Restrictions: PROC COPY ignores concatenations with catalogs. Use PROC CATALOG COPY to copy concatenated catalogs.

PROC COPY does not support data set options.

PROC COPY does not back up graphic catalogs. Use PROC CPORT or PROC CIMPORT when doing back ups with graphic catalogs.

Interaction: The International Components for Unicode (ICU) version is used to sort data sets with a linguistic collating sequence. If a linguistically sorted data set has a different ICU version number than that of the current SAS session, the following occurs: PROC COPY retains the data set's sort order in the OUT= destination library. However, the data set is no longer marked as sorted, and a message is written to the SAS log. For more information about linguistic sorting, see Chapter 64, "SORT Procedure," on page 2355.

Notes: Data set names and variable names that end with large numeric values that are larger than a long integer cannot be used in numbered-range lists. For more information, see "Restriction for Numbered Range Lists" in *SAS Language Reference: Concepts*.

PROC COPY uses a CAS action to provide the copy operation in the CAS server when both the IN= and OUT= values use the CAS libname engine and both libnames use the same CAS session. See "Copying a CAS Table to Another CAS Table" on page 620 and "CAS Processing for PROC COPY" on page 523.

Tips: Complete documentation for the COPY procedure is in COPY Statement on page 610.

For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

PROC COPY <ACCEL | NOACCEL>

OUT=*libref-1* <CLONE | NOCLONE>
<CONSTRAINT=YES | NO>
<DATECOPY>
<ENCRYPTKEY=*key-value*>

<FORCE>
IN=*libref-2*
<INDEX=YES | NO>
<MEMTYPE=(*member-type(s)*)>
<MOVE <ALTER=*alter-password*>>
<OVERRIDE=(*ds-option-1=value-1 <ds-option-2=value-2 ...>*) >;
<SELECT *SAS-file(s)*>
</ <ENCRYPTKEY=*key-value*> <ALTER=*alter-password*>
<MEMTYPE=*member-type*>>;

Statement	Task	Example
COPY	Copy one or more files	Ex. 1, Ex. 3
EXCLUDE	Exclude files or memtypes	Ex.
SELECT	Select files or memtypes	Ex. 1, Ex. 2

Usage: COPY Procedure

CAS Processing for PROC COPY

When the IN= option and OUT= option both reference a CAS engine library and both libraries use the same CAS session, the COPY procedure can use a CAS action to copy tables within the server.

PROC COPY options are valid when using a CAS LIBNAME engine except for the following:

- ENCRYPTKEY=
- OVERRIDE=
- PW=

When a copy occurs on the CAS server, the MVA session system options (like VALIDMEMNAME and VALIDVARNAME) will not be used.

SAS Cloud Analytic Services (CAS) is the analytic server and associated cloud services in SAS Viya. The CAS LIBNAME engine can connect a SAS 9.4 session to an existing SAS Cloud Analytic Services session through the CAS session name or the CAS session UUID. The libref then becomes your handle to communicate from SAS with the specific session. The following example shows how to use PROC COPY with CAS processing.

Here is an example of how to run PROC COPY with CAS.

```
/* Connect to a CAS server */
cas casauto host="cloud.example.com" port=5570;

/*Specify the LIBNAME statements*/
libname foo cas caslib=casuserhdfs;
libname bar cas caslib=casuser;


/*Loading data to Casuserhdfs. Note that you can specify OUTCASLIB=
on the PROC CASUTIL statement and it will apply to all statements
that follow (up to the quit). */
proc casutil;
load data=sashelp.class outcaslib=casuserhdfs;
load data=sashelp.class compress casout="class_comp"
outcaslib=casuserhdfs;
load data=sashelp.class promote casout="class_prom"
outcaslib=casuserhdfs;
quit;

/*Execute the PROC COPY statement*/
title 'Copy with CLONE;
proc copy in=foo out=bar;
run;
```

For information about how to use the CAS LIBNAME statement, see “Getting Started” in *SAS Cloud Analytic Services: User’s Guide*.

Using CLONE | NOCLONE on a CAS Table

The CLONE | NOCLONE option specifies whether to copy data set attributes. The only attribute that can be used with the CAS engine is COMPRESS.

Attributes are specified with data set options, system options, or LIBNAME statement options. The CAS engine supports only the COMPRESS=YES | NO option. No other attributes are supported by the CAS engine.

The following table summarizes how the COPY statement works:

Table 15.1 *CLONE Interaction with Attributes*

Attribute	To	CLONE or NOCLONE	Description
BUFSIZE= CAS engine does not support.	SAS data set to CAS table		
	CAS table to SAS data set	CLONE	OVERRIDE=(BUFSIZE=*value other than default*)

Attribute	To	CLONE or NOCLONE	Description
		NOCLONE	Uses setting of BUFSIZE= system option
	CAS table to CAS table		
COMPRESS= SAS data set - COMPRESS=BINARY | CHAR | NO CAS table - COMPRESS=NO | YES	SAS data set to CAS table	CLONE	A compressed SAS data set becomes a compressed CAS table unless OVERRIDE= is used. An uncompressed SAS data set becomes an uncompressed CAS table unless OVERRIDE= is used.
		NOCLONE	Follows the CAS LIBNAME setting.
	CAS table to SAS data set	CLONE	Compressed CAS table becomes a SAS data set CHAR unless the OVERRIDE= is used.
		NOCLONE	The COMPRESS= system option or LIBNAME option value is used.
	CAS table to CAS table	CLONE	Keeps the current setting.
		NOCLONE	Set using the CAS LIBNAME setting for the OUT= libref.
REUSE= CAS engine does not support.	SAS data set to CAS table		
	CAS table to SAS data set	CLONE	REUSE=NO unless OVERRIDE= or REUSE=YES system option is used.
		NOCLONE	Uses the REUSE= system option value.

Attribute	To	CLONE or NOCLONE	Description
	CAS table to CAS table		
POINTOBS= CAS engine does not support.	SAS data set to CAS table		
	CAS table to SAS data set	CLONE	POINTOBS=NO unless OVERRIDE= is used.
		NOCLONE	POINTOBS=NO, if the CAS table is compressed and the LIBNAME statement has POINTOBS=NO. POINTOBS=YES, if the CAS table is compressed and the LIBNAME option is missing.
	CAS table to CAS table		
OUTREP= CAS engine does not support.	SAS data set to CAS table	CLONE	Converts to LINUX_86_64 if needed. (A warning is sent to the log if the OVERRIDE= option is used.)
		NOCLONE	Converts to LINUX_86_64 if needed.
	CAS table to SAS data set		
		CLONE	Keeps data representation. (A warning is sent to the log if the OVERRIDE= option is used.)
	CAS table to CAS table		
ENCODING=	SAS data set to CAS table	CLONE	Converts to UTF-8 if needed. (A warning is sent to the log if the

Attribute	To	CLONE or NOCLONE	Description
CAS engine supports UTF-8 only. Changing encoding is not implemented for the CAS engine.			OVERRIDE= option is used.)
		NOCLONE	Converts to UTF-8 if needed.
	CAS table to SAS data set	CLONE	Keeps the UTF-8 encoding unless OVERRIDE= is used.
		NOCLONE	Keeps the UTF-8 encoding unless OUTENCODING= is used in the output data set LIBNAME is used.
	CAS table to CAS table		

Compressing Output CAS Tables

When copying previously compressed tables, the following occurs:

- if a SAS data set is compressed, then it retains the COMPRESS=YES value on the CAS table.
- if a CAS table is compressed, then it converts to a SAS data set with the COMPRESS=CHAR value.
- if a CAS table is copied to another CAS table, the COMPRESS=YES attribute is maintained.

Using the COPY Procedure

Copying Select Files from a Large Directory of Files

When using the COPY procedure, an in-memory directory of the library is obtained. This can be a performance issue if the library has thousands of members and only a few members are being copied. To resolve this performance issue, use a combination of the MEMTYPE= option in the COPY statement with a SELECT statement. The following is an example of this process:

```
proc copy in=work out=mylib memtype=(data catalog);
   select mydata x1-x10 data2;
run;
```

Note: If either MEMTYPE=ALL or a wildcard specification (":") is used, the performance code cannot be used.

TIP If the MSGLEVEL=I option is set, and the SELECT performance code can be used, the following message is sent to the SAS log:

```
INFO: COPY with SELECT performance is in use.
```

Transporting SAS Data Sets between Hosts

The COPY procedure, along with the XPORT engine and the XML engine, can create and read transport files that can be moved from one host to another. PROC COPY can create transport files only with SAS data sets, not with catalogs or other types of SAS files.

Transporting is a three-step process:

1. Use PROC COPY to copy one or more SAS data sets to a file that is created with either the transport (XPORT) engine or the XML engine. This file is referred to as a transport file and is always a sequential file.
2. After the file is created, you can move it to another operating environment via communications software, such as FTP, or tape. If you use communications software, be sure to move the file in binary format to avoid any type of conversion. If you are moving the file to a mainframe, the file must have certain

attributes. Consult the SAS documentation for your operating environment and the SAS Technical Support web page for more information.

3 After you have successfully moved the file to the receiving host, use PROC COPY to copy the data sets from the transport file to a SAS library.

For an example, see "Example 1: Copying SAS Data Sets between Hosts" on page 530.

For details about transporting files, see *Moving and Accessing SAS Files*.

The CPORT and CIMPORT procedures also provide a way to transport SAS files. For more information, see Chapter 16, "CPORT Procedure," on page 537 and Chapter 12, "CIMPORT Procedure," on page 389.

If you need to migrate a SAS library from a previous release of SAS, see the Migration focus area at http://support.sas.com/migration.

For more information, see the Details on page 618 section of the CONTENTS statement in PROC DATASETS.

Copying AES-Encrypted Data Files

You must use the ENCRYPTKEY= data set option when copying an AES-encrypted data file. An error occurs when you copy an AES-encrypted file to a library that does not support AES encryption. For more information about AES encryption, see "AES Encryption" in *SAS Programmer's Guide: Essentials* and see "Copying AES-Encrypted Data Files" on page 623.

The following is an example using the ENCRYPTKEY= data set option:

```
proc copy in=Lib1 out=Lib2;
select My-Data1 (encryptkey=key-value1) <My-Data2 (encryptkey=key-value2) ...>;
run;
```

To copy AES-encrypted data files containing referential integrity constraints, see "Copying AES-Encrypted Data Files Containing Referential Integrity Constraints " on page 624.

Compressing Output Data Files

The COPY procedure does not support data set options. Therefore, you cannot use the COMPRESS= data set option in PROC COPY or a COPY statement from PROC DATASETS. To compress an OUTPUT data set generated by PROC COPY, you can use the COMPRESS=YES system option before the PROC COPY statement with the NOCLONE option.

```
options compress=yes;
proc copy in=work out=new noclone;
select x;
run;
```

Examples: COPY Procedure

Example 1: Copying SAS Data Sets between Hosts

Features:

PROC COPY statement options
- IN=
- MEMTYPE=
- OUT=
- SELECT statement

XPORT engine

Details

This example demonstrates how to create a transport file on a host and read it on another host.

In order for this example to work correctly, the transport file must have certain characteristics, as described in the SAS documentation for your operating environment. In addition, the transport file must be moved to the receiving operating system in binary format.

Program

```
libname source 'SAS-library-on-sending-host';

libname xptout xport 'filename-on-sending-host';


proc copy in=source out=xptout memtype=data;
   select bonus budget salary;
run;



libname insource xport 'filename-on-receiving-host';
```

```
proc copy in=insource out=work;
run;
```

Program Description

Assign library references. Assign a libref, such as Source, to the SAS library that contains the SAS data set that you want to transport. Also, assign a libref to the transport file and use the XPORT keyword to specify the XPORT engine.

```
libname source 'SAS-library-on-sending-host';

libname xptout xport 'filename-on-sending-host';
```

Copy the SAS data sets to the transport file.

```
proc copy in=source out=xptout memtype=data;
   select bonus budget salary;
run;
```

Enable the procedure to read data from the transport file. The XPORT engine in the LIBNAME statement enables the procedure to read the data from the transport file.

```
libname insource xport 'filename-on-receiving-host';
```

Copy the SAS data sets to the receiving host. After you copy the files, use PROC COPY to copy the SAS data sets to the Work data library on the receiving host. You could use FTP in binary mode to the Windows host.

```
proc copy in=insource out=work;
run;
```

Log Examples

Example Code 15.1 *Source Library Log*

```
1    LIBNAME source 'SAS-library-on-sending-host ';
NOTE: Libref SOURCE was successfully assigned as follows:
      Engine:        V9
      Physical Name: SAS-library-on-sending-host
2    LIBNAME xptout xport 'filename-on-sending-host';
NOTE: Libref XPTOUT was successfully assigned as follows:
      Engine:        XPORT
      Physical Name: filename-on-sending-host
3    proc copy in=source out=xptout memtype=data;
4    select bonus budget salary;
5    run;

NOTE: Copying SOURCE.BONUS to XPTOUT.BONUS (memtype=DATA).
NOTE: The data set XPTOUT.BONUS has 1 observations and 3 variables.
NOTE: Copying SOURCE.BUDGET to XPTOUT.BUDGET (memtype=DATA).
NOTE: The data set XPTOUT.BUDGET has 1 observations and 3 variables.
NOTE: Copying SOURCE.SALARY to XPTOUT.SALARY (memtype=DATA).
NOTE: The data set XPTOUT.SALARY has 1 observations
```

Example Code 15.2 *Insource Library Log*

```
1     LIBNAME insource xport 'filename-on-receiving-host';
NOTE: Libref INSOURCE was successfully assigned as follows:
       Engine:      XPORT
       Physical Name: filename-on-receiving-host
2     proc copy in=insource out=work;
3     run;
NOTE: Input library INSOURCE is sequential.
NOTE: Copying INSOURCE.BUDGET to WORK.BUDGET (memtype=DATA).
NOTE: BUFSIZE is not cloned when copying across different engines.
      System Option for BUFSIZE was used.
NOTE: The data set WORK.BUDGET has 1 observations and 3 variables.
NOTE: Copying INSOURCE.BONUS to WORK.BONUS (memtype=DATA).
NOTE: BUFSIZE is not cloned when copying across different engines.
      System Option for BUFSIZE was used.
NOTE: The data set WORK.BONUS has 1 observations and 3 variables.
NOTE: Copying INSOURCE.SALARY to WORK.SALARY (memtype=DATA).
NOTE: BUFSIZE is not cloned when copying across different engines.
      System Option for BUFSIZE was used.
NOTE: The data set WORK.SALARY has 1 observations and 3 variables.
```

Example 2: Converting SAS Data Sets Encodings

Features: PROC COPY statement options
- IN=
- NOCLONE
- OUT=
- SELECT statement

CVP engine

Details

This example demonstrates how to convert encoding from one type to another type. In order for this example to work correctly, the two encodings must be compatible. For documentation, see "Compatible and Incompatible Encodings" in *SAS National Language Support (NLS): Reference Guide*.

Program

Assign library references. The two encodings must be compatible.

```
LIBNAME inlib cvp 'SAS-library';
LIBNAME outlib 'SAS-library' outencoding="encoding value for output";
proc copy noclone in=inlib out=outlib;
   select car;
run;
```

Log Examples

Example Code 15.3 *InLib Library Log*

```
1    LIBNAME inlib cvp  'SAS-library';
NOTE: Libref INLIB was successfully assigned as follows:
      Engine:        V9
      Physical Name: SAS-library
2    LIBNAME outlib 'SAS-library' outencoding="encoding value for output";
NOTE: Libref OUTLIB was successfully assigned as follows:
      Engine:        V9
      Physical Name: SAS-library
3    proc copy noclone in=inlib out=outlib;
4    select car;
5    run;

NOTE: Copying INLIB.CAR to OUTLIB.CAR (memtype=DATA).
NOTE: System Options for BUFSIZE and REUSE were used at user's request.

NOTE: Libname and/or system options for compress, pointobs, data representation and
encoding attributes were used at user's request.
NOTE: Data file OUTLIB.CAR.DATA is in a format that is native to another host, or
the file encoding does not match the session encoding. Cross Environment Data Access
will be used, which might require additional CPU resources and might reduce
performance.

NOTE: There were 25 observations read from the data set INLIB.CAR.

NOTE: The data set OUTLIB.CAR has 25 observations and 2 variables.
```

Example 3: Using PROC COPY to Migrate from a 32-bit to a 64-bit Machine

Features:

PROC COPY statement options
- IN=
- OUT=
- NOCLONE
- SELECTstatement

OUTREP= data set option

Details

This example demonstrates how to use PROC COPY to migrate from a 32-bit to a 64-bit environment. PROC MIGRATE does not support item stores when you migrate from a 32-bit to a 64-bit environment.

Program

```
libname source 'SAS-library';
libname target 'SAS-library'
    outrep=windows_64;

proc copy in=source out=target NOCLONE;
    select data-set-name;
run;
```

Program Description

Assign library resources. Use the OUTREP= option when changing from a 32-bit to a 64-bit machine.

```
libname source 'SAS-library';
libname target 'SAS-library'
    outrep=windows_64;
```

Copy data set from a 32-bit to a 64-bit machine.

```
proc copy in=source out=target NOCLONE;
    select data-set-name;
run;
```

Example 4: Copy a SAS Data Set to a CAS Table

Features: PROC COPY statement options
- IN=
- OUT=
- SELECT statement

Details

This example demonstrates how to copy a SAS data set into a CAS table.

Program

```
libname mycas cas;
libname mylib 'BASE-engine-library';

proc copy in=mylib out=mycas;
   select monthly;
run;
quit;
```

Program Description

Assign library references. Select the data set that you want to copy into a CAS table.

```
libname mycas cas;
libname mylib 'BASE-engine-library';
```

Use PROC COPY and the SELECT statement. Copy a SAS data set into a CAS table.

```
proc copy in=mylib out=mycas;
   select monthly;
run;
quit;
```

Log Examples

Example Code 15.4 *MyLib Library Log*

```
57         libname mycas cas;
 NOTE: Libref MYCAS was successfully assigned as follows:
       Engine:        CAS
       Physical Name: 1f436ced
 58         libname mylib 'BASE-engine-library';
 NOTE: Libref MYLIB was successfully assigned as follows:
       Engine:        V9
       Physical Name: BASE-engine-library
 59
 60         proc copy in=mylib out=mycas;
 61            select monthly;
 62         run;

 NOTE: Copying MYLIB.MONTHLY to MYCAS.MONTHLY (memtype=DATA).
 NOTE: There were 12012 observations read from the data set MYLIB.MONTHLY.
 NOTE: The data set MYCAS.MONTHLY has 12012 observations and 7 variables.
 NOTE: PROCEDURE COPY used (Total process time):
       real time           0.06 seconds
       cpu time            0.02 seconds
```

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CPORT Procedure

Overview: CPORT Procedure

What Does the CPORT Procedure Do?

The CPORT procedure writes SAS data sets, SAS catalogs, or SAS libraries to sequential file formats (transport files). Use PROC CPORT with the CIMPORT procedure to move files from one environment to another. *Transport files* are sequential files that each contain a SAS library, a SAS catalog, or a SAS data set in transport format. The transport format that PROC CPORT writes is the same for all

environments and for many releases of SAS. In PROC CPORT, *export* means to put a SAS library, a SAS catalog, or a SAS data set into transport format. PROC CPORT exports catalogs and data sets, either singly or as a SAS library. PROC CIMPORT restores (*imports*) the transport file to its original form as a SAS catalog, SAS data set, or SAS library.

PROC CPORT also *converts* SAS files, which means that it changes the format of a SAS file from the format appropriate for one version of SAS to the format appropriate for another version. For example, you can use PROC CPORT and PROC CIMPORT to move files from earlier releases of SAS to more recent releases. PROC CIMPORT automatically converts the transport file as it imports it.

Note: PROC CPORT and PROC CIMPORT can be used to back up graphic catalogs. PROC COPY cannot be used to back up graphic catalogs.

PROC CPORT produces no output (other than the transport files), but it does write notes to the SAS log.

Process for Creating and Reading a Transport File

Here is the process to create a transport file at the source computer and to read it at a target computer:

1. A transport file is created at the source computer using PROC CPORT.
2. The transport file is transferred from the source computer to the target computer via communications software or a magnetic medium.
3. The transport file is read at the target computer using PROC CIMPORT.

   Note: Transport files that are created using PROC CPORT are not interchangeable with transport files that are created using the XPORT engine.

For complete details about the steps to create a transport file (PROC CPORT), to transfer the transport file, and to restore the transport file (PROC CIMPORT), see *Moving and Accessing SAS Files*.

Syntax: CPORT Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Tip: Use PROC CPORT or PROC CIMPORT when backing up graphic catalogs. PROC COPY cannot be used to back up graphic catalogs.

See: CPORT Procedure under Windows, UNIX , z/OS

For complete details about the steps to create a transport file (PROC CPORT), to transfer the transport file, and to restore the transport file (PROC CIMPORT), see *Moving and Accessing SAS Files*

PROC CPORT *source-type=libref* | <*libref.*>*member-name* <*options*>;

EXCLUDE *SAS file(s) | catalog entry(s)* </ MEMTYPE=*mtype*> </ ENTRYTYPE=*entry-type*>;

SELECT *SAS file(s) | catalog entry(s)* </ MEMTYPE=*mtype*> </ ENTRYTYPE=*entry-type*> ;

TRANTAB NAME=*translation-table-name* <*options*>;

Statement	Task	Example
PROC CPORT	Create a transport file	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5
EXCLUDE	Exclude one or more specified files from the transport file	
SELECT	Specify one or more files or entries to include in the transport file	Ex. 2
TRANTAB	Specify one or more translation tables for characters in catalog entries to be exported	Ex. 4

PROC CPORT Statement

Creates a transport file.

Examples:

"Example 1: Exporting Multiple Catalogs" on page 553
"Example 2: Exporting Individual Catalog Entries" on page 555
"Example 3: Exporting a Single SAS Data Set" on page 556
"Example 4: Applying a Translation Table" on page 557
"Example 5: Exporting Entries Based on Modification Date" on page 558

Syntax

PROC CPORT *source-type=libref* | <*libref.*>*member-name* <*options*>;

Summary of Optional Arguments

NOEDIT

exports SAS/AF PROGRAM and SCL entries without Edit capability when you import them.

NOSRC
: specifies that exported catalog entries contain compiled SCL code, but not the source code.

OUTLIB=*libref*
: specifies a libref associated with a SAS library.

Control the contents of the transport file

ASIS
: suppresses the conversion of displayed character data to transport format.

CONSTRAINT=YES | NO
: controls the exportation of integrity constraints.

DATECOPY
: copies the created and modified date and time to the transport file.

INDEX=YES | NO
: controls the exportation of indexes with indexed SAS data sets.

INTYPE=*DBCS-type*
: specifies the type of DBCS data stored in the SAS files to be exported.

NOCOMPRESS
: suppresses the compression of binary zeros and blanks in the transport file.

OUTTYPE=UPCASE
: writes all alphabetic characters to the transport file in uppercase.

TRANSLATE=(*translation-list*)
: translates specified characters from one ASCII or EBCDIC value to another.

Identify the transport file

FILE=*fileref* | '*filename*'
: specifies the transport file to write to.

TAPE
: directs the output from PROC CPORT to a tape.

Select files to export

AFTER=*date*
: exports copies of all data sets or catalog entries that have a modification date equal to or later than the date that you specify.

EET=(*etype(s)*)
: excludes specified entry types from the transport file.

ET=(*etype(s)*)
: includes specified entry types in the transport file.

GENERATION=YES | NO
: specifies whether to export all generations of a data set.

MEMTYPE=*mtype*
: specifies that only data sets, only catalogs, or both, be moved when a library is exported.

Required Argument

source-type=libref | <libref.>member-name
identifies the type of file to export and specifies the catalog, SAS data set, or SAS library to export.

source-type
identifies one or more files to export as a single catalog, as a single SAS data set, or as the members of a SAS library. The *source-type* argument can be one of the following:

CATALOG | CAT | C
DATA | DS | D
LIBRARY | LIB | L

Note If you specify a password-protected data set as the source type, you must also include the password when creating its transport file. For details, see "READ= Data Set Option in the PROC CPORT Statement " on page 549.

libref
<libref.>member-name
specifies the specific catalog, SAS data set, or SAS library to export. If *source-type* is CATALOG or DATA, you can specify both a libref and a member name. If the *libref* is omitted, PROC CPORT uses the default library as the *libref*, which is usually the WORK library. If the *source-type* argument is LIBRARY, specify only a *libref*. If you specify a library, PROC CPORT exports only data sets and catalogs from that library. You cannot export other types of files.

See Refer to "Names in the SAS Language" in *SAS Language Reference: Concepts* for naming conventions that you can use for names and member names.

Optional Arguments

AFTER=*date*
exports copies of all data sets or catalog entries that have a modification date later than or equal to the date that you specify. The modification date is the most recent date when the contents of the data set or catalog entry changed. Specify date as a SAS date literal or as a numeric SAS date value.

Tip You can determine the modification date of a catalog entry by using the CATALOG procedure.

Example "Example 5: Exporting Entries Based on Modification Date" on page 558

ASIS
suppresses the conversion of displayed character data to transport format. Use this option when you move files that contain DBCS (double-byte character set) data from one operating environment to another if both operating environments use the same type of DBCS data.

Interactions The ASIS option invokes the NOCOMPRESS option.

You cannot use both the ASIS option and the OUTTYPE= options in the same PROC CPORT step.

CONSTRAINT=YES | NO
controls the exportation of integrity constraints that have been defined on a data set. When you specify CONSTRAINT=YES, all types of integrity constraints are exported for a library; only general integrity constraints are exported for a single data set. When you specify CONSTRAINT=NO, indexes created without integrity constraints are ported, but neither integrity constraints nor any indexes created with integrity constraints are ported. For more information about integrity constraints, see the section on SAS files in *SAS Language Reference: Concepts*.

Alias CON=

Default YES

Interactions You cannot specify both CONSTRAINT= and INDEX= in the same PROC CPORT step.

If you specify INDEX=NO, no integrity constraints are exported.

DATECOPY
copies the SAS internal date and time at which the SAS file was created and the date and time at which it was last modified to the resulting transport file. Note that the operating environment date and time are not preserved.

Restriction DATECOPY can be used only when the destination file uses the V8 or V9 engine.

Note If the file that you are transporting has attributes that require additional processing, then the last modified date might be changed to the current date and time.

Tips The DATECOPY option must be specified to transport data sets with time zone offsets.

You can alter the file creation date and time with the DTC= option in the MODIFY statement in a PROC DATASETS step. For details, see "MODIFY Statement" on page 644.

EET=(*etype(s)*)
excludes specified entry types from the transport file. If *etype* is a single entry type, then you can omit the parentheses. Separate multiple values with a space.

Interaction You cannot use both the EET= option and the ET= option in the same PROC CPORT step.

ET=(*etype(s)*)
includes specified entry types in the transport file. If *etype* is a single entry type, then you can omit the parentheses. Separate multiple values with a space.

Interaction You cannot use both the EET= option and the ET= option in the same PROC CPORT step.

FILE=*fileref* | '*filename*'
specifies a previously defined fileref or the filename of the transport file to write to. If you omit the FILE= option, then PROC CPORT writes to the fileref SASCAT, if defined. If the fileref SASCAT is not defined, PROC CPORT writes to SASCAT.DAT in the current directory.

Note The behavior of PROC CPORT when SASCAT is undefined varies from one operating environment to another. For details, see the SAS documentation for your operating environment.

Example All examples.

GENERATION=YES | NO
specifies whether to export all generations of a SAS data set. To export only the base generation of a data set, specify GENERATION=NO in the PROC CPORT statement. To export a specific generation number, use the GENNUM= data set option when you specify a data set in the PROC CPORT statement. For more information about generation data sets, see *SAS Language Reference: Concepts*.

Alias GEN=

Default YES for libraries; NO for single data sets

Note PROC CIMPORT imports all generations of a data set that are present in the transport file. It deletes any previous generation set with the same name and replaces it with the imported generation set, even if the number of generations does not match.

INDEX=YES | NO
specifies whether to export indexes with indexed SAS data sets.

Default YES

Interactions You cannot specify both INDEX= and CONSTRAINT= in the same PROC CPORT step.

If you specify INDEX=NO, no integrity constraints are exported.

INTYPE=*DBCS-type*
specifies the type of DBCS data stored in the SAS files to be exported. Double-byte character set (DBCS) data uses up to two bytes for each character in the set. *DBCS-type* must be one of the following values:

IBM | HITAC | FACOM	for z/OS
IBM	for VSE
DEC | SJIS	for OpenVMS
PCIBM | SJIS	for OS/2

Default If the INTYPE= option is not used, the DBCS type defaults to the value of the SAS system option DBCSTYPE=.

Restriction The INTYPE= option is allowed only if SAS is built with Double-Byte Character Set (DBCS) extensions. Because these extensions require significant computing resources, there is a special distribution for those sites that require it. An error is reported if this option is used at a site for which DBCS extensions are not enabled.

Interactions Use the INTYPE= option in conjunction with the OUTTYPE= option to change from one type of DBCS data to another.

The INTYPE= option invokes the NOCOMPRESS option.

You cannot use the INTYPE= option and the ASIS option in the same PROC CPORT step.

Tip You can set the value of the SAS system option DBCSTYPE= in your configuration file.

MEMTYPE=*mtype*
restricts the type of SAS file that PROC CPORT writes to the transport file. MEMTYPE= restricts processing to one member type. Values for *mtype* can be

ALL
both catalogs and data sets

CATALOG
CAT
catalogs

DATA
DS
SAS data sets

Alias MT=

Default ALL

Example “Example 1: Exporting Multiple Catalogs” on page 553

NOCOMPRESS
suppresses the compression of binary zeros and blanks in the transport file.

Alias NOCOMP

Default By default, PROC CPORT compresses binary zeros and blanks to conserve space.

Interaction The ASIS, INTYPE=, and OUTTYPE= options invoke the NOCOMPRESS option.

Note Compression of the transport file does not alter the flag in each catalog and data set that indicates whether the original file was compressed.

NOEDIT
exports SAS/AF PROGRAM and SCL entries without Edit capability when you import them.

The NOEDIT option produces the same results as when you create a new catalog to contain SCL code by using the MERGE statement with the NOEDIT option in the BUILD procedure of SAS/AF software.

Alias NEDIT

Note The NOEDIT option affects only SAS/AF PROGRAM and SCL entries. It does not affect FSEDIT SCREEN or FSVIEW FORMULA entries.

NOSRC
specifies that exported catalog entries contain compiled SCL code but not the source code.

The NOSRC option produces the same results as when you create a new catalog to contain SCL code by using the MERGE statement with the NOSOURCE option in the BUILD procedure of SAS/AF software.

Alias NSRC

OUTLIB=*libref*
specifies a libref associated with a SAS library. If you specify the OUTLIB= option, PROC CIMPORT is invoked automatically to re-create the input library, data set, or catalog in the specified library.

Alias OUT=

Tip Use the OUTLIB= option when you change SAS files from one DBCS type to another within the same operating environment if you want to keep the original data intact.

OUTTYPE=UPCASE
writes all displayed characters to the transport file and to the OUTLIB= file in uppercase.

Interaction The OUTTYPE= option invokes the NOCOMPRESS option.

TAPE
directs the output from PROC CPORT to a tape.

Default The output from PROC CPORT is sent to disk.

TRANSLATE=(*translation-list*)
translates specified characters from one ASCII or EBCDIC value to another. Each element of *translation-list* has the following form:

- *ASCII-value-1* TO *ASCII-value-2*
- *EBCDIC-value-1* TO *EBCDIC-value-2*

You can use hexadecimal or decimal representation for ASCII values. If you use the hexadecimal representation, values must begin with a digit and end with an x. Use a leading zero if the hexadecimal value begins with an alphabetic character.

For example, to translate all left brackets to left braces, specify the TRANSLATE= option as follows (for ASCII characters):

```
translate=(5bx to 7bx)
```

The following example translates all left brackets to left braces and all right brackets to right braces:

```
translate=(5bx to 7bx 5dx to 7dx)
```

EXCLUDE Statement

Excludes specified files or entries from the transport file.

Interaction: You can use either EXCLUDE statements or SELECT statements in a PROC CPORT step, but not both.

Tip: There is no limit to the number of EXCLUDE statements that you can use in one invocation of PROC CPORT.

Syntax

EXCLUDE *SAS file(s) | catalog entry(s)* </ MEMTYPE=*mtype*> </ ENTRYTYPE=*entry-type*>;

Required Argument

SAS file(s) | catalog entry(s)
specifies one or more SAS files or one or more catalog entries to be excluded from the transport file. Specify SAS filenames when you export a SAS library; specify catalog entry names when you export an individual SAS catalog. Separate multiple filenames or entry names with a space. You can use shortcuts to list many like-named files in the EXCLUDE statement. For more information, see "SAS Data Sets" in *SAS Language Reference: Concepts*.

Optional Arguments

ENTRYTYPE=*entry-type*
specifies a single entry type for the catalog entries listed in the EXCLUDE statement. See *SAS Language Reference: Concepts* for a complete list of catalog entry types.

Alias: ETYPE=, ET=

Restriction: ENTRYTYPE= is valid only when you export an individual SAS catalog.

MEMTYPE=*mtype*
specifies a single member type for one or more SAS files listed in the EXCLUDE statement. Valid values are CATALOG, DATA, or ALL. If you do not specify the

MEMTYPE= option in the EXCLUDE statement, then processing is restricted to those member types specified in the MEMTYPE= option in the PROC CPORT statement.

You can also specify the MEMTYPE= option, enclosed in parentheses, immediately after the name of a file. In parentheses, MEMTYPE= identifies the type of the filename that immediately precedes it. When you use this form of the option, it overrides the MEMTYPE= option that follows the slash in the EXCLUDE statement, but it must match the MEMTYPE= option in the PROC CPORT statement:

Alias MTYPE=, MT=

Default If you do not specify MEMTYPE= in the PROC CPORT statement or in the EXCLUDE statement, the default is MEMTYPE=ALL.

Restrictions MEMTYPE= is valid only when you export a SAS library.

If you specify a member type for MEMTYPE= in the PROC CPORT statement, it must agree with the member type that you specify for MEMTYPE= in the EXCLUDE statement.

See Refer to "Names in the SAS Language" in *SAS Language Reference: Concepts* for naming conventions that you can use for names and member names.

SELECT Statement

Includes specified files or entries in the transport file.

Interaction: You can use either EXCLUDE statements or SELECT statements in a PROC CPORT step, but not both.

Tip: There is no limit to the number of SELECT statements that you can use in one invocation of PROC CPORT.

Examples: "Example 2: Exporting Individual Catalog Entries" on page 555

"Example 4: Using PROC CIMPORT to Import a French Data Set into a UTF-8 SAS Session" on page 414

Syntax

SELECT *SAS file(s) | catalog entry(s)* </ MEMTYPE=*mtype*>
</ ENTRYTYPE=*entry-type*> ;

Required Argument

SAS file(s) | catalog entry(s)
specifies one or more SAS files or one or more catalog entries to be included in the transport file. Specify SAS filenames when you export a SAS library; specify catalog entry names when you export an individual SAS catalog. Separate multiple filenames or entry names with a space. You can use shortcuts to list many like-named files in the SELECT statement. For more information, see "SAS Data Sets" in *SAS Language Reference: Concepts*.

Optional Arguments

ENTRYTYPE=*entry-type*
specifies a single entry type for the catalog entries listed in the SELECT statement. See *SAS Language Reference: Concepts* for a complete list of catalog entry types.

Alias ETYPE=, ET=

Restriction ENTRYTYPE= is valid only when you export an individual SAS catalog.

MEMTYPE=*mtype*
specifies a single member type for one or more SAS files listed in the SELECT statement. Valid values are CATALOG, DATA, or ALL. If you do not specify the MEMTYPE= option in the SELECT statement, then processing is restricted to those member types specified in the MEMTYPE= option in the PROC CPORT statement.

You can also specify the MEMTYPE= option, enclosed in parentheses, immediately after the name of a member. In parentheses, MEMTYPE= identifies the type of the member name that immediately precedes it. When you use this form of the option, it overrides the MEMTYPE= option that follows the slash in the SELECT statement, but it must match the MEMTYPE= option in the PROC CPORT statement.

Alias MTYPE=, MT=

Default If you do not specify MEMTYPE= in the PROC CPORT statement or in the SELECT statement, the default is MEMTYPE=ALL.

Restrictions MEMTYPE= is valid only when you export a SAS library.

If you specify a member type for MEMTYPE= in the PROC CPORT statement, it must agree with the member type that you specify for MEMTYPE= in the SELECT statement.

See Refer to "Names in the SAS Language" in *SAS Language Reference: Concepts* for naming conventions that you can use for names and member names.

TRANTAB Statement

Specifies translation tables for characters in catalog entries that you export.

Restriction: The TRANTAB statement does not support DBCS or UTF-8 SAS sessions.

Tip: You can specify only one translation table for each TRANTAB statement. However, you can use more than one translation table in a single invocation of PROC CPORT.

See: The TRANTAB Statement for the CPORT Procedure and the UPLOAD and DOWNLOAD Procedures in *SAS National Language Support (NLS): Reference Guide*.

Example: "Example 4: Applying a Translation Table" on page 557

Syntax

TRANTAB NAME=*translation-table-name* <*options*>;

Usage: CPORT Procedure

READ= Data Set Option in the PROC CPORT Statement

To be authorized to create the transport file for a read-protected data set, you must include the password (clear-text or encoded). If the password is not included, the transport file cannot be created.

If you are working with a password protected data set, you can supply that password using the READ= option. If you do not supply the password using the READ= option for a read-protected data set, you are prompted for the password.

Use the READ= data set option to include the appropriate password for the read-protected data set when creating a transport file. In Example 1, PROC CPORT copies the input file that is named SOURCE.GRADES, includes the password ADMIN with the data set, and creates the transport file named GRADESOUT.

Example 1: Clear-Text Password:

```
proc cport data=source.grades(read=admin) file=gradesout;
```

In Example 2, an encoded password is specified with the READ= option. An encoded password is generated via the PWENCODE procedure. For details, see Chapter 54, "PWENCODE Procedure," on page 1939.

Example 2: Encoded Password

```
proc cport
data=source.grades(read={sas003}6EDB396015B96DBD9E80F0913A543819A8E5)
   file=gradesout;
```

If the password is omitted when referring to a password protected data set, SAS prompts for the password. If an invalid password is specified, an error message is sent to the log. Here is an example error:

```
ERROR: Invalid or missing READ password on member WORK.XYZ.DATA
```

If the data set is transported as part of a library or named in a SELECT statement, a password is not required. However, if a data set with a password is transported and the target SAS engine does not support passwords, the transport file cannot be imported.

For details about the READ= data set option, see *SAS Data Set Options: Reference*, and for details about password-protected data sets, see *SAS Language Reference: Concepts*.

Note: PROC CIMPORT does not require a password in order to restore the transport file in the target environment. However, other SAS procedures that use the password-protected data set must include the password.

CPORT Problems: Creating Transport Files

About Transport Files and Encodings

The character data in a transport file is created for the following types of encodings:

- the UTF-8 encoding of the SAS session in which the transport file is created.
- the Windows encoding that is associated with the locale of the SAS session in which the transport file is created. However, starting in SAS 9.4M3, PROC CIMPORT supports the ability to import data sets that are created in non-UTF-8 SAS sessions into UTF-8 SAS sessions.

  Using PROC CIMPORT to import a data set in a UTF-8 session preserves the encoding value of the data set. For example, if a data set with SHIFT-JIS encoding is imported into a UTF-8 session using PROC CIMPORT, PROC CONTENTS shows that the SHIFT-JIS encoding is maintained.

Note: The ENCODINGINFO= option displays the Window's encoding associated with the locale of the SAS session in which the transport file was created.

- In SAS 9.4, when you use PROC CPORT to create a transport file that is encoded with US-ASCII on an ASCII platform, regardless of the session encoding, the US-ASCII encoding is preserved for that transport file. If you then transport that data set to an ASCII platform using PROC CIMPORT, the US-ASCII encoding for that transport file is preserved and is not transcoded. The data set that is created has the US-ASCII encoding, not the session encoding. For example, if your session encoding is WLATIN1, you use PROC CPORT to create a data set that has an encoding of US-ASCII. The US-ASCII encoding is preserved in the transport file, instead of the WLATIN1 encoding. This preservation also occurs when you use PROC CIMPORT on this data set. The US-ASCII encoding is preserved and is not transcoded when you use PROC CIMPORT to transport the data set to an ASCII platform.

  Note: The preservation of the US-ASCII encoding occurs only on an ASCII platform, not on z/OS.

- on a z/OS platform, PROC CIMPORT creates data sets using the session encoding.

These examples show how SAS applies an encoding to a transport file:

Table 16.1 *Assignment of Encodings to Transport Files*

Encoding Value of the Transport File	Example of Applying an Encoding in a SAS Invocation	Explanation
utf-8 or us-ascii	sas9 -encoding utf8;	A SAS session is invoked using the UTF-8 encoding. The session encoding is applied to the transport file. Note that starting in SAS 9.4M3, if the data set is US-ASCII, the US-ASCII encoding is preserved, not the session encoding.
wlatin2	sas9 -locale pl_PL;	A SAS session is invoked using the default UNIX encoding, LATIN2, which is associated with the Polish Poland locale.

For a complete list of encodings that are associated with each locale, see Locale Tables in *SAS National Language Support (NLS): Reference Guide*.

In order for a transport file to be imported successfully, the encodings of the source and target SAS sessions must be compatible. Here is an example of compatible source and target SAS sessions:

Table 16.2 Compatible Encodings

Source SAS Session			Target SAS Session	
Locale	**UNIX SAS Session Encoding**	**Transport File Encoding**	**Locale**	**Windows SAS Session Encoding**
es_MX (Spanish Mexico)	latin1	wlatin1	it_IT (Italian Italy)	wlatin1

The encodings of the source and target SAS sessions are compatible because the Windows default encoding for the es_MX locale is WLATIN1 and the encoding of the target SAS session is WLATIN1. For more detailed information about compatible languages and encodings, see the SAS Press book SAS Encoding: Understanding the Details, by Manfred Kiefer.

However, if the encodings of the source and target SAS sessions are incompatible, a transport file might not be successfully imported. (See the introduction to this section.) Here is an example of incompatible encodings:

Table 16.3 Incompatible Encodings

Source SAS Session			Target SAS Session	
Locale	**UNIX SAS Session Encoding**	**Transport File Encoding**	**Locale**	**z/OS Encoding**
cs_CZ (Czech Czechoslovakia)	latin2	wlatin2	de_DE (German Germany)	open_ed-1141

The encodings of the source and target SAS sessions are incompatible because the Windows default encoding for the cs_CZ locale is WLATIN2 and the encoding of the target SAS session is OPEN_ED-1141. A transport file cannot be imported between these locales.

When importing transport files, you can use the ENCODINGINFO= option to see the encoding value of the transport file. Otherwise, you are alerted to compatibility problems via warnings and error messages. For more information about the ENCODINGINFO= option, see "ENCODINGINFO=ALL | *n*" on page 394.

Data Control Blocks Characteristics

A common problem when you create or import a transport file under the z/OS environment is a failure to specify the correct Data Control Block (DCB)

characteristics. When you reference a transport file, you must specify the following DCB characteristics:

- LRECL=80
- BLKSIZE=8000
- RECFM=FB
- DSORG=PS

Another common problem can occur if you use communications software to move files from another environment to z/OS. In some cases, the transport file does not have the proper DCB characteristics when it arrives on z/OS. If the communications software does not allow you to specify file characteristics, try the following approach for z/OS:

1. Create a file under z/OS with the correct DCB characteristics and initialize the file.
2. Move the transport file from the other environment to the newly created file under z/OS using binary transfer.

Loss of Numeric Precision

PROC CPORT and PROC CIMPORT can lose precision on numeric values that are extremely small and large. Refer to "Loss of Numeric Precision and Magnitude" in *SAS/CONNECT User's Guide* for details.

Examples: CPORT Procedure

Example 1: Exporting Multiple Catalogs

Features: PROC CPORT statement options
FILE=
MEMTYPE=

Details

This example shows how to use PROC CPORT to export entries from all of the SAS catalogs in the SAS library that you specify.

Program

```
libname source 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;

proc cport library=source file=tranfile memtype=catalog;
run;
```

Program Description

Specify the library reference for the SAS library that contains the source files to be exported and the file reference to which the output transport file is written. The LIBNAME statement assigns a libref for the SAS library. The FILENAME statement assigns a fileref and any operating environment options for file characteristics for the transport file that PROC CPORT creates.

```
libname source 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;
```

Create the transport file. The PROC CPORT step executes on the operating environment where the source library is located. MEMTYPE=CATALOG writes all SAS catalogs in the source library to the transport file.

```
proc cport library=source file=tranfile memtype=catalog;
run;
```

Log Examples

Example Code 16.1 *Exporting Multiple Catalogs*

```
NOTE: Proc CPORT begins to transport catalog SOURCE.FINANCE
NOTE: The catalog has 5 entries and its maximum logical record length is 866.
NOTE: Entry LOAN.FRAME has been transported.
NOTE: Entry LOAN.HELP has been transported.
NOTE: Entry LOAN.KEYS has been transported.
NOTE: Entry LOAN.PMENU has been transported.
NOTE: Entry LOAN.SCL has been transported.

NOTE: Proc CPORT begins to transport catalog SOURCE.FORMATS
NOTE: The catalog has 2 entries and its maximum logical record length is 104.
NOTE: Entry REVENUE.FORMAT has been transported.
NOTE: Entry DEPT.FORMATC has been transported.
```

Example 2: Exporting Individual Catalog Entries

Features: PROC CPORT statement option
FILE=
SELECT statement

Details

This example shows how to use PROC CPORT to export individual catalog entries, rather than all of the entries in a catalog.

Program

```
libname source 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;

proc cport catalog=source.finance file=tranfile;
select loan.scl;
run;
```

Program Description

Assign library references. The LIBNAME and FILENAME statements assign a libref for the source library and a fileref for the transport file, respectively.

```
libname source 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;
```

Write an entry to the transport file. SELECT writes only the LOAN.SCL entry to the transport file for export.

```
proc cport catalog=source.finance file=tranfile;
select loan.scl;
run;
```

Log Examples

Example Code 16.2 *Exporting Individual Catalog Entries*

```
NOTE: Proc CPORT begins to transport catalog SOURCE.FINANCE
NOTE: The catalog has 5 entries and its maximum logical record length is 866.
NOTE: Entry LOAN.SCL has been transported.
```

Example 3: Exporting a Single SAS Data Set

Features: PROC CPORT statement option
FILE=

Details

This example shows how to use PROC CPORT to export a single SAS data set.

Program

```
libname source 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;

proc cport data=source.times file=tranfile;
```

```
run;
```

Program Description

Assign library references. The LIBNAME and FILENAME statements assign a libref for the source library and a fileref for the transport file, respectively.

```
libname source 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;
```

Specify the type of file that you are exporting. The DATA= specification in the PROC CPORT statement tells the procedure that you are exporting a SAS data set rather than a library or a catalog.

```
proc cport data=source.times file=tranfile;
run;
```

Log Examples

Example Code 16.3 *Exporting a Single SAS Data Set*

```
NOTE: Proc CPORT begins to transport data set SOURCE.TIMES
NOTE: The data set contains 2 variables and 2 observations.
      Logical record length is 16.
NOTE: Transporting data set index information.
```

Example 4: Applying a Translation Table

Features:

PROC CPORT statement option
FILE=

TRANTAB statement option
TYPE=

Details

This example shows how to apply a customized translation table to the transport file before PROC CPORT exports it. For this example, assume that you have already created a customized translation table called TTABLE1.

Program

```
libname source 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;

proc cport catalog=source.formats file=tranfile;
   trantab name=ttable1 type=(format);
run;
```

Program Description

Assign library references. The LIBNAME and FILENAME statements assign a libref for the source library and a fileref for the transport file, respectively.

```
libname source 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;
```

Apply the translation specifics. The TRANTAB statement applies the translation that you specify with the customized translation table TTABLE1. TYPE= limits the translation to FORMAT entries.

```
proc cport catalog=source.formats file=tranfile;
   trantab name=ttable1 type=(format);
run;
```

Log Examples

Example Code 16.4 *Applying a Translation Table*

```
NOTE: Proc CPORT begins to transport catalog SOURCE.FORMATS
NOTE: The catalog has 2 entries and its maximum logical record length is 104.
NOTE: Entry REVENUE.FORMAT has been transported.
NOTE: Entry DEPT.FORMATC has been transported.
```

Example 5: Exporting Entries Based on Modification Date

Features: PROC CPORT statement options
AFTER=
FILE=

Details

This example shows how to use PROC CPORT to transport only the catalog entries with modification dates equal to or later than the date that you specify in the AFTER= option.

Program

```
libname source 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;

proc cport catalog=source.finance file=tranfile
           after='09sep1996'd;
run;
```

Program Description

Assign library references. The LIBNAME and FILENAME statements assign a libref for the source library and a fileref for the transport file, respectively.

```
libname source 'sas-library';
filename tranfile 'transport-file';

host-options-for-file-characteristics;
```

Specify the catalog entries to be written to the transport file. AFTER= specifies that only catalog entries with modification dates on or after September 9, 1996, should be written to the transport file.

```
proc cport catalog=source.finance file=tranfile
           after='09sep1996'd;
run;
```

Log Examples

PROC CPORT writes messages to the SAS log to inform you that it began the export process for all the entries in the specified catalog. However, PROC CPORT wrote only the entries LOAN.FRAME and LOAN.HELP in the FINANCE catalog to the transport file because only those two entries had a modification date equal to or later than September 9, 1996. That is, of all the entries in the specified catalog, only two met the requirement of the AFTER= option.

Example Code 16.5 *Exporting Entries Based on Modification Date*

```
NOTE: Proc CPORT begins to transport catalog SOURCE.FINANCE
NOTE: The catalog has 5 entries and its maximum logical record length is 866.
NOTE: Entry LOAN.FRAME has been transported.
NOTE: Entry LOAN.HELP has been transported.
```

17

DATASETS Procedure

Overview: DATASETS Procedure

Managing Data Sets Using the DATASETS Procedure

The DATASETS procedure is a utility procedure that manages your SAS files. With PROC DATASETS, you can do the following:

- copy SAS files from one SAS library to another
- rename SAS files
- repair SAS files
- delete SAS files
- list the SAS files that are contained in a SAS library
- list the attributes of a SAS data set:
  - the date on which the data was last modified
  - whether the data is compressed
  - whether the data is indexed
- manipulate passwords on SAS files
- append SAS data sets
- modify attributes of SAS data sets and variables within the data sets
- create and delete indexes on SAS data sets
- create and manage audit files for SAS data sets
- create and delete integrity constraints on SAS data sets
- create and manage extended attributes of data sets

Notes

- Although the DATASETS procedure can perform some operations on catalogs, generally the CATALOG procedure is the best utility to use for managing catalogs.
- The term *member* often appears as a synonym for *SAS file*. If you are unfamiliar with SAS files and SAS libraries, see "SAS Files Concepts" in *SAS Language Reference: Concepts*.
- If the NOLIST option is specified, then the PROC DATASETS statement does not list the SAS files. However, if you are using the ODS LISTING statement the result is displayed in the Results window. To view the output only in the SAS log, use the ODS EXCLUDE statement with the LISTING destination.
- PROC DATASETS cannot work with sequential data libraries.
- You cannot change the length of a variable using the LENGTH statement or the LENGTH= option in an ATTRIB statement.
- There can be a discrepancy between the modified date in PROC DATASETS, PROC CONTENTS, and other components of SAS, such as SAS Explorer. The two modified dates and times are distinctly different:
  - Operating-environment modified date and time is reported by the SAS Explorer and the PROC DATASETS LIST option.
  - The modified date and time reported by the CONTENTS statement is the date and time that the data within the data set was actually modified.

- If you have a library containing a large number of members, the DATASETS procedure might show an increase in process time. You might want to reorganize your library into smaller libraries for better performance.
- Beginning in the SAS 9.4 release, extended attributes are supported.
- If you want to use the KILL functionality of the DATASETS procedure and the DBMS=Redshift, then you need to use a SCHEMA= option in the LIBNAME statement.

Concepts: DATASETS Procedure

Procedure Execution

Execution of Statements

When you start the DATASETS procedure, you specify the procedure input library in the PROC DATASETS statement. If you omit a procedure input library, the procedure processes the current default SAS library (usually the Work library). To specify a new procedure input library, issue the DATASETS procedure again.

Statements execute in the order in which they are written. Use CONTENTS, COPY, CONTENTS if you want to see the contents of a data set, copy a data set, and then visually compare the contents of the second data set with the first.

RUN-Group Processing

PROC DATASETS supports RUN-group processing. RUN-group processing enables you to submit RUN groups without ending the procedure.

The DATASETS procedure supports four types of RUN groups. Each RUN group is defined by the statements that compose it and by what causes it to execute.

Some statements in PROC DATASETS act as implied RUN statements because they cause the RUN group preceding them to execute.

The following list discusses what statements compose a RUN group and what causes each RUN group to execute:

- The PROC DATASETS statement always executes immediately. No other statement is necessary to cause the PROC DATASETS statement to execute. Therefore, the PROC DATASETS statement alone is a RUN group.
- The MODIFY statement, and any of its subordinate statements, form a RUN group. These RUN groups always execute immediately. No other statement is necessary to cause a MODIFY RUN group to execute.
- The APPEND, CONTENTS, and COPY statements (including EXCLUDE and SELECT, if present), form their own separate RUN groups. Every APPEND statement forms a single-statement RUN group; every CONTENTS statement forms a single-statement RUN group; and every COPY step forms a RUN group. Any other statement in the procedure, except those that are subordinate to either the COPY or MODIFY statement, causes the RUN group to execute.
- One or more of the following statements form a RUN group:
  - AGE
  - CHANGE
  - DELETE
  - EXCHANGE
  - REPAIR
  - SAVE

  If any of these statements appear in sequence in the PROC step, the sequence forms a RUN group. For example, if a REPAIR statement appears immediately after a SAVE statement, the REPAIR statement does not force the SAVE statement to execute; it becomes part of the same RUN group. To execute the RUN group, submit one of the following statements:
  - PROC DATASETS
  - APPEND
  - CONTENTS
  - COPY
  - MODIFY
  - QUIT
  - RUN
  - another DATA or PROC step

SAS reads the program statements that are associated with one task until it reaches a RUN statement or an implied RUN statement. SAS executes all of the preceding statements immediately and continues reading until it reaches another RUN statement or implied RUN statement. To execute the last task, you must use a RUN statement or a statement that stops the procedure.

The following PROC DATASETS step contains five RUN groups:

```
LIBNAME dest 'SAS-library';
   /* RUN group */

proc datasets;
      /* RUN group */
```

```
      change nutr=fatg;
      delete bldtest;
      exchange xray=chest;
         /* RUN group */
      copy out=dest;
         select report;
         /* RUN group */
      modify bp;
         label dias='Taken at Noon';
         rename weight=bodyfat;
         /* RUN group */
      append base=tissue data=newtiss;
   quit;
```

Note: If you are running in interactive line mode, you can receive messages that statements have already executed before you submit a RUN statement. Plan your tasks carefully if you are using this environment for running PROC DATASETS.

Error Handling

Generally, if an error occurs in a statement, the RUN group containing the error does not execute. RUN groups preceding or following the one containing the error execute normally. The MODIFY RUN group is an exception. If a syntax error occurs in a statement subordinate to the MODIFY statement, only the statement containing the error fails. The other statements in the RUN group execute.

Note: If the first word of the statement (the statement name) is in error and the procedure cannot recognize it, the procedure treats the statement as part of the preceding RUN group.

Password Errors

If there is an error involving an incorrect or omitted password in a statement, the error affects only the statement containing the error. The other statements in the RUN group execute.

Forcing a RUN Group with Errors to Execute

The FORCE option in the PROC DATASETS statement forces execution of the RUN group even if one or more of the statements contain errors. Only the statements that are error-free execute.

Ending the Procedure

To stop the DATASETS procedure, you must issue a QUIT statement, a RUN CANCEL statement, a new PROC statement, or a DATA statement. Submitting a QUIT statement executes any statements that have not executed. Submitting a RUN CANCEL statement cancels any statements that have not executed.

Extended Attributes

Extended attributes are customized metadata for your SAS files. They are user-defined characteristics that you associate with a SAS data set or variable. Whereas common SAS attributes, such as length for variables for data sets are predefined SAS system attributes, extended attributes are attributes that you define yourself. Extended attributes are organized into (name, value) pairs.

Use the MODIFY statement to add, delete, remove, set, and update extended attributes. When using the COPY statement, if the OUT= library engine supports extended attributes, they are copied. Extended attributes are not appended when using the APPEND statement, unless the BASE= data set does not exist.

Extended attributes can be used to automate tasks that require a custom attribute to be associated with a variable or a data set.

An extended attribute can have numeric or character values. There is no maximum length to an extended attribute character value. By default, each value is stored in 256-byte segments. The length of the segment can be changed with the SEGLEN= option of the XATTR OPTIONS statement. This option indicates the length of the storage element that will hold the character attribute value. Should the segment size not be large enough for some particular character attribute value, another segment is allocated. To minimize processing time, choose a length that would accommodate most attribute values for the data set.

The following output shows a data set and variables with extended attributes.

Output 17.1 *Contents of a Data Set with Extended Attributes*

Alphabetic List of Variables and Attributes			
#	Variable	Type	Len
2	age	Num	8
5	cars	Num	8
3	income	Num	8
4	kids	Num	8
1	purchase	Char	3

Alphabetic List of Data Set Extended Attributes		
Extended Attribute	Numeric Value	Character Value
attrib	.	table
role	.	train

Alphabetic List of Extended Attributes on Variables			
Extended Attribute	Attribute Variable	Numeric Value	Character Value
level	income	.	interval
level	purchase	.	nominal
role	age	.	reject
role	income	.	input
role	purchase	.	target

For information about using extended attributes, see "XATTR ADD Statement" on page 660, "XATTR DELETE Statement" on page 661, "XATTR REMOVE Statement" on page 662, "XATTR SET Statement" on page 663, and "XATTR UPDATE Statement" on page 664.

Contents of a Library at the Directory Level

In a concatenated library, each physical piece of the library is a level. Level 1 is the first location in the libref definition, Level 2 is the second location, and so on. PROC DATASETS reports the number of levels in the library as a value under the LEVEL specification.

The following example shows that there are 6 Levels in the libref named Samp.

The SAS System

Directory	
Libref	SAMP
Levels	6

Level 1	
Engine	V9
Physical Name	C:\Program Files\SASHome\SASFoundation\9.4\core\sample
Filename	C:\Program Files\SASHome\SASFoundation\9.4\core\sample

Level 2	
Engine	V9
Physical Name	C:\Program Files\SASHome\SASFoundation\9.4\access\sample
Filename	C:\Program Files\SASHome\SASFoundation\9.4\access\sample

Level 3	
Engine	V9
Physical Name	C:\Program Files\SASHome\SASFoundation\9.4\accesssample\sample
Filename	C:\Program Files\SASHome\SASFoundation\9.4\accesssample\sample

Level 4	
Engine	V9
Physical Name	C:\Program Files\SASHome\SASFoundation\9.4\connect\sample
Filename	C:\Program Files\SASHome\SASFoundation\9.4\connect\sample

Level 5	
Engine	V9
Physical Name	C:\Program Files\SASHome\SASFoundation\9.4\eis\sample
Filename	C:\Program Files\SASHome\SASFoundation\9.4\eis\sample

Level 6	
Engine	V9
Physical Name	C:\Program Files\SASHome\SASFoundation\9.4\ets\sample
Filename	C:\Program Files\SASHome\SASFoundation\9.4\ets\sample

CONTENTS Statement with VARCHAR

If there is a VARCHAR data type in the table, PROC CONTENTS or PROC DATASETS CONTENTS statement shows the Length in bytes and characters, as well as the max bytes used. PROC CONTENTS reports metadata about the table and the metadata about the variables. The CAS engine is the only engine supporting VARCHAR.

The bottom portion of PROC CONTENTS (related to the variable metadata) is the metadata that is represented in the SAS session. Based on what type of transcoding that might or might not be needed to go from the CAS UTF–8 encoding to the SAS session encoding. The variable byte length used in SAS is dependent on the encoding of the SAS session. The variable byte length used in the SAS session might differ from the byte length.

Output 17.2 *Contents of Mycas.French2 Table*

Data Set Name	MYCAS.FRENCH2	**Observations**	11
Member Type	DATA	**Variables**	2
Engine	CAS	**Indexes**	0
Created	08/16/2017 18:05:10	**Observation Length**	40
Last Modified	08/16/2017 18:05:10	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information	
Data Limit	100MB
Caslib	CASUSER,
Scope	Session

Alphabetic List of Variables and Attributes

#	Variable	Type	Len		Max Bytes Used
			Bytes	Chars	
1	nterm	Varchar	80	20	19
2	term	Char	19		

Use the following code to show the contents of the Mycas library:

```
proc datasets lib=mycas;
contents data=cars;
run;
```

Output 17.3 *Mycas Library and Mycas.Cars Table*

Data Set Name	MYCAS.CARS	Observations	428
Member Type	DATA	Variables	15
Engine	CAS	Indexes	0
Created	08/16/2017 17:55:43	Observation Length	160
Last Modified	08/16/2017 17:55:43	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information	
Data Limit	100MB
Caslib	CASUSER
Scope	Session

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
9	Cylinders	Num	8		
5	DriveTrain	Char	5		
8	EngineSize	Num	8		Engine Size (L)
10	Horsepower	Num	8		
7	Invoice	Num	8	DOLLAR8.	
15	Length	Num	8		Length (IN)
11	MPG_City	Num	8		MPG (City)
12	MPG_Highway	Num	8		MPG (Highway)
6	MSRP	Num	8	DOLLAR8.	
1	Make	Char	13		
2	Model	Char	40		
4	Origin	Char	6		
3	Type	Char	8		
13	Weight	Num	8		Weight (LBS)
14	Wheelbase	Num	8		Wheelbase (IN)

Use the following code to show the contents of the Mycas library:

```
proc datasets lib=mycas;
contents data=mycs.cars directory details;
run;
```

Using the DIRECTORY and DETAILS Option

Directory	
Libref	MYCAS
Engine	CAS
Physical Name	eb4545e1
Session UUID	eb4545e1
Session Name	SASCAS1
Server Host	rdoesx
Server Port	55
Caslib	CASUSER

#	Name	Member Type	Obs, Entries or Indexes	Vars	Label	Number of Rows	Number of Columns	Last Modified	Data Encoding	Scope
1	CARS	DATA	428	15		428	15	08/16/2017 19:29:50	utf-8	Session
2	LASTMONTH	DATA	12	7		12	7	08/16/2017 18:56:09	utf-8	Session

Differences in the DATASETS Procedure Output When Using SAS/ACCESS LIBNAME Engines

When you use a SAS/ACCESS LIBNAME engine to access a database, some of the information that is available in the header of a SAS data set is not available to the procedure. Therefore, the procedure does not have the information to display. The CONTENTS procedure, the DATASETS COPY statement, and the DATASETS CONTENTS statement do not provide information about the indexes, integrity constraints, and number of observations. For example, copying a table with indexes and integrity constraints results in a table with no indexes or integrity constraints if the engine used to access the table is a SAS/ACCESS LIBNAME engine. In the following code, the output from the CONTENTS statement displays a `0` (zero) in the index field although the database has indexes, and displays a `.` (period) for the unknown number of observations.

```
proc datasets lib=mylib details;
   contents data=table-name;
run;
quit;
```

To obtain the number of observations, run an SQL query to obtain the count using the LIBNAME engine or explicit-pass through on the DBMS table.

To obtain the information about indexes and integrity constraints, you can use explicit pass-through of database-specific syntax to query the system tables. For documentation on explicit pass-through, see "Connecting to a DBMS By Using the SQL Procedure Pass-Through Facility" in *SAS SQL Procedure User's Guide*.

CAS Processing for the DATASETS Procedure

Accessing CAS tables through the CAS LIBNAME engine with the DATASETS procedure results in some behavior that differs from other LIBNAME engines. The following is a summary of these behavior differences:

- Indexes, integrity constraints, and extended attributes are not supported in CAS tables.
- The MODIFY statement results in an error because UPDATE access is not supported.
- If there is a VARCHAR data type in the table, the CONTENTS statement shows the length in bytes, length in characters, and maximum bytes used.
- The encoding shown by the CONTENTS statement is the encoding of the CAS table.
- The block I/O method cannot be used when appending a CAS table to a SAS data set.
- You cannot use the APPEND statement to add data to a CAS table because UPDATE access is not supported. Data from a CAS table can be appended to a SAS data set.
- If the CAS LIBNAME engine is used for both the input and output libraries with the COPY statement, the COPY task is executed on the CAS server. The NOACCEL option disables this behavior, causing the COPY task to be executed in the SAS session.

PROC DATASETS and the Output Delivery System (ODS)

Most procedures send their messages to the log and their procedure results to the output. PROC DATASETS is unique because it sends procedure results to both the log and the procedure output table. When the interface to ODS was created, it was decided that all procedure results (from both the log and the procedure output table) should be available to ODS. In order to implement this feature and maintain compatibility with earlier releases, the interface to ODS had to be slightly different from the usual interface.

By default, the PROC DATASETS statement itself produces two output objects: Members and Directory. These objects are routed to the log. The CONTENTS statement produces three output objects by default: Attributes, EngineHost, and Variables. (The use of various options adds other output objects.) These objects are routed to the procedure output table. If you open an ODS destination (such as HTML, RTF, or PRINTER), all of these objects are, by default, routed to that destination.

You can use the ODS SELECT and ODS EXCLUDE statements to control which objects go to which destination, just as you can for any other procedure.

PROC DATASETS and PROC CONTENTS assign a name to each table that they create. You can use these names to reference the table when using the Output Delivery System (ODS) to select tables and create output tables.

PROC CONTENTS generates the same ODS tables as PROC DATASETS with the CONTENTS statement.

Table 17.1 *ODS Tables Produced by the DATASETS Procedure without the CONTENTS Statement*

ODS Table	Description	Generates Table
Directory	General library information	Unless you specify the NOLIST option
Members	Library member information	Unless you specify the NOLIST option

Table 17.2 *ODS Table Names Produced by PROC CONTENTS and PROC DATASETS with the CONTENTS Statement*

ODS Table	Description	Generates Table
Attributes	Data set attributes	Unless you specify the SHORT option
Directory	General library information	If you specify DATA=<*libref*.>_ALL_ or the DIRECTORY option
Members	Library member information	If you specify DATA=<*libref*.>_ALL_ or the DIRECTORY option
Position	A detailed listing of variables by logical position in the table	If you specify the VARNUM option and you do not specify the SHORT option
PositionShort	A concise listing of variables by logical position in the table	If you specify the VARNUM option and the SHORT option
Variables	A detailed listing of variables in alphabetical order	Unless you specify the SHORT option
VariablesShort	A concise listing of variables in alphabetical order	If you specify the SHORT option

Syntax: DATASETS Procedure

Notes: Data set names and variable names that end with large numeric values that are larger than a long integer cannot be used in numbered-range lists. For more information, see "Restriction for Numbered Range Lists" in *SAS Language Reference: Concepts*.

NOTE: _LAST_ is the name of the last data set that is created in your session. When the BASE= data set does not exist and PROC APPEND creates it, PROC APPEND sets _LAST_ to the name of the BASE= data set.

Tips: Supports RUN-group processing.

Supports the Output Delivery System. For details, see "Output Delivery System: Basic Concepts" in *SAS Output Delivery System: User's Guide*.

See: For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

DATASETS Procedure under Windows, UNIX, z/OS

PROC DATASETS <*options*>;

AGE *current-name related-SAS-file(s)*
</ <ALTER=*alter-password*> <MEMTYPE=*member-type*>>;

APPEND BASE=<*libref.*>*SAS-data-set*
<APPENDVER=V6>
<DATA=<*libref.*>*SAS-data-set*>
<ENCRYPTKEY=*key-value*>
<FORCE>
<GETSORT>
<NOWARN>;

AUDIT *SAS-file* <(*SAS-password* <ENCRYPTKEY=*key-value*>
<GENNUM=*integer*>)>;

INITIATE <AUDIT_ALL=NO | YES>;

LOG <ADMIN_IMAGE=YES | NO>
<BEFORE_IMAGE=YES | NO>
<DATA_IMAGE=YES | NO>
<ERROR_IMAGE=YES | NO>;

<SUSPEND | RESUME | TERMINATE; >

<USER_VAR> *variable-name-1* <$> <*length*> <LABEL='*variable-label*' >
<*variable-name-2* <$> <*length*> <LABEL='*variable-label*' > ...>;

CHANGE *old-name-1=new-name-1*
<*old-name-2=new-name-2* ...>
</ <ENCRYPTKEY=*key-value*>
<ALTER=*alter-password*> <GENNUM=ALL | *integer*> <MEMTYPE=*member-type*>>;

CONTENTS <*options*>;

COPY <ACCEL | NOACCEL>OUT=*libref-1*
<CLONE | NOCLONE>
<CONSTRAINT=YES | NO>
<DATECOPY>
<ENCRYPTKEY=*key-value*>
<FORCE>
IN=*libref-2*
<INDEX=YES | NO>
<MEMTYPE=(*member-type(s)*)>
<MOVE <ALTER=*alter-password*>>
<OVERRIDE=(*ds-option-1=value-1 <ds-option-2=value-2 ...>*) >;

SELECT *SAS-file(s)*
</ <ENCRYPTKEY=*key-value*> <ALTER=*alter-password*>
<MEMTYPE=*member-type*>>;

DELETE *SAS-file(s)*
</ <ALTER=*alter-password*>
<ENCRYPTKEY=*key-value*>
<GENNUM=ALL | HIST | REVERT | *integer*>
<MEMTYPE=*member-type*>>;

EXCHANGE *name-1=other-name-1 <name-2=other-name-2 ...>*
</ <ALTER=*alter-password*> <MEMTYPE=*member-type*>>;

MODIFY *SAS-file* <(*options*)>
</ <CORRECTENCODING=*encoding-value*> <DTC=*SAS-date-time*>
<GENNUM=*integer*> <MEMTYPE=*member-type*>>;

ATTRIB *variable-list(s) attribute-list(s)*;

FORMAT *variable-1* <*format-1*>
<*variable-2* <*format-2*> ...>;

IC CREATE <*constraint-name=*> *constraint* <MESSAGE='*message-string*'
<MSGTYPE=USER>>;

IC DELETE *constraint-name(s)* | _ALL_;

IC REACTIVATE *foreign-key-name* REFERENCES *libref*;

INDEX CENTILES *index(s)*
</ <REFRESH> <UPDATECENTILES=ALWAYS | NEVER | *integer*>>;

INDEX CREATE *index-specification(s)*
</ <NOMISS> <UNIQUE> <UPDATECENTILES=ALWAYS | NEVER |
integer>>;

INDEX DELETE *index(s)* | _ALL_;

INFORMAT *variable-1* <*informat-1*>
<*variable-2* <*informat-2*> ...>;

LABEL *variable-1=<'label-1' | ' '>*
<*variable-2=<'label-2' | ' '> ...>*;

RENAME *old-name-1=new-name-1*
<*old-name-2=new-name-2 ...*>;

XATTR ADD DS *attribute-name-1=attribute-value-1*
<*attribute-name-2=attribute-value-2 ...*>;

or

XATTR ADD VAR *variable-name-1 (attribute-name-1=attribute-value-1*

< *attribute-name-2=attribute-value-2 ...>)*
<*variable-name-2* (*attribute-name-1=attribute-value-1*
<*attribute-name-2=attribute-value-2 ...*>) >;

XATTR DELETE;

XATTR OPTIONS <SEGLEN=*number-of-bytes*>;

XATTR REMOVE DS *attribute-name(s)* ;

or

XATTR REMOVE VAR *variable-name-1* (*attribute-name(s)*)
<*variable-name-2* (*attribute-name(s) ...*)>;

XATTR SET DS *attribute-name-1=attribute-value-1*
<*attribute-name-2="attribute-value-2" ...*>;

or

XATTR SET VAR *variable-name-1* (*attribute-name-1=attribute-value-1*
<*attribute-name-2=attribute-value-2 ... >*)
<*variable-name-2* (*attribute-name-1=attribute-value-1*
<*attribute-name-2=attribute-value-2*> ...)>;

XATTR UPDATE DS *attribute-name-1=attribute-value-1*
<*attribute-name-2=attribute-value-2 ...*>;

or

XATTR UPDATE VAR *variable-name-1* (*attribute-name-1=attribute-value-1*
<*attribute-name-2=attribute-value-2 ...*>)
<*variable-name-2* (*attribute-name-1=attribute-value-1*
<*attribute-name-2=attribute-value-2 ...*>)>;

REBUILD *SAS-file* </ <ENCRYPTKEY=*key-value*>
<ALTER=*password*> <GENNUM=*n*> <MEMTYPE=*member-type*>
<NOINDEX>>;

REPAIR </ <ENCRYPTKEY=*key-value*>
<ALTER=*alter-password*> <GENNUM=*integer*> <MEMTYPE=*member-type*>>;

SAVE *SAS-file(s)* </ MEMTYPE=*member-type*>;

Statement	Task	Example
PROC DATASETS	Manage SAS files	
AGE	Rename a group of related SAS files	Ex. 7
APPEND	Add observations from one SAS data set to the end of another SAS data set	Ex. 6
ATTRIB	Associate a format, informat, or label with variables in the SAS data set specified in the MODIFY statement	Ex. 1
AUDIT	Initiate, control, suspend, resume, or terminate event logging to an audit file	
CHANGE	Rename one or more SAS files	Ex. 2

Statement	Task	Example
CONTENTS	Describe the contents of one or more SAS data sets and prints a directory of the SAS library	Ex. 5
COPY	Copy all or some of the SAS files	Ex. 2
DELETE	Delete SAS files	Ex. 2
EXCHANGE	Exchange the names of two SAS files	Ex. 2
EXCLUDE	Exclude SAS files from copying	Ex. 2
FORMAT	Permanently assign, change, and remove variable formats	Ex. 4
IC CREATE	Create an integrity constraint	
IC DELETE	Delete an integrity constraint	
IC REACTIVATE	Reactivate a foreign key integrity constraint	
INDEX CENTILES	Update centiles statistics for indexed variables	
INDEX CREATE	Create simple or composite indexes	Ex. 4
INDEX DELETE	Delete one or more indexes	
INFORMAT	Permanently assign, change, and remove variable informats	Ex. 4
INITIATE	Create an audit file that has the same name as the SAS data file and a data set type of AUDIT	Ex. 8
LABEL	Assign, change, and remove variable labels	Ex. 4
LOG	Specify the settings for an audit file	Ex. 8
MODIFY	Change the attributes of a SAS file and the attributes of variables	Ex. 4
REBUILD	Specify whether to restore or delete the disabled indexes and integrity constraints	
RENAME	Rename variables in the SAS data set	Ex. 4
REPAIR	Attempt to restore damaged SAS data sets or catalogs	
RESUME	Resume event logging to the audit file, if the audit file was suspended	Ex. 8
SAVE	Delete all the SAS files except the ones listed in the SAVE statement	Ex. 3
SELECT	Select SAS files for copying	Ex. 2
SUSPEND	Suspend event logging to the audit file	Ex. 8

Statement	Task	Example
TERMINATE	Terminate event logging and deletes the audit file	Ex. 8
USER_VAR	Define optional variables to be logged in the audit file with each update to an observation	Ex. 8
XATTR ADD	Add an extended attribute to a variable or a data set	Ex. 9
XATTR DELETE	Delete all of the extended attributes from a data set	
XATTR OPTIONS	Specify options as needed for extended attributes	Ex. 9
XATTR REMOVE	Remove an extended attribute from a variable or a data set	
XATTR SET	Update or add an extended attribute to a variable or a data set	
XATTR UPDATE	Update an extended attribute of a variable or a data set	Ex. 9

PROC DATASETS Statement

Manages SAS files.

Syntax

PROC DATASETS <*options*>;

Summary of Optional Arguments

ALTER=*alter-password*
: provides Alter access to any alter-protected SAS file in the SAS library.

DETAILS

NODETAILS
: includes information in the log about the number of observations, number of variables, number of indexes, and data set labels.

ENCRYPTKEY=*key-value*
: specifies the key value for AES encryption.

FORCE

forces either a RUN group to execute even when there are errors or forces an Append operation.

GENNUM=ALL | HIST | REVERT | *integer*
: restricts processing for generation data sets.

KILL
: deletes SAS files.

LIBRARY=*libref*
: specifies the procedure input/output library.

MEMTYPE=(*member-type(s)*)
: restricts processing to a certain type of SAS file.

NODETAILS
: see the description of DETAILS | NODETAILS.

NOLIST
: suppresses the printing of the directory.

NOPRINT
: suppresses the printing of the output to the log and listing.

NOWARN
: suppresses error processing.

PW= *password*
: provides Read, Write, or Alter access.

READ=*read-password*
: provides Read access.

Optional Arguments

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files in the SAS library.

See "Using Passwords with the DATASETS Procedure" on page 665

DETAILS | NODETAILS
determines whether the following columns are written to the log:

Obs, Entries, or Indexes	gives the number of observations for SAS files of type AUDIT, DATA, and VIEW; the number of entries for type CATALOG; and the number of files of type INDEX that are associated with a data file, if any. If SAS cannot determine the number of observations in a SAS data set, the value in this column is set to missing. For example, in a very large data set, if the number of observations or deleted observations exceeds the number that can be stored in a double-precision integer, the count shows as missing. The value for type CATALOG is the total number of entries. For other types, this column is blank.
Vars	gives the number of variables for types AUDIT, DATA, and VIEW. If SAS cannot determine the number of variables in the SAS data set, the value in this column is set to missing. For other types, this column is blank.
Label	contains the label associated with the SAS data set. This column prints a label only for the type DATA.

> **TIP** The value for files of type INDEX includes both user-defined indexes and indexes created by integrity constraints. To view index ownership and attribute information, use PROC DATASETS with the CONTENTS statement and the OUT2 option.

Note: The DETAILS option affects output only when a directory is specified and requires Read access to all read-protected SAS files in the SAS library. If you do not supply the Read password, the directory listing contains missing values for the columns produced by the DETAILS option.

Default If neither DETAILS or NODETAILS is specified, the default is the system option setting. The default system option setting is NODETAILS.

Tip If you are using the SAS windowing environment and specify the DETAILS option for a library that contains read-protected SAS files, a dialog box prompts you for each Read password that you do not specify in the PROC DATASETS statement. Therefore, you might want to assign the same Read password to all SAS files in the same SAS library.

Example "Example 2: Manipulating SAS Files" on page 696

ENCRYPTKEY=*key-value*
specifies the key value for AES encryption.

See "Appending AES-Encrypted Data Sets" on page 592

FORCE
performs two separate actions:

- forces a RUN group to execute even if errors are present in one or more statements in the RUN group. See "RUN-Group Processing" on page 564 for a discussion of RUN-group processing and error handling.
- forces all APPEND statements to concatenate two data sets even when the variables in the data sets are not exactly the same. The APPEND statement drops the extra variables and issues a warning message to the SAS log unless the NOWARN option is specified (either with the APPEND statement or PROC DATASETS). For more information about the FORCE option, see APPEND statement on page 586.

GENNUM=ALL | HIST | REVERT | *integer*
restricts processing for generation data sets. Valid values are as follows:

ALL for subordinate CHANGE and DELETE statements, refers to the base version and all historical versions in a generation group.

HIST for a subordinate DELETE statement, refers to all historical versions, but excludes the base version in a generation group.

REVERT | 0
: for a subordinate DELETE statement, refers to the base version in a generation group and changes the most current historical version, if it exists, to the base version.

integer
: for subordinate AUDIT, CHANGE, MODIFY, DELETE, and REPAIR statements, refers to a specific version in a generation group. Specifying a positive number is an absolute reference to a specific generation number that is appended to a data set name (that is, **gennum=2** specifies MYDATA#002). Specifying a negative number is a relative reference to a historical version in relation to the base version, from the youngest to the oldest (that is, **gennum=-1** refers to the youngest historical version).

See "Restricting Processing for Generation Data Sets" on page 667

KILL
deletes all SAS files in the SAS library that are available for processing. The MEMTYPE= option subsets the member types that the statement deletes. The following example deletes all the data files in the Work library:

```
proc datasets lib=work kill memtype=data; run; quit;
```

CAUTION
The KILL option deletes the SAS files immediately after you submit the statement. If the SAS file has an ALTER= password assigned, it must be specified in order to delete the SAS file.

LIBRARY=*libref*
names the library that the procedure processes. This library is the *procedure input/output library*.

Aliases
: DDNAME=
: DD=
: LIB=

Default
: Work or User

Note
: A SAS library that is accessed via a sequential engine (such as a tape format engine) cannot be specified as the value of the LIBRARY= option.

See
: For information about the Work and User libraries, see "One-level SAS Data Set Names" in *SAS Language Reference: Concepts*.

Example
: "Example 2: Manipulating SAS Files" on page 696

MEMTYPE=(*member-type(s)*)
restricts processing to one or more member types and restricts the listing of the data library directory to SAS files of the specified member types. For example, the following PROC DATASETS statement limits processing to SAS data sets in the default data library and limits the directory listing in the SAS log to SAS files of member type DATA:

```
proc datasets memtype=data;
```

Aliases MTYPE=

MT=

Default ALL

See "Restricting Member Types for Processing" on page 668

NODETAILS

See "DETAILS|NODETAILS" on page 580.

NOLIST

suppresses the printing of the directory of the SAS files in the SAS log and any open non-LISTING destination.

Note If you have ODS LISTING turned on and open a non-LISTING ODS destination, PROC DATASETS output goes to both the SAS log and the ODS destination. The NOLIST option suppresses output to both. To see the output in the SAS log only, use the ODS EXCLUDE statement by specifying the Members and Directory output objects. For example, if the RTF and LISTING destinations are both open and Directory and Members information is desired in the LOG window only, use the following:

```
ods rtf file="listing_nolist.rtf";
ods trace on;
ods rtf exclude directory members;

proc datasets lib=work;
run;
quit;

ods rtf close;
```

Example "Example 4: Modifying SAS Data Sets" on page 704

NOPRINT

suppresses the printing of the output and the printing of the directory of the SAS files in the log and any open non-LISTING destination. The NOPRINT option is a combination of the NOLIST option and the NOPRINT option in the CONTENTS statement.

NOWARN

suppresses the error processing that occurs when a SAS file that is specified in a SAVE, CHANGE, EXCHANGE, REPAIR, DELETE, or COPY statement or listed as the first SAS file in an AGE statement, is not in the procedure input library. When an error occurs and the NOWARN option is in effect, PROC DATASETS continues processing that RUN group. If NOWARN is not in effect, PROC DATASETS stops processing that RUN group and issues a warning for all operations except DELETE, for which it does not stop processing.

PW= ***password***
provides the password for any protected SAS files in the SAS library. PW= can act as an alias for READ=, WRITE=, or ALTER=.

See "Using Passwords with the DATASETS Procedure" on page 665

READ=*read-password*
provides the Read password for any read-protected SAS files in the SAS library.

See "Using Passwords with the DATASETS Procedure" on page 665

AGE Statement

Renames a group of related SAS files in a library.

Example: "Example 7: Aging SAS Data Sets" on page 713

Syntax

AGE *current-name related-SAS-file(s)*
</ <ALTER=*alter-password*> <MEMTYPE=*member-type*>>;

Required Arguments

current-name
is a SAS file that the procedure renames. *current-name* receives the name of the first name in *related-SAS-file(s)*.

related-SAS-file(s)
is one or more SAS files in the SAS library.

Optional Arguments

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files named in the AGE statement. Because an AGE statement renames and deletes SAS files, you need Alter access to use the AGE statement. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

See "Using Passwords with the DATASETS Procedure" on page 665

MEMTYPE=*member-type*
restricts processing to one member type. All of the SAS files that you name in the AGE statement must be the same member type. You can use the option after a forward slash after the name of each SAS file.

Aliases MTYPE=

MT=

Default If you do not specify MEMTYPE= in the PROC DATASETS statement, the default is DATA.

See "Restricting Member Types for Processing" on page 668

Details

The AGE statement renames the *current-name* to the name of the first name in the *related-SAS-files*, renames the first name in the *related-SAS-files* to the second name in the *related-SAS-files*, and so on, until it changes the name of the next-to-last SAS file in the *related-SAS-files* to the last name in the *related-SAS-files*. The AGE statement then deletes the last file in the *related-SAS-files*.

If the first SAS file named in the AGE statement does not exist in the SAS library, PROC DATASETS stops processing the RUN group containing the AGE statement and issues an error message. The AGE statement does not age any of the *related-SAS-files*. To override this behavior, use the NOWARN option in the PROC DATASETS statement.

If one of the *related-SAS-files* does not exist, the procedure prints a warning message to the SAS log but continues to age the SAS files that it can.

If you age a data set that has an index, the index continues to correspond to the data set.

You can age only entire generation groups. For example, if data sets A and B have generation groups, then the following statement deletes generation group B and ages (renames) generation group A to the name B:

```
age a b;
```

For example, suppose the generation group for data set A has three historical versions and the generation group for data set B has two historical versions. Then aging A to B has this effect:

Table 17.3 *Generation Groups*

Old Name	Version	New Name	Version
A	base	B	base
A	1	B	1
A	2	B	2
A	3	B	3
B	base	is deleted	

Old Name	Version	New Name	Version
B	1	is deleted	
B	2	is deleted	

APPEND Statement

Adds the observations from one SAS data set to the end of another SAS data set.

Default: If the BASE= data set is accessed through a SAS server and if no other user has the data set open at the time the APPEND statement begins processing, the BASE= data set defaults to CNTLLEV=MEMBER (member-level locking). When this behavior happens, no other user can update the file while the data set is processed.

Restriction: The BASE= option cannot be an existing CAS table.

Requirement: The BASE= data set must be a member of a SAS library that supports update processing.

Note: If you use the DROP=, KEEP=, or RENAME= options on the BASE= data set, the options ONLY affect the APPEND processing and does not change the variables in the appended BASE= data set. Variables that are dropped or not kept using the DROP= and KEEP= options still exist in the appended BASE= data set. Variables that are renamed using the RENAME= option remain with their original name in the appended BASE= data set. The CAS engine does not support update processing and therefore an existing CAS table cannot be specified with BASE=.

Tips: You can specify most data set options for the BASE= argument and DATA= option. However, if you specify DROP=, KEEP=, or RENAME= data set option for the BASE= data set, the option is ignored. You can use any global statements as well.

If a failure occurs during processing, the data set is marked as damaged and is reset to the pre-append condition at the next REPAIR statement. If the data set has an index, the index is not updated with each observation but is updated once at the end. (This behavior is Version 7 and later, as long as APPENDVER=V6 is not set.)

Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

Example: "Example 6: Concatenating Two SAS Data Sets" on page 710

Syntax

APPEND BASE=<*libref.*>*SAS-data-set*
<APPENDVER=V6>
<DATA=<*libref.*>*SAS-data-set*>
<ENCRYPTKEY=*key-value*>
<FORCE>

<GETSORT>
<NOWARN>;

Required Argument

BASE=<*libref.*> *SAS-data-set*
names the data set to which you want to add observations.

libref
specifies the library that contains the SAS data set. If you omit the libref, the default is the libref for the procedure input library. If you are using PROC APPEND, the default for libref is either Work or User.

SAS-data-set
names a SAS data set. If the APPEND statement cannot find an existing data set with this name, it creates a new data set in the library. That is, you can use the APPEND statement to create a data set by specifying a new data set name in the BASE= argument.

Whether you are creating a new data set or appending to an existing data set, the BASE= data set is the current SAS data set after all Append operations.

Alias OUT=

Example "Example 6: Concatenating Two SAS Data Sets" on page 710

Optional Arguments

APPENDVER=V6
uses the Version 6 behavior for appending observations to the BASE= data set, which is to append one observation at a time. Beginning in Version 7, to improve performance, the default behavior changed so that all observations are appended after the data set is processed.

See "Appending to an Indexed Data Set — Fast-Append Method" on page 593

DATA=<*libref.*> *SAS-data-set*
names the SAS data set containing observations that you want to append to the end of the SAS data set specified in the BASE= argument.

libref
specifies the library that contains the SAS data set. If you omit libref, the default is the libref for the procedure input library. The DATA= data set can be from any SAS library. You must use the two-level name if the data set resides in a library other than the procedure input library.

SAS-data-set
names a SAS data set. If the APPEND statement cannot find an existing data set with this name, it stops processing.

Alias NEW=

Default the most recently created SAS data set, from any SAS library

See "Appending with Generation Groups" on page 596

Example "Example 6: Concatenating Two SAS Data Sets" on page 710

ENCRYPTKEY=*key-value*
specifies the key value for AES encryption.

See "Appending AES-Encrypted Data Sets" on page 592

FORCE
forces the APPEND statement to concatenate data sets when the DATA= data set contains variables that meet one of the following criteria:

- are not in the BASE= data set
- do not have the same type as the variables in the BASE= data set
- are longer than the variables in the BASE= data set

Tip You can use the GENNUM= data set option to append to or from a specific version in a generation group. Here are some examples:

```
/* appends historical version to base A */
proc datasets;
   append base=a
      data=a (gennum=2);

/* appends current version of A to historical version */
proc datasets;
   append base=a (gennum=1)
      data=a;
```

See "Appending to Data Sets with Different Variables" on page 594 and "Appending to Data Sets That Contain Variables with Different Attributes" on page 595

Example "Example 6: Concatenating Two SAS Data Sets" on page 710

GETSORT
copies the sort indicator from the DATA= data set to the BASE= data set. The sort indicator is established by either a PROC SORT or an ORDERBY clause in PROC SQL if the following criteria are met:

- The BASE= data set must meet the following criteria:
  - be SAS Version 7 or later
  - contain no observations
  - accept sort indicators

CAUTION
Any pre-existing sort indicator on the BASE= data set is overwritten with no warning, even if the DATA= data set is not sorted at all.

- The DATA= data set must meet the following criteria:
  - contain a sort indicator established by PROC SORT
  - be the same data representation as the BASE= data set

Restrictions The GETSORT option has no effect on the data sets if the BASE= data set has an audit trail associated with it. This restriction causes a WARNING in the output while the APPEND process continues.

The GETSORT option has no effect on the data sets if there are dropped, kept, or renamed variables in the DATA= data file.

NOWARN
suppresses the warning when used with the FORCE option to concatenate two data sets with different variables.

Details

Using the APPEND Procedure Instead of the APPEND Statement

The only difference between the APPEND procedure and the APPEND statement in PROC DATASETS, is the default for libref in the BASE= and DATA= arguments. For PROC APPEND, the default is either Work or User. For the APPEND statement, the default is the libref of the procedure input library.

You can use the WHERE= data set option with the DATA= data set to restrict the observations that are appended. Similarly, you can use the WHERE statement to restrict the observations from the DATA= data set. The WHERE statement has no effect on the BASE= data set.

CAUTION
If there is a WHERE option used on an existing BASE= data set, it is used only if the WHEREUP= option is set to YES. If the BASE= data set does not exist, then no WHEREUP= option is needed for the WHERE option to take effect.

Appending Sorted Data Sets

You can append sorted data sets and maintain the sort using the following guidelines:

- The DATA= data set and the BASE= data set contain sort indicators from the SORT procedure.
- The DATA= data set and the BASE= data set are sorted using the same variables.
- The observations added from the DATA= data set do not violate the sort order of the BASE= data set.

The sort indicator from the BASE= data set is retained.

Using the Block I/O Method to Append

Note: The block I/O method cannot be used when appending a CAS table to a SAS data set.

The block I/O method is used to append blocks of data instead of one observation at a time. This method increases performance when you are appending large data sets. SAS determines whether to use the block I/O method. Not all data sets can use the block I/O method. There are restrictions set by the APPEND statement and the Base SAS engine.

To display information in the SAS log about the append method that is being used, you can specify the MSGLEVEL= system option as follows:

```
options msglevel=i;
```

The following message is written to the SAS log, if the block I/O method is not used:

```
INFO: Data set block I/O cannot be used because:
```

If the APPEND statement determines that the block I/O will not be used, one of the following explanations is written to the SAS log:

```
INFO: - The data sets use different engines, have different variables
or have attributes that might differ.

INFO: - There is a WHERE clause present.

INFO: - There is no member level locking.

INFO: - The OBS option is active.

INFO: - The FIRSTOBS option is active.
```

If the Base SAS engine determines that the block I/O method will not be used, one of the following explanations is written to the SAS log:

```
INFO: - Referential Integrity Constraints exist.

INFO: - Cross Environment Data Access is being used.

INFO: - The file is compressed.

INFO: - The file has an audit file which is not suspended.
```

Restricting the Observations That Are Appended

You can use the WHERE= data set option with the DATA= data set in order to restrict the observations that are appended. Likewise, you can use the WHERE statement in order to restrict the observations from the DATA= data set. The WHERE statement has no effect on the BASE= data set. If you use the WHERE= data set option with the BASE= data set, WHERE= has no effect.

CAUTION

For an existing BASE= data set: If there is a WHERE statement in the BASE= data set, it takes effect only if the WHEREUP= option is set to YES.

CAUTION
For the non-existent BASE= data set: If there is a WHERE statement in the non-existent BASE= data set, regardless of the WHEREUP option setting, you use the WHERE statement.

Note: You cannot append a data set to itself by using the WHERE= data set option.

Choosing between the SET Statement and the APPEND Statement

If you use the SET statement in a DATA step to concatenate two data sets, SAS must process all the observations in both data sets to create a new one. The APPEND statement bypasses the processing of data in the original data set and adds new observations directly to the end of the original data set. Using the APPEND statement can be more efficient than using a SET statement if any of the following occurs:

- The BASE= data set is large.
- All variables in the BASE= data set have the same length and type as the variables in the DATA= data set and if all variables exist in both data sets.

  Note: You can use the CONTENTS statement to see the variable lengths and types.

The APPEND statement is especially useful if you frequently add observations to a SAS data set (for example, in production programs that are constantly appending data to a journal-type data set).

Appending Password-Protected SAS Data Sets

In order to use the APPEND statement, you need Read access to the DATA= data set and Write access to the BASE= data set. To gain access, use the READ= and WRITE= data set options in the APPEND statement in parentheses immediately after the data set name. When you are appending password-protected data sets, use the following guidelines:

- If you do not give the Read password for the DATA= data set in the APPEND statement, by default the procedure looks for the Read password for the DATA= data set in the PROC DATASETS statement. However, the procedure does not look for the Write password for the BASE= data set in the PROC DATASETS statement. Therefore, you must specify the Write password for the BASE= data set in the APPEND statement.
- If the BASE= data set is read-protected only, you must specify its Read password in the APPEND statement.

Appending AES-Encrypted Data Sets

When appending two AES-encrypted data sets, you must use the ENCRYPTKEY= data set option for access to the data sets. Here is an example using the ENCRYPTKEY= option on both data sets:

```
proc datasets;
   append base=a (encryptkey=secret)
      data=a (encryptkey=jlgh56);
run;
```

When appending to a non-encrypted data set, you must specify the ENCRYPTKEY= on the DATA= data set. Then, you can append to the data set even if the BASE= data set engine does not support AES encryption. The data appended will not be encrypted.

```
proc datasets;
   append base=a
      data=a (encryptkey=key-value);
run;
```

For more information about AES encryption, see "AES Encryption" in *SAS Programmer's Guide: Essentials*. For more information about the ENCRYPTKEY= data set option, see "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*.

Appending to a Compressed Data Set

You can concatenate compressed SAS data sets. Either or both of the BASE= and DATA= data sets can be compressed. If the BASE= data set allows the reuse of space from deleted observations, the APPEND statement might insert the observations into the middle of the BASE= data set to use available space.

Either or both of the BASE= SAS data set and DATA= data set or CAS table can be compressed. If the BASE= data set allows the reuse of space from deleted rows, the APPEND statement might insert the rows into the middle of the BASE= data set.

For information about the COMPRESS= and REUSE= data set and system options, see *SAS Data Set Options: Reference* and *SAS System Options: Reference*.

PROC APPEND places all of the new observations at the end of the BASE= data-set and tries to reuse space, which is part of the fast-append behavior that was added in SAS 7. The fast-append behavior was added for better performance writing to the BASE data set and updating indexes. If you want to reuse space, then you need to add the APPENDVER=v6 option to the PROC DATASETS APPEND statement. PROC DATASETS APPEND reuses space only when the new observations fit into the space previously occupied by the deleted observations.

```
proc append base=libref.data-set data=librefdata-set appendver=v6;
run;
```

Appending to Data Sets That Contain Variables with Different Attributes

If a variable has different attributes in the BASE= SAS data set than it does in the DATA= data set or table, the attributes in the BASE= data set prevail.

If the formats in the DATA= SAS data set or CAS table are different from those in the BASE= SAS data set, then the formats in the BASE= data set are used. However, the data from the DATA= data set or table is not converted in order to be consistent with the formats in the BASE= data set. The result could be data that seems to be incorrect. A warning message is displayed in the log.

Use the FORCE option if one of the following occurs:

- if the length of a variable is longer in the DATA= SAS data set or CAS table than in the BASE= data set
- if the same variable is a character variable in one data set or table and a numeric variable in the other

Using FORCE has the following consequences:

- The length of the variables in the BASE= SAS data set takes precedence. The values might be truncated from the DATA= data set or CAS table to fit them into the length that is specified in the BASE= data set.
- The type of the variables in the BASE= data set takes precedence. The APPEND statement replaces values of the wrong type (all values for the variable in the DATA= data set or table) with missing values.

Appending to an Indexed Data Set — Fast-Append Method

Beginning with Version 7, the behavior of appending to an indexed data set changed to improve performance.

- In Version 6, when you appended to an indexed data set, the index was updated for each added observation. Index updates tend to be random. Therefore, disk I/O could have been high.
- Currently, SAS does not update the index until all observations are added to the data set. After the append, SAS internally sorts the observations and inserts the data into the index sequentially. The behavior reduces most of the disk I/O and results in a faster append method.

The fast-append method is used by default when the following requirements are met. Otherwise, the Version 6 method is used:

- The BASE= data set is open for member-level locking. If CNTLLEV= is set to record, then the fast-append method is not used.
- The BASE= data set does not contain referential integrity constraints.
- The BASE= data set is not accessed using the Cross Environment Data Access (CEDA) facility.
- The BASE= data set is not using a WHERE= data set option.

To display information in the SAS log about the append method that is being used, you can specify the MSGLEVEL= system option as follows:

```
options msglevel=i;
```

Either a message appears if the fast-append method is in use, or a message or messages appear as to why the fast-append method is not in use.

The current append method initially adds observations to the BASE= data set regardless of the restrictions that are determined by the index. For example, a variable that has an index that was created with the UNIQUE option does not have its values validated for uniqueness until the index is updated. Then, if a nonunique value is detected, the offending observation is deleted from the data set. After observations are appended, some of them might subsequently be deleted.

For a simple example, consider that the BASE= data set has ten observations numbered from 1 to 10 with a UNIQUE index for the variable ID. You append a data set that contains five observations numbered from 1 to 5, and observations 3 and 4 both contain the same value for ID. The following actions occur:

1. After the observations are appended, the BASE= data set contains 15 observations numbered from 1 to 15.
2. SAS updates the index for ID, validates the values, and determines that observations 13 and 14 contain the same value for ID.
3. SAS deletes one of the observations from the BASE= data set, resulting in 14 observations that are numbered from 1 to 15. For example, observation 13 is deleted. Note that you cannot predict which observation is deleted, because the internal sort might place either observation first. (In Version 6, you could predict that observation 13 would be added and observation 14 would be rejected.)

If you do not want the current behavior (which could result in deleted observations) or if you want to be able to predict which observations are appended, request the Version 6 append method by specifying the APPENDVER=V6 option:

```
proc datasets;
   append base=a data=b appendver=v6;
run;
```

Note: In Version 6, deleting the index and then re-creating it after the append could improve performance. The current method might eliminate the need to do that. However, the performance depends on the nature of your data.

Appending to Data Sets with Different Variables

If the DATA= data set contains variables that are not in the BASE= data set, use the FORCE option in the APPEND statement to force the concatenation of the two data sets. The APPEND statement drops the extra variables and issues a warning message. You can use the NOWARN option to suppress the warning message.

If the BASE= data set contains a variable that is not in the DATA= data set, the APPEND statement concatenates the data sets, but the observations from the DATA= data set have a missing value for the variable that was not present in the DATA= data set. The FORCE option is not necessary in this case.

If you use the DROP=, KEEP=, or RENAME= options on the BASE= data set, the options ONLY affect the APPEND processing and does not change the variables in

the appended BASE= data set. Variables that are dropped or not kept using the DROP= and KEEP= options still exist in the appended BASE= data set. Variables that are renamed using the RENAME= option remain with their original name in the appended BASE= data set.

Appending to Data Sets That Contain Variables with Different Attributes

If a variable has different attributes in the BASE= data set than it does in the DATA= data set, the attributes in the BASE= data set prevail.

If the SAS formats in the DATA= data set are different from those in the BASE= data set, then the SAS formats in the BASE= data set are used. However, SAS does not convert the data from the DATA= data set in order to be consistent with the SAS formats in the BASE= data set. The result could be data that seems to be incorrect. A warning message is displayed in the SAS log. The following example illustrates appending data by using different SAS formats:

```
data format1;
   input Date date9.;
   format Date date9.;
datalines;
24sep1975
22may1952
;

data format2;
   input Date datetime20.;
   format Date datetime20.;
datalines;
25aug1952:11:23:07.4
;

proc append base=format1 data=format2;
run;
```

The following messages are displayed in the SAS log.

```
NOTE: Appending WORK.FORMAT2 to WORK.FORMAT1.
WARNING: Variable Date has format DATE9. on the BASE data set
   and format DATETIME20. on the DATA data set. DATE9. used.
NOTE: There were 1 observations read from the data set WORK.FORMAT2.
NOTE: 1 observations added.
NOTE: The data set WORK.FORMAT1 has 3 observations and 1 variables.
```

If the length of a variable is longer in the DATA= data set than in the BASE= data set, or if the same variable is a character variable in one data set and a numeric variable in the other, use the FORCE option. Using FORCE has the following consequences:

- The length of the variables in the BASE= data set takes precedence. SAS truncates values from the DATA= data set to fit them into the length that is specified in the BASE= data set.

- The type of the variables in the BASE= data set takes precedence. The APPEND statement replaces values of the wrong type (all values for the variable in the DATA= data set) with missing values.

Note: If a character variable's transcoding attribute is opposite in the BASE= and DATA= data sets (for example, one is YES and the other is NO), then a warning is issued. To determine the transcoding attributes, use the CONTENTS procedure for each data set. You set the transcoding attribute with the TRANSCODE= option in the ATTRIB statement or with the TRANSCODE= column modifier in PROC SQL.

Appending Data Sets That Contain Integrity Constraints

If the DATA= data set contains integrity constraints and the BASE= data set does not exist, the APPEND statement copies the general constraints. Note that the referential constraints are not copied. If the BASE= data set exists, the APPEND action copies only observations.

Appending to a Data Set with Integrity Constraints or Indexes

Here is a simple way to get the indexes and integrity constraints from an existing data set and then apply them to another data set. Note that Work.Model should already exist and have observations:

```
Proc contents data=sashelp.zipcode out2=work.ConstraintsIndexes;
run;

proc sql noprint;
   select recreate into :macroVarCIs separated by ' '
          from work.ConstraintsIndexes;
quit;

data work.test_zipcode;
   set sashelp.zipcode;
run;

proc datasets lib=work nolist;
   modify test_zipcode;
   &macroVarCIs
quit;

proc contents data=work.test_zipcode;
run;
```

Appending with Generation Groups

You can use the GENNUM= data set option to append to a specific version in a generation group. Here are examples:

Table 17.4 *Appending with Generation Groups*

SAS Statements	Result

`proc datasets;`
`  append base=a`
`  data=b(gennum=2);`
	Appends historical version B#002 to base A

`proc datasets;`
`  append base=a(gennum=2)`
`  data=b(gennum=2);`
	Appends historical version B#002 to historical version A#002

System Failures

If a system failure or some other type of interruption occurs while the procedure is executing, the Append operation might not be successful; it is possible that not all, perhaps none, of the observations are added to the BASE= data set. In addition, the BASE= data set might suffer damage. The Append operation performs an update in place, which means that it does not make a copy of the original data set before it begins to append observations. If you want to be able to restore the original observations, you can initiate an audit trail for the base data file and choose to store a before-update image of the observations. Then you can write a DATA step to extract and reapply the original observations to the data file. For information about initiating an audit trail, see "AUDIT Statement" on page 598.

ATTRIB Statement

Associates a format, informat, or label with variables in the SAS data set specified in the MODIFY statement.

Restriction: The ATTRIB statement must appear in a MODIFY RUN group

Note: The ATTRIB statement does not affect the CONTENTS statement output. CONTENTS reports the labels, informats, and formats on the actual member.

Example: AUDIT statement on page 691

Syntax

ATTRIB *variable-list(s) attribute-list(s)*;

Required Arguments

variable-list(s)
names the variables that you want to associate with the attributes. You can list the variables in any form that SAS allows.

attribute-list(s)
specifies one or more attributes to assign to *variable-list*. Specify one or more of the following attributes in the ATTRIB statement:

FORMAT=*format*
associates a format with variables in *variable-list.*

Tip The format can be either a standard SAS format or a format that is defined with the FORMAT procedure.

INFORMAT=*informat*
associates an informat with variables in *variable-list.*

Tip The informat can be either a standard SAS informat or an informat that is defined with the FORMAT procedure.

LABEL='*label*'
associates a label with variables in the *variable-list.*

Details

Within the DATASETS procedure, the ATTRIB statement must be used in a MODIFY RUN group and can use only the FORMAT, INFORMAT, and LABEL options. The ATTRIB statement is the simplest way to remove or change all variable labels, formats, or informats in a data set using the keyword _ALL_. For an example, see "Example 1: Removing All Labels and Formats in a Data Set" on page 691.

If you are not deleting or changing all attributes, it is easier to use the following statements, LABEL statement on page 642 , FORMAT Statement on page 632, and INFORMAT statement on page 640.

AUDIT Statement

Initiates and controls event logging to an audit file as well as suspends, resumes, or terminates event logging in an audit file.

Tips: The AUDIT statement takes one of two forms, depending on whether you are initiating the audit trail or suspending, resuming, or terminating event logging in an audit file.

You can define attributes such as format and informat for the user variables in the data file by using the PROC DATASETS MODIFY statement.

See: "Understanding an Audit Trail" in *SAS Language Reference: Concepts*

Syntax

AUDIT *SAS-file* <(*SAS-password* <ENCRYPTKEY=*key-value*>
<GENNUM=*integer*>)>;

INITIATE <AUDIT_ALL=NO | YES>;

LOG<ADMIN_IMAGE=YES | NO>
<BEFORE_IMAGE=YES | NO>
<DATA_IMAGE=YES | NO>
<ERROR_IMAGE=YES | NO>;

<SUSPEND | RESUME | TERMINATE; >

<USER_VAR *variable(s)* >;

Required Argument

SAS-file
specifies the SAS data file in the procedure input library that you want to audit.

Optional Arguments

SAS-password
specifies the password for the SAS data file, if one exists. The parentheses are required.

ENCRYPTKEY=*key-value*
specifies the key value for AES encryption.

GENNUM=*integer*
specifies that the SUSPEND, RESUME, or TERMINATE action be performed on the audit trail of a generation file. You cannot initiate an audit trail on a generation file. Valid values for GENNUM= are *integers*, which is a number that references a specific version from a generation group. Specifying a positive number is an absolute reference to a specific generation number that is appended to a data set's name (that is, `gennum=2` specifies MYDATA#002). Specifying a negative number is a relative reference to a historical version in relation to the base version, from the youngest to the oldest (that is, `gennum=-1` refers to the youngest historical version). Specifying 0, which is the default, refers to the base version. The parentheses are required.

Restriction The GENNUM= option cannot be specified before an INITIATE or USER_VAR statement.

Details

Creating an Audit File

Note: The initiation of an audit trail is possible only with the Base SAS engine.

The following example creates the audit file MyLib.MyFile.audit to log updates to the data file MyLib.MyFile.data, storing all available record images:

```
proc datasets library=mylib;
   audit myfile (alter=password);
   initiate;
run;
```

The following example creates the same audit file but stores only error record images:

```
proc datasets library=mylib;
   audit myfile (alter=password);
   initiate;
      log data_image=no
          before_image=no
          data_image=no;
run;
```

The following example initiates an audit file using AUDIT_ALL=YES:

```
proc datasets lib=mylib;  /* all audit image types will be logged
                             and the file cannot be suspended */
     audit myfile (alter=password);
     initiate audit_all=yes;
quit;
```

The following example terminates an audit file:

```
proc datasets lib=mylib;
     audit myfile (alter=password);
     terminate;
quit;
```

The AUDIT statement starts an *audit run group* for a file. Multiple audit run groups for that file can be submitted in the following ways:

- in the same PROC DATASETS step
- in separate PROC DATASETS steps
- in separate SAS sessions

All audit file related statements (INITIATE, USER_VAR, LOG, SUSPEND, RESUME, TERMINATE) must be preceded by an AUDIT statement, which identifies the file that they apply to.

The INITIATE statement creates an audit file and must be submitted in the first AUDIT statement occurrence. No other audit-related statement, such as USER_VAR, LOG, SUSPEND, RESUME, or TERMINATE will be valid for that audit file until the INITIATE statement has been submitted. You can initiate an audit file on a generation data set, but it must be the latest generation of the generation group. You cannot specify a GENNUM to identify the latest generation. You will get the latest generation by default.

Here is an example of the AUDIT statement in the first AUDIT RUN group for a given file:

```
AUDIT file <(SAS-password)>;
```

Once an audit file has been initiated, the AUDIT statements that follow the INITIATE statement for that file can specify a GENNUM:

```
AUDIT file <(<SAS-password><GENNUM=integer>)>;
```

The USER_VAR statement must directly follow the INITIATE statement in the same AUDIT RUN group.

CHANGE Statement

Renames one or more SAS files in the same SAS library.

Example: "Example 2: Manipulating SAS Files" on page 696

Syntax

CHANGE *old-name-1=new-name-1*
<*old-name-2=new-name-2* ...>
</ <ENCRYPTKEY=*key-value*>
<ALTER=*alter-password*> <GENNUM=ALL | *integer*> <MEMTYPE=*member-type*>>;

Required Argument

old-name=new-name
changes the name of a SAS file in the input data library. *old-name* must be the name of an existing SAS file in the input data library.

Example "Example 2: Manipulating SAS Files" on page 696

Optional Arguments

ENCRYPTKEY=*key-value*
specifies the key value for AES encryption. This option is needed only if RELATIVE GENNUM is specified. For more information, see "Library Contents and AES Encryption" on page 607.

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files named in the CHANGE statement. Because a CHANGE statement changes the names of SAS files, you need Alter access to use the CHANGE statement for *new-name*. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

See "Using Passwords with the DATASETS Procedure" on page 665

GENNUM=ALL | *integer*
restricts processing for generation data sets. You can use the option either in parentheses after the name of each SAS file or after a forward slash. The following list shows valid values:

ALL
0
refers to the base version and all historical versions of a generation group.

integer
refers to a specific version from a generation group. Specifying a positive number is an absolute reference to a specific generation number that is appended to a data set's name (that is, **gennum=2** specifies MYDATA#002). Specifying a negative number is a relative reference to a historical version in relation to the base version, from the youngest to the oldest (that is, **gennum=-1** refers to the youngest historical version).

For example, the following statements change the name of version A#003 to base B:

```
proc datasets;
   change A=B / gennum=3;

proc datasets;
   change A(gennum=3)=B;
```

The following CHANGE statement produces an error:

```
proc datasets;
   change A(gennum=3)=B(gennum=3);
```

See "Restricting Processing for Generation Data Sets" on page 667 and "Understanding Generation Data Sets" in *SAS Language Reference: Concepts*

MEMTYPE=*member-type*
restricts processing to one member type. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

Aliases MTYPE=

MT=

Default If you do not specify MEMTYPE= in the PROC DATASETS statement, the default is MEMTYPE=ALL.

See "Restricting Member Types for Processing" on page 668

Details

The CHANGE statement changes names by the order in which the *old-names* occur in the directory listing, not in the order in which you list the changes in the CHANGE statement.

If the *old-name* SAS file does not exist in the SAS library, PROC DATASETS stops processing the RUN group containing the CHANGE statement and issues an error message. To override this behavior, use the NOWARN option in the PROC DATASETS statement.

If you change the name of a data set that has an index, the index continues to correspond to the data set.

CONTENTS Statement

Describes the contents of one or more SAS data sets and prints the directory of the SAS library.

Restriction: You cannot use the WHERE option to affect the output because PROC CONTENTS does not process any observations.

Notes: The ATTRIB statement does not affect the CONTENTS statement output. CONTENTS reports the labels, informats, and formats on the actual member.

When using the CONTENTS statement with SAS/ACCESS LIBNAME engines, see "Differences in the DATASETS Procedure Output When Using SAS/ACCESS LIBNAME Engines" on page 572.

Tip: You can use data set options with the DATA=, OUT=, and OUT2= options. You can use any global statements as well.

Example: "Example 5: Describing a SAS Data Set" on page 707

Syntax

CONTENTS <*options*>;

Optional Arguments

CENTILES
prints centiles information for indexed variables.

The following additional fields are printed in the default report of PROC CONTENTS when the CENTILES option is selected and an index exists on the data set. Note that the additional fields depend on whether the index is simple or complex.

#	number of the index on the data set.
Index	name of the index.
Update Centiles	percentage of the data values that must be changed before the CENTILES for the indexed variables are automatically updated.
Current Update Percentage	percentage of index updated since CENTILES were refreshed.
# of Unique Values	number of unique indexed values.
Variables	names of the variables used to make up the index. Centile information is listed below the variables.

DATA=*SAS-file-specification*

specifies an entire library or a specific SAS data set within a library. *SAS-file-specification* can take one of the following forms:

<libref.>SAS-data-set

names one SAS data set to process. The default for libref is the libref of the procedure input library. For example, to obtain the contents of the SAS data set HtWt from the procedure input library, use the following CONTENTS statement:

```
contents data=HtWt;
```

To obtain the contents of a specific version from a generation group, use the GENNUM= data set option as shown in the following CONTENTS statement:

```
contents data=HtWt(gennum=3);
```

***<libref.>*_ALL_**

gives you information about all SAS data sets that have the type or types specified by the MEMTYPE= option. *libref* refers to the SAS library. The default for libref is the libref of the procedure input library.

- If you are using the _ALL_ keyword, you need Read access to all read-protected SAS data sets in the SAS library.
- DATA=_ALL_ automatically prints a listing of the SAS files that are contained in the SAS library. Note that for SAS views, all librefs that are associated with the views must be assigned in the current session in order for them to be processed for the listing.

Default most recently created data set in your job or session, from any SAS library.

Tip If you specify a read-protected data set in the DATA= option but do not give the Read password, by default the procedure looks in the PROC DATASETS statement for the Read password. However, if you do not specify the DATA= option and the default data set (last one created in the session) is Read protected, the procedure does not look in the PROC DATASETS statement for the Read password.

Example "Example 5: Describing a SAS Data Set" on page 707

DETAILS | NODETAILS

includes information in the output about the number of observations, number of variables, number of indexes, and data set labels. DETAILS includes these additional columns of information in the output, but only if DIRECTORY is also specified.

Default If neither DETAILS nor NODETAILS is specified, the defaults are as follows: for the CONTENTS procedure, the default is the system option setting, which is NODETAILS; for the CONTENTS statement, the default is whatever is specified in the PROC DATASETS statement, which also defaults to the system option setting.

See a description of the additional columns in the Optional Argument section of PROC DATASETS Statement on page 579

DIRECTORY
prints a list of all SAS files in the specified SAS library. If DETAILS is also specified, using DIRECTORY causes the additional columns described in DETAILS | NODETAILS on page 604 to be printed.

ENCRYPTKEY=*key-value*
specifies the key value for AES encryption. For more information, see "Library Contents and AES Encryption" on page 607.

FMTLEN
prints the length of the informat or format. If you do not specify a length for the informat or format when you associate it with a variable, the length does not appear in the output of the CONTENTS statement unless you use the FMTLEN option. The length also appears in the FORMATL or INFORML variable in the output data set.

MEMTYPE=(*member-type(s)*)
restricts processing to one or more member types. The CONTENTS statement produces output only for member types DATA, VIEW, and ALL, which includes DATA and VIEW.

MEMTYPE= in the CONTENTS statement differs from MEMTYPE= in most of the other statements in the DATASETS procedure in the following ways:

- A slash does not precede the option.
- You cannot enclose the MEMTYPE= option in parentheses to limit its effect to only the SAS file immediately preceding it.

MEMTYPE= results in a directory of the library in which the DATA= member is located. However, MEMTYPE= does not limit the types of members whose contents are displayed unless the _ALL_ keyword is used in the DATA= option. For example, the following statements produce the contents of only the SAS data sets with the member type DATA:

```
proc datasets memtype=data;
   contents data=_all_;
run;
```

Aliases MTYPE=
MT=

Default DATA

NODS
suppresses printing the contents of individual files when you specify _ALL_ in the DATA= option. The CONTENTS statement prints only the SAS library directory. You cannot use the NODS option when you specify only one SAS data set in the DATA= option.

NODETAILS
See "DETAILS|NODETAILS" on page 604.

NOPRINT
suppresses printing the output of the CONTENTS statement.

ORDER=COLLATE | CASECOLLATE | IGNORECASE | VARNUM

COLLATE	prints a list of variables in alphabetical order beginning with uppercase and then lowercase names.
CASECOLLATE	prints a list of variables in alphabetical order even if they include mixed-case names and numerics.
IGNORECASE	prints a list of variables in alphabetical order ignoring the case of the letters.
VARNUM	is the same as the VARNUM option.

Note The ORDER= option does not affect the order of the OUT= and OUT2= data sets.

See "VARNUM" on page 607

Example See "Example 4: Using the ORDER= Option" on page 515 to compare the default and the four options for ORDER=.

OUT=*SAS-data-set*

names an output SAS data set.

Tip OUT= does not suppress the printed output from the statement. If you want to suppress the printed output, you must use the NOPRINT option.

See "The OUT= Data Set" on page 683 for a description of the variables in the OUT= data set.

OUT2=*SAS-data-set*

names the output data set to contain information about indexes and integrity constraints.

Note When you use the OUT2=*PermanentLibrary*_ALL_ option within PROC CONTENTS or PROC DATASETS with the CONTENTS statement, you must also set the REPLACE=YES data set option or the REPLACE system option.

Tips If UPDATECENTILES was not specified in the index definition, then the default value of 5 is used in the re-create variable of the OUT2 data set.

OUT2= does not suppress the printed output from the statement. To suppress the printed output, use the NOPRINT option.

See "The OUT2= Data Set" on page 689 for a description of the variables in the OUT2= data set.

SHORT

prints only the list of variable names, the index information, and the sort information for the SAS data set.

Restriction If the list of variables is more than 32,767 characters, the list is truncated and a WARNING is written to the SAS log. To get a complete list of the variables, request an alphabetical listing of the variables.

VARNUM
prints a list of the variable names in the order of their logical position in the data set. By default, the CONTENTS statement lists the variables alphabetically. The physical position of the variable in the data set is engine-dependent.

Details

Using the CONTENTS Procedure Instead of the CONTENTS Statement

The only difference between the CONTENTS procedure and the CONTENTS statement in PROC DATASETS is the default for libref in the DATA= option. For PROC CONTENTS, the default is Work. For the CONTENTS statement, the default is the libref of the procedure input library.

Printing Variables

The CONTENTS statement prints an alphabetical listing of the variables by default, except for variables in the form of a numbered range list. Numbered range lists, such as x1–x100, are printed in incrementing order, that is, x1–x100. For more information, see "Alphabetic List of Variables and Attributes" on page 678.

Note: If a label is changed after a view is created from a data set with variable labels, the CONTENTS or DATASETS procedure output shows the original labels. The view must be recompiled in order for the CONTENTS or DATASETS procedure output to reflect the new variable labels.

Displaying the ICU Revision Number

The CONTENTS statement prints the International Components for Unicode (ICU) revision number when you use the SORT procedure for a linguistic sort on a data set. For more information about linguistic sorting, see Chapter 64, "SORT Procedure," on page 2355.

Library Contents and AES Encryption

When requesting the contents of all data files in a library, use the _ALL_ option. If the library contains data files that are AES -encrypted, the ENCRYPTKEY= data set option must be used to access the data files. Here is an example using the ENCRYPTKEY= option:

```
proc contents data=MyLib._all_ (encryptkey=key-value);
run;
```

If the key value does not match the key value for a particular data file in the library, then you will be prompted to enter the correct key value.

For more information about AES encryption, see "AES Encryption" in *SAS Programmer's Guide: Essentials*. For more information about the ENCRYPTKEY=

data set option, see "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*.

Observation Length, Alignment, and Padding for a SAS Data Set

There are three different cases for alignment.

- Observations within a SAS data set are aligned on double-byte boundaries whenever possible. As a result, 8-byte and 4-byte numeric variables are positioned at 8-byte boundaries at the front of the data set. They are followed by character variables in the order in which they are encountered. If the data set contains only 4-byte numeric data, the alignment is based on 4-byte boundaries. Since numeric doubles can be operated upon directly rather than being moved and aligned before doing comparisons or increments, the boundaries cause better performance.

  Since there are many observations contained within a given disk data page buffer, there might be padding between observations. The padding is to let each observation be aligned on a double-byte boundary. See the following example:

```
data a;
   length aa 7 bb 6 cc $10 dd 8 ee 3;
   aa = 1;
   bb = 2;
   cc = 'abc';
   dd = 3;
   ee = 4;
   ff = 5;
   output;
run;

proc contents data=a out=a1;
run;

proc print data=a1(keep=name length varnum npos);
run;
```

Figure 17.1 Observation Length

The CONTENTS Procedure

Data Set Name	WORK.A	Observations	1
Member Type	DATA	Variables	6
Engine	V9	Indexes	0
Created	08/16/2016 12:08:25	Observation Length	48
Last Modified	08/16/2016 12:08:25	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_64		
Encoding	wlatin1 Western (Windows)		

PROC CONTENTS shows an observation length of 48. PROC PRINT displays the internal layout of the variables within the observation where NPOS is the zero-based offset for each variable.

Figure 17.2 Observation and Variable Boundaries

Obs	NAME	LENGTH	VARNUM	NPOS
1	aa	7	1	16
2	bb	6	2	23
3	cc	10	3	32
4	dd	8	4	0
5	ee	3	5	29
6	ff	8	6	8

Variables DD and FF, the only true numeric doubles, are at offsets 0 and 8, respectively, so they are automatically aligned. The rest of the observation contains the remaining numeric variables and then character variables.

The last physical variable in this layout is CC with an offset of 32 and a length of 10. This gives you an internal length of 42, even though PROC CONTENTS reports the observation length as 48. The difference is the 6 bytes of padding so that the next observation is aligned on a double-byte boundary within the disk page buffer.

- No alignment is done when the observation does not contain 8-byte numeric variables as demonstrated in the next example, which gives you an observation length of 7 and no padding between observations within disk page buffers:

```
data b;
   length aa 6 cc $1;
   aa = 1;
   cc = 'x';
   output;
run;

proc contents data=b out=b1;
run;

proc print data=b1(keep=name length varnum npos);
run;
```

Figure 17.3 *Variables and Attributes*

Obs	NAME	LENGTH	VARNUM	NPOS
1	aa	6	1	0
2	cc	1	2	6

- Observations for compressed data sets are not aligned within the disk page buffer, but the same algorithm is used for positioning the variables within the observations. Compressed observations must be uncompressed and moved into a work buffer. The 8-byte numeric values will be aligned and ready for use immediately after uncompressing. The observation length in the PROC CONTENTS output might be larger due to operating system-specific overhead.

COPY Statement

Copies all or some of the SAS files in a SAS library.

Restriction: The COPY statement does not support data set options.

Notes: When using the COPY statement with SAS/ACCESS LIBNAME engines, see "Differences in the DATASETS Procedure Output When Using SAS/ACCESS LIBNAME Engines" on page 572.

For CAS engine specifics, see "CAS Processing for PROC COPY" on page 523.

Tips: See the example in PROC COPY on page 534 to migrate from a 32-bit machine to a 64-bit machine.

The COPY statement defaults to the encoding and data representation of the output library when you use Remote Library Services (RLS) such as SAS/SHARE or SAS/CONNECT. If you are not using RLS, you must use the PROC COPY option NOCLONE for the output files to take on the encoding and data representation of

the output library. Using the NOCLONE option results in a copy with the data representation of the data library (if specified in the OUTREP= LIBNAME option) or the native data representation of the operating environment.

Example: "Example 2: Manipulating SAS Files" on page 696

Syntax

COPY <ACCEL | NOACCEL>OUT=*libref-1*
<CLONE | NOCLONE>
<CONSTRAINT=YES | NO>
<DATECOPY>
<ENCRYPTKEY=*key-value*>
<FORCE>
IN=*libref-2*
<INDEX=YES | NO>
<MEMTYPE=(*member-type(s)*)>
<MOVE <ALTER=*alter-password*>>
<OVERRIDE=(*ds-option-1=value-1 <ds-option-2=value-2 ...>*) >;

Required Argument

OUT=*libref-1*
names the SAS library to copy SAS files to.

Alias OUTLIB= and OUTDD=

Example "Example 2: Manipulating SAS Files" on page 696

Optional Arguments

ACCEL | NOACCEL
specifies whether to perform the copy operation in CAS. Both the IN= and OUT= libraries must be CAS engine libraries and they must use the same CAS session.

Default ACCEL

See "Copying a CAS Table to Another CAS Table" on page 620

CLONE | NOCLONE
specifies whether to copy the following data set attributes:

- size of input/output buffers
- whether the data set is compressed
- whether free space is reused
- data representation of input data set, library, or operating environment
- encoding value
- whether a compressed data set can be randomly accessed by an observation number

These attributes are specified with data set options, SAS system options, and LIBNAME statement options:

- BUFSIZE= value for the size of the input/output buffers
- COMPRESS= value for whether the data set is compressed
- REUSE= value for whether free space is reused
- OUTREP= value for data representation
- ENCODING= or INENCODING= for encoding value
- POINTOBS= value for whether a compressed data set can be randomly accessed by an observation number

For the BUFSIZE= attribute, the following table summarizes how the COPY statement works:

Table 17.5 *CLONE and the Buffer Page Size Attribute*

Option	COPY Statement
CLONE	Uses the BUFSIZE= value from the input data set for the output data set. However, specifying BUFSIZE= value in the OVERRIDE= option list results in a copy that uses the specified value.
NOCLONE	Uses the current setting of the SAS system option BUFSIZE= for the output data set.
Neither	Determines the type of access method, sequential or random, used by the engine for the input data set and the engine for the output data set. If both engines use the same type of access, the COPY statement uses the BUFSIZE= value from the input data set for the output data set. If the engines do not use the same type of access, the COPY statement uses the setting of SAS system option BUFSIZE= for the output data set.

For the COMPRESS= attribute, the following table summarizes how the COPY statement works:

Table 17.6 *CLONE and the Compression Attribute*

Option	COPY Statement
CLONE	Uses the values from the input data set for the output data set. However, specifying COMPRESS= value in the OVERRIDE= option list results in a copy that uses the specified encoding.

Option	COPY Statement
NOCLONE	Results in a copy with the compression of the operating environment or, if specified, the value of the COMPRESS= option in the LIBNAME statement for the library.
Neither	Defaults to CLONE.

For the REUSE= attribute, the following table summarizes how the COPY statement works:

Table 17.7 *CLONE and the Reuse Space Attribute*

Option	COPY Statement
CLONE	Uses the values from the input data set for the output data set. If the engine for the input data set does not support the reuse space attribute, then the COPY statement uses the current setting of the corresponding SAS system option. However, specifying REUSE= value in the OVERRIDE= option list results in a copy that uses the specified value.
NOCLONE	Uses the current setting of the SAS system options COMPRESS= and REUSE= for the output data set.
Neither	Defaults to CLONE.

For the OUTREP= attribute, the following table summarizes how the COPY statement works:

Table 17.8 *CLONE and the Data Representation Attribute*

Option	COPY Statement
CLONE	Results in a copy with the same data representation of the input data set. However, if you specify an OUTREP= value in the OVERRIDE= option list, the data representation is changed, and its encoding will change to an encoding that is compatible with the data representation and the locale of the current session. The encoding will also change if it is specified in the OVERRIDE= option list.
NOCLONE	Results in a copy with the data representation of the operating environment or, if specified, the value of the OUTREP= option in the LIBNAME statement for the OUT= library.

Option	COPY Statement
Neither	Defaults to CLONE.

Data representation is the form in which data is stored in a particular operating environment. Different operating environments use the following different standards or conventions:

- for storing floating-point numbers (for example, IEEE or IBM 390)
- for character encoding (ASCII or EBCDIC)
- for the ordering of bytes in memory (big Endian or little Endian)
- for word alignment (4-byte boundaries or 8-byte boundaries)
- for data-type length (16-bit, 32-bit, or 64-bit)

Native data representation is when the data representation of a file is the same as the CPU operating environment. For example, a file in Windows data representation is native to the Windows operating environment.

For the ENCODING= attribute, the following table summarizes how the COPY statement works.

Table 17.9 *CLONE and the Encoding Attribute*

Option	COPY Statement
CLONE	Results in a copy that uses the encoding of the input data set or, if specified, the value of the INENCODING= option in the LIBNAME statement for the input library. However, specifying ENCODING= value in the OVERRIDE= option list results in a copy that uses the specified encoding.
NOCLONE	Results in a copy that uses the encoding of the current session encoding or, if specified, the value of the OUTENCODING= option in the LIBNAME statement for the output library.
Neither	Defaults to CLONE.

All text (character) data that is stored, transmitted, or processed by a computer is in an encoding. An encoding maps each character to a unique numeric representation. An encoding is a combination of a character set with an encoding method. A character set is the repertoire of characters and symbols that are used by a language or group of languages. An encoding method is the set of rules that are used to assign the numbers to the set of characters that are used in an encoding.

For the POINTOBS= attribute, the following table summarizes how the COPY statement works. To use POINTOBS=, the output data set must be compressed.

Table 17.10 CLONE and the POINTOBS= Attribute

Option	COPY Statement
CLONE	Uses the POINTOBS= value from the input data set for the output data set. However, specifying POINTOBS= value in the OVERRIDE= option list results in a copy that uses the specified value.
NOCLONE	Uses the LIBNAME statement if the output data set is compressed and the POINTOBS= option is specified and supported by the output engine. If the LIBNAME statement is not specified and the data set is compressed, the default is POINTOBS=YES when supported by the output engine.
Neither	Defaults to CLONE.

CONSTRAINT=YES | NO

specifies whether to copy all integrity constraints when copying a data set.

Default NO

Tip For data sets with integrity constraints that have a foreign key, the COPY statement copies the general and referential constraints if CONSTRAINT=YES is specified and the entire library is copied. If you use the SELECT or EXCLUDE statement to copy the data sets, then the referential integrity constraints are not copied. For more information, see "Understanding Integrity Constraints" in *SAS Language Reference: Concepts*.

DATECOPY

copies the SAS internal date and time at which the SAS file was created and when it was last modified to the resulting copy of the file. Note that the operating environment date and time are not preserved.

Restrictions DATECOPY cannot be used with encrypted files or catalogs.

DATECOPY can be used only when the resulting SAS file uses the V8 or V9 engine.

Tips You can alter the file creation date and time with the DTC= option in the MODIFY statement. See MODIFY statement on page 644.

If the file that you are copying has attributes that require additional processing, the last modified date is changed to the current date. For example, when you copy a data set that has an index, the index must be rebuilt, and the last modified date changes to the current date. Other attributes that require additional processing and that could affect the last modified date include integrity constraints and a sort indicator.

ENCRYPTKEY= *key-value*
specifies the key value needed to copy data sets in the IN= library that have AES encryption.

Note If the output library does not support AES-encryption and the input data set is AES-encrypted, the COPY process will produce an error.

See "Copying AES-Encrypted Data Files Containing Referential Integrity Constraints " on page 624

FORCE
enables you to use the MOVE option for a SAS data set on which an audit trail exists.

Note The AUDIT file is not moved with the audited data set.

IN=*libref-2*
names the SAS library containing SAS files to copy.

Alias INLIB= and INDD=

Default the libref of the procedure input library

Interaction To copy only selected members, use the SELECT or EXCLUDE statements.

INDEX=YES | NO
specifies whether to copy all indexes for a data set when copying the data set to another SAS library.

Default YES

MEMTYPE=(*member-type(s)*)
restricts processing to one or more member types.

Aliases MTYPE=

MT=

Default If you omit MEMTYPE= in the PROC DATASETS statement, the default is MEMTYPE=ALL.

Note When PROC COPY processes a SAS library on tape and the MEMTYPE= option is not specified, it scans the entire sequential library for entries until it reaches the end-of-file. If the sequential library is a multivolume tape, all tape volumes are mounted. This behavior is also true for single-volume tape libraries.

See "Specifying Member Types When Copying or Moving SAS Files" on page 620 and "Member Types" on page 669

Example "Example 2: Manipulating SAS Files" on page 696

MOVE
moves SAS files from the input data library (named with the IN= option) to the output data library (named with the OUT= option). And deletes the original files from the input data library.

See "Using Passwords with the DATASETS Procedure" on page 665

Restriction The MOVE option can be used to delete a member of a SAS library only if the IN= engine supports the deletion of tables. A tape format engine does not support table deletion. If you use a tape format engine, SAS suppresses the MOVE operation and prints a warning.

Example "Example 2: Manipulating SAS Files" on page 696

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files that you are moving from one data library to another. Because the MOVE option deletes the SAS file from the original data library, you need Alter access to move the SAS file.

OVERRIDE=(*ds-option-1=value-1 <ds-option-2=value-2> ...*)
overrides specified output data set options copied from the input data set. Some data set options might not be appropriate in the output data set context of COPY.

Restriction The OVERRIDE option is ignored if the NOCLONE option is specified. However, it can be used to modify data set attributes other than those controlled by the NOCLONE option.

Interaction When you specify an OUTREP= value in the OVERRIDE= option, the default encoding is based on the operating environment that is represented by the OUTREP= value and the locale of the current SAS session. To assign a nondefault encoding such as UTF-8, you must also specify an ENCODING= value in the OVERRIDE=option. For more information about locale and encoding, see *SAS National Language Support (NLS): Reference Guide*.

Tip The default (or CLONE) behavior is to preserve many attributes, including the data representation and encoding, from the input data set. If instead you want the data representation and encoding of the SAS session that is executing the procedure, then specify OVERRIDE=(OUTREP=SESSION ENCODING=SESSION) in PROC COPY or in the COPY statement. If you do not want to preserve any attributes from the input data set, then specify NOCLONE instead.

NOCLONE
See the description of "CLONE|NOCLONE" on page 611.

Details

Performance Improvement Using SELECT with MEMTYPE

When using the COPY statement, an in-memory directory of the library is obtained. This can be a performance issue if the library has thousands of members and only a few members are being copied. To resolve this performance issue, use a combination of the MEMTYPE= option in the COPY statement with a SELECT statement. Here is an example of this process:

```
proc datasets lib=work;
    copy out=mylib memtype=(data catalog);
    select mydata x1-x10 data2;
run;
```

Note: If either MEMTYPE=ALL or a wildcard specification (":") is used, the performance code cannot be used.

Using the Block I/O Method to Copy

The block I/O method is used to copy blocks of data instead of one observation at a time. This method can increase performance when you are copying large data sets. SAS determines whether to use this method. Not all data sets can use the block I/O method. There are restrictions set by the COPY statement and the Base SAS engine.

To display information in the SAS log about the copy method that is being used, you can specify the MSGLEVEL= system option as follows:

```
options msglevel=i;
```

The following message is written to the SAS log, if the block I/O method is not used:

```
INFO: Data set block I/O cannot be used because:
```

If the COPY statement determines that the block I/O will not be used, one of the following explanations is written to the SAS log:

```
INFO: - The data sets use different engines, have different variables
or have attributes that might differ.

INFO: - There is no member level locking.

INFO: - The OBS option is active.

INFO: - The FIRSTOBS option is active.
```

If the Base SAS engine determines that the block I/O method will not be used, one of the following explanations is written to the SAS log:

```
INFO: - Referential Integrity Constraints exist.

INFO: - Cross Environment Data Access is being used.

INFO: - The file is compressed.
```

```
INFO: - The file has an audit file which is not suspended.
```

If you are having performance issues and want to create a subset of a large data set for testing, you can use the OBS=0 option. In this case, you want to reduce the use of system resources by disabling the block I/O method.

The following example uses the OBS=0 option to reduce the use of system resources:

```
options obs=0 msglevel=i;
proc copy in=old out=lib;
select a;
run;
```

You get the same results when you use the SET statement:

```
data lib.new;
    if 0 then set old.a;
    stop;
run;
```

Copying an Entire Library

To copy an entire SAS library, simply specify an input data library and an output data library following the COPY statement. For example, the following statements copy all the SAS files in the Source data library into the Dest data library:

```
proc datasets library=source;
   copy out=dest;
run;
```

Copying Selected SAS Files

To copy selected SAS files, use a SELECT or EXCLUDE statement. For more discussion of using the COPY statement with a SELECT statement or an EXCLUDE statement, see "Specifying Member Types When Copying or Moving SAS Files" on page 620 and see Manipulating SAS Files on page 696 for an example. Also, see EXCLUDE statement on page 631 and SELECT statement on page 656.

You can also select or exclude an abbreviated list of members. For example, the following statement selects members Tabs, Test1, Test2, and Test3:

```
select tabs test1-test3;
```

Also, you can select a group of members whose names begin with the same letter or letters by entering the common letters followed by a colon (:). For example, you can select the four members in the previous example and all other members having names that begin with the letter T by specifying the following statement:

```
select t:;
```

You specify members to exclude in the same way that you specify those to select. That is, you can list individual member names, use an abbreviated list, or specify a common letter or letters followed by a colon (:). For example, the following statement excludes the members Stats, Teams1, Teams2, Teams3, Teams4 and all the members that begin with the letters RBI from the copy operation:

```
exclude stats teams1-teams4 rbi:;
```

Note that the MEMTYPE= option affects which types of members are available to be selected or excluded.

When a SELECT or EXCLUDE statement is used with CONSTRAINT=YES, only the general integrity constraints on the data sets are copied. Any referential integrity constraints are not copied. For more information, see "Understanding Integrity Constraints" in *SAS Language Reference: Concepts*.

Copying a CAS Table to Another CAS Table

When PROC COPY IN= and OUT= options are set to a CAS libref, and the same CAS session is used by both librefs by default the copy occurs in CAS.

This is a change to the default behavior. If options MSGLEVEL=I system option is set, when the COPY occurs in CAS, an INFO message is sent to the log: `INFO: Running COPY in Cloud Analytic Services.`

The PROC COPY option ACCEL | NOACCEL determines where the COPY procedure executes. ACCEL is the default, which means the COPY operation runs on the CAS server. If the COPY procedure fails on the CAS server, it does not attempt to copy the file by pulling the observations into V9 SAS.

If the OVERRIDE option is specified on the PROC COPY invocation, the option is ignored, and a note is sent to the log.

You cannot copy between sessions with PROC COPY. If the CAS libraries are defined with two different sessions, the following error is displayed: `ERROR: The CAS sessions SESS1 and SESS2 used for this action do not match.`

Specifying Member Types When Copying or Moving SAS Files

The MEMTYPE= option in the COPY statement differs from the MEMTYPE= option in other statements in the procedure in several ways:

- A slash does not precede the option.
- You cannot limit its effect to the member immediately preceding it by enclosing the MEMTYPE= option in parentheses.
- The SELECT and EXCLUDE statements and the IN= option (in the COPY statement) affect the behavior of the MEMTYPE= option in the COPY statement according to the following rules:

  1. MEMTYPE= in a SELECT or EXCLUDE statement takes precedence over the MEMTYPE= option in the COPY statement. The following statements copy only Vision.catalog and Nutr.data from the default data library to the Dest data library; the MEMTYPE= value in the first SELECT statement overrides the MEMTYPE= value in the COPY statement.

```
proc datasets;
   copy out=dest memtype=data;
      select vision(memtype=catalog) nutr;
run;
```

  2. If you do not use the IN= option, or you use it to specify the library that happens to be the procedure input library, the value of the MEMTYPE= option in the PROC DATASETS statement limits the types of SAS files that

are available for processing. The procedure uses the order of precedence described in rule 1 to further subset the types available for copying. The following statements do not copy any members from the default data library to the Dest data library. Instead, the procedure issues an error message because the MEMTYPE= value specified in the SELECT statement is not one of the values of the MEMTYPE= option in the PROC DATASETS statement.

```
      /* This step fails! */
proc datasets memtype=(data program);
   copy out=dest;
      select apples / memtype=catalog;
run;
```

3 If you specify an input data library in the IN= option other than the procedure input library, the MEMTYPE= option in the PROC DATASETS statement has no effect on the copy operation. Because no subsetting has yet occurred, the procedure uses the order of precedence described in rule 1 to subset the types available for copying. The following statements successfully copy Bodyfat.data to the Dest data library because the Source library specified in the IN= option in the COPY statement is not affected by the MEMTYPE= option in the PROC DATASETS statement.

```
proc datasets library=work memtype=catalog;
   copy in=source out=dest;
      select bodyfat / memtype=data;
run;
```

When using the COPY statement, an in-memory directory of the library is obtained. This can be a performance issue if the library has thousands of members and only a few members are being copied. To resolve this performance issue, use a combination of the MEMTYPE= option in the COPY statement with a SELECT statement. Here is an example of this process:

```
proc datasets lib=work;
    copy out=mylib memtype=(data catalog);
    select mydata x1-x10 data2;
run;
```

Note: If either MEMTYPE=ALL or a wildcard specification (":") is used, the performance code cannot be used.

Copying Views

The COPY statement with NOCLONE specified supports the OUTREP= and ENCODING= LIBNAME options for SQL views, DATA step views, and some views (Oracle and Sybase). When you use the COPY statement with Remote Library Services (RLS) such as SAS/SHARE or SAS/CONNECT, the COPY statement defaults to the encoding and data representation of the output library.

CAUTION
If you use the DATA statement's SOURCE=NOSAVE option when creating a DATA step view, the view cannot be copied from one version of SAS to another version.

Copying Password-Protected SAS Files

You can copy a password-protected SAS file without specifying the password. In addition, because the password continues to correspond to the SAS file, you must know the password in order to access and manipulate the SAS file after you copy it.

Copying Data Sets with Long Variable Names

If the VALIDVARNAME=V6 system option is set and the data set has long variable names, the long variable names are truncated, unique variables names are generated, and the copy succeeds. The same is true for index names. If VALIDVARNAME=ANY, the copy fails with an error if the OUT= engine does not support long variable names.

When a variable name is truncated, the variable name is shortened to eight bytes. If this name has already been defined in the data set, the name is shortened and a digit is added, starting with the number 2. The process of truncation and adding a digit continues until the variable name is unique. For example, a variable named LONGVARNAME becomes LONGVARN, provided that a variable with that name does not already exist in the data set. In that case, the variable name becomes LONGVAR2.

CAUTION

Truncated variable names can collide with names already defined in the input data set. This behavior is possible when the variable name that is already defined is exactly eight bytes long and ends in a digit. In the following example, the truncated name is defined in the output data set and the name from the input data set is changed:

```
options validvarname=any;
data test;
   longvar10='aLongVariableName';
   retain longvar1-longvar5 0;
run;

options validvarname=v6;
proc copy in=work out=sasuser;
   select test;
run;
```

In this example, LONGVAR10 is truncated to LONGVAR1 and placed in the output data set. Next, the original LONGVAR1 is copied. Its name is no longer unique. Therefore, it is renamed LONGVAR2. The other variables in the input data set are also renamed according to the renaming algorithm. The following example is from the SAS log:

```
1    options validvarname=any;
2    data test;
3       longvar10='aLongVariableName';
4       retain longvar1-longvar5 0;
5    run;

NOTE: The data set WORK.TEST has 1 observations and 6 variables.
NOTE: DATA statement used (Total process time):
      real time           2.60 seconds
      cpu time            0.07 seconds
```

```
6
7    options validvarname=v6;
8    proc copy in=work out=sasuser;
9       select test;
10   run;

NOTE: Copying WORK.TEST to SASUSER.TEST (memtype=DATA).
NOTE: The variable name longvar10 has been truncated to longvar1.
NOTE: The variable longvar1 now has a label set to longvar10.
NOTE: Variable LONGVAR1 already exists on file SASUSER.TEST, using LONGVAR2
instead.
NOTE: The variable LONGVAR2 now has a label set to LONGVAR1.
NOTE: Variable LONGVAR2 already exists on file SASUSER.TEST, using LONGVAR3
instead.
NOTE: The variable LONGVAR3 now has a label set to LONGVAR2.
NOTE: Variable LONGVAR3 already exists on file SASUSER.TEST, using LONGVAR4
instead.
NOTE: The variable LONGVAR4 now has a label set to LONGVAR3.
NOTE: Variable LONGVAR4 already exists on file SASUSER.TEST, using LONGVAR5
instead.
NOTE: The variable LONGVAR5 now has a label set to LONGVAR4.
NOTE: Variable LONGVAR5 already exists on file SASUSER.TEST, using LONGVAR6
instead.
NOTE: The variable LONGVAR6 now has a label set to LONGVAR5.
NOTE: There were 1 observations read from the data set WORK.TEST.
NOTE: The data set SASUSER.TEST has 1 observations and 6 variables.
NOTE: PROCEDURE COPY used (Total process time):
      real time           13.18 seconds
      cpu time            0.31 seconds


11
12   proc print data=test;
13   run;

ERROR: The value LONGVAR10 is not a valid SAS name.
NOTE: The SAS System stopped processing this step because of errors.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.15 seconds
      cpu time            0.01 seconds
```

Copying AES-Encrypted Data Files

In order to copy data files with AES encryption, you must specify the ENCRYPTKEY=*key-value* in one of two ways:

- if all the AES-encrypted data sets in the library have the same ENCRYPTKEY=*key-value*, use the following example:

```
proc copy in=lib1 out=lib2 encryptkey=key-value;
run;
```

- if the ENCRYPTKEY=*key-value* is different for each data set, use the SELECT statement as shown in the following example:

```
proc copy in=lib1 out=lib2;
    select mydata1 (encryptkey=key-value1) mydata2 (encryptkey=key-value2);
run;
```

For more information about AES encryption, see "AES Encryption" in *SAS Programmer's Guide: Essentials*. For more information about the ENCRYPTKEY= data set option, see "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*.

Copying AES-Encrypted Data Files Containing Referential Integrity Constraints

In order to copy data files with AES encryption and with referential integrity constraints, you must do the following:

- copy the entire contents of the IN=library
- specify the CONSTRAINT=YES statement option
- specify the ENCRYPTKEY=*key-value* option or the library must be metadata bound with the encryption key recorded for the library

```
proc copy in=Lib1 out=Lib2 constraint=yes encryptkey=key-value;
run;
```

However, the above code will not work if there are multiple data primary key and referential data set pairs in the IN=LIB and each pair has different ENCYPTKEY= values. For example, if there are two pairs:

```
primarydset1/foreigndset1 having ENCRYPTKEY=secret1
primarydset2/foreigndset2 having ENCRYPTKEY=secret2
```

then the above scheme would work for only one pair. All pairs must have the same key value.

For more information, see "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference*.

Copying Generation Groups

You can use the COPY statement to copy an entire generation group. However, you cannot copy a specific version in a generation group.

Transporting SAS Data Sets between Hosts

You use the COPY procedure, along with the XPORT engine or a REMOTE engine, to transport SAS data sets between hosts. For more information, see "Strategies for Moving and Accessing SAS Files" in *Moving and Accessing SAS Files*.

Using the COPY Procedure Instead of the COPY Statement

Generally, the COPY procedure functions the same as the COPY statement in the DATASETS procedure. Here is a list of differences:

- The IN= argument is required with PROC COPY. In the COPY statement, IN= is optional. If omitted, the default value is the libref of the procedure input library.

- PROC DATASETS cannot work with libraries that allow only sequential data access.
- The COPY statement honors the NOWARN option but PROC COPY does not.

DELETE Statement

Deletes SAS files from a SAS library.

Example: "Example 2: Manipulating SAS Files" on page 696

Syntax

DELETE *SAS-file(s)*
</ <ALTER=*alter-password*>
<ENCRYPTKEY=*key-value*>
<GENNUM=ALL | HIST | REVERT | *integer*>
<MEMTYPE=*member-type*>>;

Required Argument

SAS-file(s)
specifies one or more SAS files that you want to delete. If the SAS file has an ALTER= password assigned, it must be specified in order to delete the SAS file. You can also use a numbered range list or colon list. For more information, see "Data Set Name Lists" in *SAS Programmer's Guide: Essentials*.

Optional Arguments

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files that you want to delete. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

See "Using Passwords with the DATASETS Procedure" on page 665

ENCRYPTKEY=*key-value*
specifies the key value for AES encryption. This option is required when specifying GENNUM=REVERT (which is the same as GENNUM=0) or GENNUM=*relative-generation-number*. The key value for the ENCRYPTKEY= option must be the key value for the base version. For more information, see "Library Contents and AES Encryption" on page 607.

GENNUM=ALL | HIST | REVERT | *integer*
restricts processing for generation data sets. You can use the option either in parentheses after the name of each SAS file or after a forward slash. Here is a list of valid values:

ALL	refers to the base version and all historical versions in a generation group.
HIST	refers to all historical versions, but excludes the base version in a generation group.
REVERT | 0	deletes the base version and changes the most current historical version, if it exists, to the base version.
integer	is a number that references a specific version from a generation group. Specifying a positive number is an absolute reference to a specific generation number that is appended to a data set's name (that is, `gennum=2` specifies MYDATA#002). Specifying a negative number is a relative reference to a historical version in relation to the base version, from the youngest to the oldest (that is, `gennum=-1` refers to the youngest historical version).

See "Understanding Generation Data Sets" in *SAS Language Reference: Concepts* and "Restricting Processing for Generation Data Sets" on page 667

MEMTYPE=*member-type*

restricts processing to one member type. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

Aliases MTYPE=

MT=

Default DATA

See "Restricting Member Types for Processing" on page 668

Example "Example 2: Manipulating SAS Files" on page 696

Details

The Basics

SAS immediately deletes SAS files when the RUN group executes. You do not have an opportunity to verify the Delete operation before it begins.

If the SAS file has an ALTER= password assigned, it must be specified in order to delete the SAS file.

If you attempt to delete a SAS file that does not exist in the procedure input library, PROC DATASETS issues a message and continues processing. If NOWARN is used, no message is issued.

When you use the DELETE statement to delete a data set that has indexes associated with it, the statement also deletes the indexes.

You cannot use the DELETE statement to delete a data file that has a foreign key integrity constraint or a primary key with foreign key references. For data files that have foreign keys, you must remove the foreign keys before you delete the data file. For data files that have primary keys with foreign key references, you must remove the foreign keys that reference the primary key before you delete the data file.

If you attempt to delete a CAS table that does not exist in the input CAS engine libref, a message is written to the log and processing continues. If NOWARN is used, no message is issued.

Working with Generation Groups

Overview of Working with Generation Groups

When you are working with generation groups, you can use the DELETE statement to delete the following versions:

- delete the base version and all historical versions
- delete the base version and rename the youngest historical version to the base version
- delete an absolute version
- delete a relative version
- delete all historical versions and leave the base version

Deleting the Base Version and All Historical Versions

The following statements delete the base version and all historical versions where the data set name is A:

```
proc datasets;
   delete A(gennum=all);

proc datasets;
   delete A / gennum=all;

proc datasets gennum=all;
   delete A;
```

The following statements delete the base version and all historical versions where the data set name begins with the letter A:

```
proc datasets;
   delete A:(gennum=all);

proc datasets;
   delete A: / gennum=all;

proc datasets gennum=all;
   delete A:;
```

Deleting the Base Version and Renaming the Youngest Historical Version to the Base Version

The following statements delete the base version and rename the youngest historical version to the base version, where the data set name is A:

```
proc datasets;
   delete A(gennum=revert);

proc datasets;
   delete A / gennum=revert;

proc datasets gennum=revert;
   delete A;
```

The following statements delete the base version and rename the youngest historical version to the base version, where the data set name begins with the letter A:

```
proc datasets;
   delete A:(gennum=revert);

proc datasets;
   delete A: / gennum=revert;

proc datasets gennum=revert;
   delete A:;
```

Deleting a Version with an Absolute Number

The following statements use an absolute number to delete the first historical version:

```
proc datasets;
   delete A(gennum=1);

proc datasets;
   delete A / gennum=1;

proc datasets gennum=1;
   delete A;
```

The following statements delete a specific historical version, where the data set name begins with the letter A:

```
proc datasets;
   delete A:(gennum=1);

proc datasets;
   delete A: / gennum=1;

proc datasets gennum=1;
   delete A:;
```

Deleting a Version with a Relative Number

The following statements use a relative number to delete the youngest historical version, where the data set name is A:

```
proc datasets;
   delete A(gennum=-1);

proc datasets;
   delete A / gennum=-1;

proc datasets gennum=-1;
   delete A;
```

The following statements use a relative number to delete the youngest historical version, where the data set name begins with the letter A:

```
proc datasets;
   delete A:(gennum=-1);

proc datasets;
   delete A: / gennum=-1;

proc datasets gennum=-1;
   delete A:;
```

Deleting All Historical Versions and Leaving the Base Version

The following statements delete all historical versions and leave the base version, where the data set name is A:

```
proc datasets;
   delete A(gennum=hist);

proc datasets;
   delete A / gennum=hist;

proc datasets gennum=hist;
   delete A;
```

The following statements delete all historical versions and leave the base version, where the data set name begins with the letter A:

```
proc datasets;
   delete A:(gennum=hist);

proc datasets;
   delete A: / gennum=hist;

proc datasets gennum=hist;
   delete A:;
```

EXCHANGE Statement

Exchanges the names of two SAS files in a SAS library.

Example: "Example 2: Manipulating SAS Files" on page 696

Syntax

EXCHANGE *name-1=other-name-1* <*name-2=other-name-2* ...>
</ <ALTER=*alter-password*> <MEMTYPE=*member-type*>>;

Required Argument

name=other-name
exchanges the names of SAS files in the procedure input library. Both *name* and *other-name* must already exist in the procedure input library.

Optional Arguments

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files whose names you want to exchange. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

See "Using Passwords with the DATASETS Procedure" on page 665

MEMTYPE=*member-type*
restricts processing to one member type. You can exchange only the names of SAS files of the same type. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

Default If you do not specify MEMTYPE= in the PROC DATASETS statement, the default is ALL.

See "Restricting Member Types for Processing" on page 668

Details

When you exchange more than one pair of names in one EXCHANGE statement, PROC DATASETS performs the exchanges in the order in which the names of the SAS files occur in the directory listing, not in the order in which you list the exchanges in the EXCHANGE statement.

If the *name* SAS file does not exist in the SAS library, PROC DATASETS stops processing the RUN group that contains the EXCHANGE statement and issues an error message. To override this behavior, specify the NOWARN option in the PROC DATASETS statement.

The EXCHANGE statement also exchanges the associated indexes so that they correspond with the new name.

The EXCHANGE statement allows only two existing generation groups to exchange names. You cannot exchange a specific generation number with either an existing base version or another generation number.

EXCLUDE Statement

Excludes SAS files from copying.

Restrictions: The EXCLUDE statement must follow a COPY statement

The EXCLUDE statement cannot appear in the same COPY step with a SELECT statement

Example: "Example 2: Manipulating SAS Files" on page 696

Syntax

EXCLUDE *SAS-file(s)* </ MEMTYPE=*member-type*>;

Required Argument

SAS-file(s)
specifies one or more SAS files to exclude from the copy operation. All SAS files you name in the EXCLUDE statement must be in the library that is specified in the IN= option in the COPY statement. If the SAS files are generation groups, the EXCLUDE statement allows only selection of the base versions.

You can use the following shortcuts to list several SAS files in the EXCLUDE statement:

Table 17.11 *Using the EXCLUDE Statement*

Notation	Meaning
x1–xn	Specifies files X1 through Xn. The numbers must be consecutive.
x:	Specifies all files that begin with the letter X.

Optional Argument

MEMTYPE=*member-type*
restricts processing to one member type. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

Aliases MTYPE=

MT=

Default If you do not specify MEMTYPE= in the PROC DATASETS statement, the COPY statement, or in the EXCLUDE statement, the default is MEMTYPE=ALL.

See "Specifying Member Types When Copying or Moving SAS Files" on page 620 and "Restricting Member Types for Processing" on page 668

Details

Excluding Several Like-Named Files

You can use shortcuts for listing several SAS files in the EXCLUDE statement.

FORMAT Statement

Assigns, changes, and removes variable formats in the SAS data set specified in the MODIFY statement permanently.

Restriction: The FORMAT statement must appear in a MODIFY RUN group

Example: "Example 4: Modifying SAS Data Sets" on page 704

Syntax

FORMAT *variable-1* <*format-1*>
<*variable-2* <*format-2*> ...>;

Required Argument

variable
specifies one or more variables whose format you want to assign, change, or remove. If you want to disassociate a format with a variable, list the variable last in the list with no format following:

```
format x1-x3 4.1 time hhmm2.2 age;
```

Optional Argument

format
specifies a format to apply to the variable or variables listed before it. If you do not specify a format, the FORMAT statement removes any format associated with the variables in *variable-list*.

Tip To remove all formats from a data set, use the ATTRIB Statement on page 597 and the _ALL_ keyword.

IC CREATE Statement

Creates an integrity constraint.

Restriction: The IC CREATE statement must appear in a MODIFY RUN group

Note: In order for a referential constraint to be established, the foreign key must specify the same number of variables as the primary key, in the same order, and the variables must be of the same type (character or numeric) and length.

See: "Understanding Integrity Constraints" in *SAS Language Reference: Concepts*

Syntax

IC CREATE <*constraint-name=*> *constraint* <MESSAGE='*message-string*' <MSGTYPE=USER>>;

Required Argument

constraint
is the type of constraint. Here is a list of valid values:

NOT NULL (*variable*)	specifies that *variable* does not contain a SAS missing value, including special missing values.
UNIQUE (*variables*)	specifies that the values of *variables* must be unique. This constraint is identical to DISTINCT.
DISTINCT (*variables*)	specifies that the values of *variables* must be unique. This constraint is identical to UNIQUE.
CHECK (WHERE-*expression*)	limits the data values of variables to a specific set, range, or list of values. This behavior is accomplished with a WHERE expression.
PRIMARY KEY (*variables*)	specifies a primary key, that is, a set of variables that do not contain missing values and whose values are unique.

When defining overlapping primary key and foreign key constraints, which means that variables in a data file are part of both a primary key and a foreign key definition, if you use exactly the same variables, then the variables must be defined in a different order.

A primary key affects the values of an individual data file until it has a foreign key referencing it.

Note: If a not null constraint exists for a variable that is being used to define a new primary key constraint, then the primary key constraint replaces the existing not null constraint.

FOREIGN KEY (*variables*) REFERENCES *table-name* <ON DELETE *referential-action*> <ON UPDATE *referential-action*>
: specifies a foreign key, that is, a set of variables whose values are linked to the values of the primary key variables in another data file. The referential actions are enforced when updates are made to the values of a primary key variable that is referenced by a foreign key. There are three types of referential actions: RESTRICT, SET NULL, and CASCADE:

The following operations can be done with the RESTRICT referential action:

a delete operation
: deletes the primary key row, but only if no foreign key values match the deleted value.

an update operation
: updates the primary key value, but only if no foreign key values match the current value to be updated.

The following operations can be done with the SET NULL referential action:

a delete operation
: deletes the primary key row and sets the corresponding foreign key values to NULL.

an update operation
: modifies the primary key value and sets all matching foreign key values to NULL.

The following operations can be done with the CASCADE referential action:

an update operation
: modifies the primary key value, and also modifies any matching foreign key values to the same value. CASCADE is not supported for Delete operations.

Default
: RESTRICT is the default action if no referential action is specified.

Requirements
: When defining overlapping primary key and foreign key constraints, which means that variables in a data file are part of both a primary key and a foreign key definition, the following actions are required:

  If you use exactly the same variables, then the variables must be defined in a different order.

  The foreign key's update and delete referential actions must both be RESTRICT.

Interaction
: Before it enforces a SET NULL or CASCADE referential action, SAS checks to see whether there are other foreign keys that reference the primary key and that specify RESTRICT for the intended operation. If RESTRICT is specified, or if the constraint reverts to the default values, then RESTRICT is enforced for all

foreign keys, unless no foreign key values match the values to updated or deleted.

Optional Arguments

<*constraint-name*=>
is an optional name for the constraint. The name must be a valid SAS name. When you do not supply a constraint name, a default name is generated. This default constraint name has the following form:

Table 17.12 *Using RESTRICT=*

Default Name	Constraint Type
NM*xxxx*	Not Null
UN*xxxx*	Unique
CK*xxxx*	Check
PK*xxxx*	Primary key
FK*xxxx*	Foreign key

xxxx is a counter beginning at 0001.

Note: The names PRIMARY, FOREIGN, MESSAGE, UNIQUE, DISTINCT, CHECK, and NOT cannot be used as values for *constraint-name*.

<MESSAGE='*message-string*' <MSGTYPE=USER>>
message-string is the text of an error message to be written to the log when the data fails the constraint:

```
ic create not null(socsec)
   message='Invalid Social Security number';
```

<MSGTYPE=USER> controls the format of the integrity constraint error message. By default when the MESSAGE= option is specified, the message that you define is inserted into the SAS error message for the constraint, separated by a space. MSGTYPE=USER suppresses the SAS portion of the message.

Length The maximum length of the message is 250 characters.

Example The following examples show how to Create integrity constraints:

```
ic create a = not null(x);
ic create Unique_D = unique(d);
ic create Distinct_DE = distinct(d e);
ic create E_less_D = check(where=(e < d or d = 99));
ic create primkey = primary key(a b);
ic create forkey = foreign key (a b) references table-name
  on update cascade on delete set null;
```

```
ic create not null (x);
```

IC DELETE Statement

Deletes an integrity constraint.

Restriction: IC DELETE must be in a MODIFY RUN group

See: "Understanding Integrity Constraints" in *SAS Language Reference: Concepts*

Syntax

IC DELETE *constraint-name(s)* | _ALL_;

Required Arguments

constraint-name(s)
names one or more constraints to delete. For example, to delete the constraints Unique_D and Unique_E, use the following statement: `ic delete Unique_D Unique_E;`

ALL
deletes all constraints for the SAS data file specified in the preceding MODIFY statement.

IC REACTIVATE Statement

Reactivates a foreign key integrity constraint that is inactive.

Restriction: IC REACTIVATE must be in a MODIFY RUN group

See: "Understanding Integrity Constraints" in *SAS Language Reference: Concepts*

Syntax

IC REACTIVATE *foreign-key-name* REFERENCES *libref*;

Required Arguments

foreign-key-name
is the name of the foreign key to reactivate.

libref
refers to the SAS library containing the data set that contains the primary key that is referenced by the foreign key.

Example

Suppose that you have the foreign key FKEY defined in data set MyLib.MyOwn and that FKEY is linked to a primary key in data set MainLib.Main. If the integrity constraint is inactivated by a copy or move operation, you can reactivate the integrity constraint by using the following code:

```
proc datasets library=mylib;
   modify myown;
   ic reactivate fkey references mainlib;
run;
```

INDEX CENTILES Statement

Updates centiles statistics for indexed variables.

Restriction: INDEX CENTILES must be in a MODIFY RUN group

See: "Understanding SAS Indexes" in *SAS Language Reference: Concepts*

Syntax

INDEX CENTILES *index(s)*
</ <REFRESH> <UPDATECENTILES=ALWAYS | NEVER | *integer*>>;

Required Argument

index(s)
names one or more indexes.

Optional Arguments

REFRESH
updates centiles immediately, regardless of the value of UPDATECENTILES.

UPDATECENTILES=ALWAYS | NEVER | *integer*
specifies when centiles are to be updated. It is not practical to update centiles after every data set update. Therefore, you can specify as the value of UPDATECENTILES the percentage of the data values that can be changed before centiles for the indexed variables are updated.

Here is a list of valid values:

ALWAYS | 0	updates centiles when the data set is closed if any changes have been made to the data set index. You can specify ALWAYS or 0 and produce the same results.
NEVER | 101	does not update centiles. You can specify NEVER or 101 and produce the same results.
integer	is the percentage of values for the indexed variable that can be updated before centiles are refreshed. The alias is UPDCEN. The default is 5 (percent).

INDEX CREATE Statement

Creates simple or composite indexes for the SAS data set specified in the MODIFY statement.

Restriction: INDEX CREATE must be in a MODIFY RUN group

See: "Understanding SAS Indexes" in *SAS Language Reference: Concepts*

Example: "Example 4: Modifying SAS Data Sets" on page 704

Syntax

INDEX CREATE *index-specification(s)*
</ <NOMISS> <UNIQUE> <UPDATECENTILES=ALWAYS | NEVER | *integer*>>;

Required Argument

index-specification(s)
can be one or both of the following forms:

variable
creates a simple index on the specified variable.

index=(variables)
creates a composite index. The name that you specify for *index* is the name of the composite index. It must be a valid SAS name and cannot be the same as any variable name or any other composite index name. You must specify at least two variables.

Note The index name must follow the same rules as a SAS variable name, including avoiding the use of reserved names for automatic variables, such as _N_, and special variable list names, such as _ALL_. For more information, see "Words in the SAS Language" in *SAS Language Reference: Concepts*.

Optional Arguments

NOMISS
excludes from the index all observations with missing values for all index variables.

When you create an index with the NOMISS option, SAS uses the index only for WHERE processing and only when missing values fail to satisfy the WHERE expression. For example, if you use the following WHERE statement, SAS does not use the index, because missing values satisfy the WHERE expression:

```
where dept ne '01';
```

For more information, see *SAS Language Reference: Concepts*.

BY-group processing ignores indexes that are created with the NOMISS option.

Example "Example 4: Modifying SAS Data Sets" on page 704

UNIQUE
specifies that the combination of values of the index variables must be unique. If you specify UNIQUE and multiple observations have the same values for the index variables, the index is not created.

Example "Example 4: Modifying SAS Data Sets" on page 704

UPDATECENTILES=ALWAYS | NEVER | *integer*
specifies when centiles are to be updated. It is not practical to update centiles after every data set update. Therefore, you can specify the percentage of the data values that can be changed before centiles for the indexed variables are updated. Here is a list of valid values:

ALWAYS | 0	updates centiles when the data set is closed if any changes have been made to the data set index. You can specify ALWAYS or 0 and produce the same results.
NEVER | 101	does not update centiles. You can specify NEVER or 101 and produce the same results.
integer	specifies the percentage of values for the indexed variable that can be updated before centiles are refreshed. The alias is UPDCEN and the default is 5 (percent).

INDEX DELETE Statement

Deletes one or more indexes associated with the SAS data set specified in the MODIFY statement.

Restriction: The INDEX DELETE statement must appear in a MODIFY RUN group

Note: You can use the CONTENTS statement to produce a list of all indexes for a data set.

Syntax

INDEX DELETE *index(s)* | _ALL_;

Required Arguments

index(s)
names one or more indexes to delete. The index(es) must be for variables in the SAS data set that is named in the preceding MODIFY statement. You can delete both simple and composite indexes.

ALL
deletes all indexes, except for indexes that are owned by an integrity constraint. When an index is created, it is marked as owned by the user, by an integrity constraint, or by both. If an index is owned by both a user and an integrity constraint, the index is not deleted until both an IC DELETE statement and an INDEX DELETE statement are processed.

INFORMAT Statement

Assigns, changes, and removes variable informats in the data set specified in the MODIFY statement permanently.

Restriction: The INFORMAT statement must appear in a MODIFY RUN group

Example: "Example 4: Modifying SAS Data Sets" on page 704

Syntax

INFORMAT *variable-1* <*informat-1*>
<*variable-2* <*informat-2*> ...>;

Required Argument

variable
specifies one or more variables whose informats you want to assign, change, or remove. If you want to disassociate an informat with a variable, list the variable last in the list with no informat following:

```
informat a b 2. x1-x3 4.1 c;
```

Optional Argument

informat
specifies an informat for the variables immediately preceding it in the statement. If you do not specify an informat, the INFORMAT statement removes any existing informats for the variables in *variable-list*.

Tip To remove all informats from a data set, use the ATTRIB statement on page 597 and the _ALL_ keyword.

INITIATE Statement

Creates an audit file that has the same name as the SAS data file and a data set type of AUDIT.

Restrictions: The INITIATE statement must appear in an AUDIT RUN group.

An INITIATE statement is a required statement that can occur only once per audit file and must be placed directly after the AUDIT statement in the first AUDIT RUN group for that file.

Example: "Example 8: Initiating an Audit File" on page 715

Syntax

INITIATE <AUDIT_ALL=NO | YES>;

Optional Argument

AUDIT_ALL=NO | YES
specifies whether logging can be suspended and audit settings can be changed. AUDIT_ALL=YES specifies that all images are logged and cannot be suspended. That is, you cannot use the LOG statement to turn off logging of particular images, and you cannot suspend event logging by using the SUSPEND statement. To turn off logging, you must use the TERMINATE statement, which terminates event logging and deletes the audit file.

Default NO

Example "Example 8: Initiating an Audit File" on page 715

Details

The audit file logs additions, deletions, and updates to the SAS data file. You must initiate an audit trail before you can suspend, resume, or terminate it. Although the AUDIT statement immediately preceding the INITIATE statement cannot specify a GENNUM= option, if the specified file identifies a generation data set group, the audit file created by the INITIATE statement will be attached to the most recently created generation in the generation group.

The following example creates the audit file MyLib.MyFile.audit to log updates to the data file MyLib.MyFile.data, storing all available record images:

```
proc datasets library=mylib;
   audit myfile (alter=password);
```

```
   initiate;
run;
```

The following example initiates an audit file using AUDIT_ALL=YES:

```
proc datasets lib=mylib;  /* all audit image types will be logged
                             and the file cannot be suspended */
     audit myfile (alter=password);
     initiate audit_all=yes;
quit;
```

LABEL Statement

Assigns, changes, and removes variable labels for the SAS data set specified in the MODIFY statement.

Restriction: The LABEL statement must appear in a MODIFY RUN group

Example: "Example 4: Modifying SAS Data Sets" on page 704

Syntax

LABEL *variable-1=<'label-1' | ' '>*
<variable-2=<'label-2' | ' '> ...>;

Required Argument

variable=<'label'>
specifies a text string of up to 256 characters. If the label text contains single quotation marks, use double quotation marks around the label, or use two single quotation marks in the label text and enclose the string in single quotation marks. To remove a label from a data set, assign a label that is equal to a blank that is enclosed in quotation marks.

Range 1 - 256 characters

Tip To remove all variable labels in a data set, use the ATTRIB statement on page 597 and the _ALL_ keyword.

LOG Statement

specifies the audit file settings.

Restriction: The LOG statement must appear after the INITIATE statement in an AUDIT RUN group.

Example: "Example 8: Initiating an Audit File" on page 715

Syntax

LOG <ADMIN_IMAGE=YES | NO>
<BEFORE_IMAGE=YES | NO>
<DATA_IMAGE=YES | NO>
<ERROR_IMAGE=YES | NO>;

Optional Arguments

ADMIN_IMAGE=YES | NO
specifies whether the administrative events are logged to the audit file (that is, the SUSPEND and RESUME actions).

Default YES

Tip If you do not want to log a particular image, specify NO for the image type. For example, the following code turns off logging the error images, but the administrative, before, and data images continue to be logged: `log error_image=no;`

BEFORE_IMAGE=YES | NO
specifies whether the before-update record images are logged to the audit file.

Default YES

DATA_IMAGE=YES | NO
specifies whether the added, deleted, and after-update record images are logged to the audit file.

Default YES

ERROR_IMAGE=YES | NO
specifies whether the after-update record images are logged to the audit file.

Default YES

Details

The following example creates the same audit file but stores only error record images:

```
proc datasets library=mylib;
   audit myfile (alter=password);
   initiate;
      log admin_image=no
          before_image=no
          data_image=no;
run;
```

MODIFY Statement

Changes the attributes of a SAS file and, through the use of subordinate statements, the attributes of variables in the SAS file.

Restriction: You cannot change the length of a variable using the LENGTH= option in an ATTRIB statement.

Example: "Example 4: Modifying SAS Data Sets" on page 704

Syntax

MODIFY *SAS-file* <(*options*)>
</ <CORRECTENCODING=*encoding-value*> <DTC=*SAS-date-time*>
<GENNUM=*integer*> <MEMTYPE=*member-type*>>;

Required Argument

SAS-file
specifies a SAS file that exists in the procedure input library.

Optional Arguments

ALTER=*password-modification*
assigns, changes, or removes an Alter password for the SAS file named in the MODIFY statement. *password-modification* is one of the following:

- *new-password*
- *old-password* / *new-password*
- / *new-password*
- *old-password* /
- /

See "Manipulating Passwords" on page 648

CORRECTENCODING=*encoding-value*
enables you to change the encoding indicator, which is recorded in the file's descriptor information, in order to match the actual encoding of the file's data.

See "CORRECTENCODING= Option Statement" in *SAS National Language Support (NLS): Reference Guide*

ENCRYPTKEY=*key-value*
specifies a key value for AES encryption.

Requirement ENCRYPTKEY= data set option is required if the data file has AES encryption.

DTC=*SAS-date-time*

specifies a date and time to substitute for the date and time stamp placed on a SAS file at the time of creation. You cannot use this option in parentheses after the name of each SAS file; you must specify DTC= after a forward slash:

```
modify mydata / dtc='03MAR00:12:01:00'dt;
```

Restrictions A SAS file's creation date and time cannot be set later than the date and time the file was actually created.

DTC= cannot be used with encrypted files or sequential files.

DTC= can be used only when the resulting SAS file uses the V8 or V9 engine.

Tip Use DTC= to alter a SAS file's creation date and time before using the DATECOPY option in the COPY procedure, CPORT procedure, SORT procedure, and the COPY statement in the DATASETS procedure.

GENMAX=*number-of-generations*

specifies the maximum number of versions. Use this option in parentheses after the name of SAS file.

Default 0

Range 0 to 1,000

GENNUM=*integer*

restricts processing for generation data sets. You can specify GENNUM= either in parentheses after the name of each SAS file or after a forward slash. Valid value is *integer*, which is a number that references a specific version from a generation group. Specifying a positive number is an absolute reference to a specific generation number that is appended to a data set's name (that is, `gennum=2` specifies MYDATA#002). Specifying a negative number is a relative reference to a historical version in relation to the base version, from the youngest to the oldest (that is, `gennum=-1` refers to the youngest historical version). Specifying 0, which is the default, refers to the base version.

See "Understanding Generation Data Sets" in *SAS Language Reference: Concepts*

LABEL='*data-set-label*' | ' '

assigns, changes, or removes a data set label for the SAS data set named in the MODIFY statement. If a single quotation mark appears in the label, write it as two single quotation marks. LABEL= or LABEL=' ' removes the current label.

Range 1 - 256 characters

Restriction A view label cannot be updated after the label is created.

Tip To remove all variable labels in a data set, use the ATTRIB statement on page 597.

See "Example 4: Modifying SAS Data Sets" on page 704

MEMTYPE=*member-type*
restricts processing to one member type. You cannot specify MEMTYPE= in parentheses after the name of each SAS file; you must specify MEMTYPE= after a forward slash.

Aliases MTYPE=

MT=

Default If you do not specify the MEMTYPE= option in the PROC DATASETS statement or in the MODIFY statement, the default is MEMTYPE=DATA.

PW=*password-modification*
assigns, changes, or removes a Read, Write, or Alter password for the SAS file named in the MODIFY statement. *password-modification* is one of the following:

- *new-password*
- *old-password* / *new-password*
- / *new-password*
- *old-password* /
- /

READ=*password-modification*
assigns, changes, or removes a Read password for the SAS file named in the MODIFY statement. *password-modification* is one of the following:

- *new-password*
- *old-password* / *new-password*
- / *new-password*
- *old-password* /
- /

See "Manipulating Passwords" on page 648

Example "Example 4: Modifying SAS Data Sets" on page 704

SORTEDBY=*sort-information*
specifies how the data are currently sorted. SAS stores the sort information with the file but does not verify that the data are sorted the way you indicate. *sort-information* can be one of the following:

by-clause </ *collate-name*> indicates how the data are currently sorted. Values for *by-clause* are the variables and options that you can use in a BY statement in a PROC SORT step. *collate-name* names the collating sequence used for the sort. By default, the

collating sequence is that of your host operating environment.

NULL removes any existing sort indicator.

Restriction The data must be sorted in the order in which you specify. If the data is not in the specified order, SAS does not sort it for you.

Tip When using the MODIFY SORTEDBY option, you can also use a numbered range list or colon list. For more information, see "Data Set Name Lists" in *SAS Programmer's Guide: Essentials*.

Example "Example 4: Modifying SAS Data Sets" on page 704

TYPE=*special-type*
assigns or changes the special data set type of a SAS data set. SAS does not verify the following:

- the SAS data set type that you specify in the TYPE= option (except to check if it has a length of eight or fewer characters)
- that the SAS data set's structure is appropriate for the type that you have designated

Note Do not confuse the TYPE= option with the MEMTYPE= option. The TYPE= option specifies a type of special SAS data set. The MEMTYPE= option specifies one or more types of SAS files in a SAS library.

Tip Most SAS data sets have no special type. However, certain SAS procedures, like the CORR procedure, can create a number of special SAS data sets. In addition, SAS/STAT software and SAS/EIS software support special data set types.

WRITE=*password-modification*
assigns, changes, or removes a Write password for the SAS file named in the MODIFY statement. *password-modification* is one of the following:

- *new-password*
- *old-password* / *new-password*
- / *new-password*
- *old-password* /
- /

See "Manipulating Passwords" on page 648

Details

Changing Data Set Labels and Variable Labels

The LABEL option can change either the data set label or a variable label within the data set. To change a data set label, use the following syntax:

```
modify datasetname(label='Label for Data Set');
run;
```

You can change one or more variable labels within a data set. To change a variable label within the data set, use the following syntax:

```
modify datasetname;
    label  variablename='Label for Variable';
run;
```

For an example of changing both a data set label and a variable label in the same PROC DATASETS, see "Example 4: Modifying SAS Data Sets" on page 704.

Manipulating Passwords

In order to assign, change, or remove a password, you must specify the password for the highest level of protection that currently exists on that file.

Assigning Passwords

```
/* assigns a password to an unprotected file */
modify colors (pw=green);

/* assigns an Alter password to an already read-protected SAS data set */
modify colors (read=green alter=red);
```

Changing Passwords

```
/* changes the Write password from YELLOW to BROWN */
modify cars (write=yellow/brown);

/* uses Alter access to change unknown Read password to BLUE */
modify colors (read=/blue alter=red);
```

Removing Passwords

```
/* removes the Alter password RED from STATES */
modify states (alter=red/);

/* uses Alter access to remove the Read password */
modify zoology (read=green/ alter=red);

/* uses PW= as an alias for either WRITE= or ALTER= to remove unknown
   Read password */
modify biology (read=/ pw=red);
```

Working with Generation Groups

Changing the Number of Generations

```
/* changes the number of generations on data set A to 99 */
modify A (genmax=99);
```

Removing Passwords

```
/* removes the Alter password RED from STATES#002 */
modify states (alter=red/) / gennum=2;
```

REBUILD Statement

Specifies whether to restore or delete the disabled indexes and integrity constraints.

Default: Rebuild indexes and integrity constraints

Restriction: The REBUILD statement applies only to data sets created in Version 7 or later

Syntax

REBUILD *SAS-file* </ <ENCRYPTKEY=*key-value*>
<ALTER=*password*> <GENNUM=*n*> <MEMTYPE=*member-type*> <NOINDEX>>;

Required Argument

SAS-file
specifies a SAS data file that contains the disabled indexes and integrity constraints. You can also use a numbered range list or colon list.

See "Data Set Name Lists" in *SAS Programmer's Guide: Essentials*.

Optional Arguments

ENCRYPTKEY=*key-value*
specifies a key value for AES encryption.

Requirement ENCRYPTKEY= data set option is required if the data file has AES encryption.

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files that are named in the REBUILD statement. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

GENNUM=*integer*
restricts processing for generation data sets. You can use the option either in parentheses after the name of each SAS file or after a forward slash. Valid value is *integer*, which is a number that references a specific version from a generation group. Specifying a positive number is an absolute reference to a specific generation number that is appended to a data set's name (that is, `gennum=2` specifies MYDATA#002). Specifying a negative number is a relative reference to a historical version in relation to the base version, from the youngest to the oldest (that is, `gennum=-1` refers to the youngest historical version). Specifying 0, which is the default, refers to the base version.

See "Understanding Generation Data Sets" in *SAS Language Reference: Concepts*

MEMTYPE=*member-type*
restricts processing to one member type.

Aliases MTYPE=

MT=

Default If you do not specify the MEMTYPE= option in the PROC DATASETS statement or in the REBUILD statement, the default is MEMTYPE=ALL.

NOINDEX
specifies to delete the disabled indexes and integrity constraints.

Restriction The NOINDEX option cannot be used for data files that contain one or more referential integrity constraints.

Details

When the DLDMGACTION=NOINDEX data set or system option is specified and SAS encounters a damaged data file, SAS does the following:

- repairs the data file without indexes and integrity constraints
- deletes the index file
- updates the data file to reflect the disabled indexes and integrity constraints
- limits the data file to be opened only in INPUT mode
- writes the following warning to the SAS log:

```
WARNING: SAS data file MYLIB.MYFILE.DATA was damaged and
         has been partially repaired. To complete the repair,
         execute the DATASETS procedure REBUILD statement.
```

The REBUILD statement completes the repair of a damaged SAS data file by rebuilding or deleting all of the data file's disabled indexes and integrity constraints. The REBUILD statement establishes and uses member-level locking in order to process the new index file and to restore the indexes and integrity constraints.

To rebuild the index file and restore the indexes and integrity constraints, use the following code:

```
proc datasets library=mylib;
rebuild myfile
/alter=password
 gennum=n
 memtype=mytype;
```

To delete the disabled indexes and integrity constraints, use the following code:

```
proc datasets library=mylib;
rebuild myfile /noindex;
```

After you execute the REBUILD statement, the data file is no longer restricted to INPUT mode.

The REBUILD statement default is to rebuild the indexes and integrity constraints and the index file.

If a data file contains one or more referential integrity constraints and you use the NOINDEX option with the REBUILD statement, the following error message is written to the SAS log:

```
Error: Unable to rebuild data file MYLIB.MYFILE.DATA using the
             NOINDEX option because the data file contains referential
             constraints. Resubmit the REBUILD statement without the
             NOINDEX option to restore the data file.
```

RENAME Statement

Renames variables in the SAS data set specified in the MODIFY statement.

Restriction: The RENAME statement must appear in a MODIFY RUN group

Example: "Example 4: Modifying SAS Data Sets" on page 704

Syntax

RENAME *old-name-1=new-name-1*
<*old-name-2=new-name-2* ...>;

Required Argument

old-name=new-name
changes the name of a variable in the data set specified in the MODIFY statement. *old-name* must be a variable that already exists in the data set. *new-name* cannot be the name of a variable that already exists in the data set or the name of an index, and the new name must be a valid SAS name.

For example, assume the Oxygen data set includes a variable named OXYGEN. The following code renames the OXYGEN variable to intake:

```
modify oxygen;
      rename oxygen=intake;
```

Alphabetic List of Variables and Attributes				
#	Variable	Type	Len	Label
1	AGE	Num	8	
6	MAXPULSE	Num	8	
4	RSTPULSE	Num	8	
5	RUNPULSE	Num	8	
3	RUNTIME	Num	8	
2	WEIGHT	Num	8	
7	intake	Num	8	Intake Measurement

See "Rules for Words and Names in the SAS Language" in *SAS Language Reference: Concepts*

Details

If *old-name* does not exist in the SAS data set or *new-name* already exists, PROC DATASETS stops processing the RUN group containing the RENAME statement and issues an error message.

When you use the RENAME statement to change the name of a variable for which there is a simple index, the statement also renames the index.

If the variable that you are renaming is used in a composite index, the composite index automatically references the new variable name. However, if you attempt to rename a variable to a name that has already been used for a composite index, you receive an error message.

REPAIR Statement

Attempts to restore damaged SAS data sets or catalogs, in permanent libraries, to a usable condition.

Note: The REPAIR statement is not a replacement for having a current backup.

Syntax

REPAIR *SAS-file(s)*
</ <ENCRYPTKEY=*key-value*>
<ALTER=*alter-password*> <GENNUM=*integer*> <MEMTYPE=*member-type*>>;

Required Argument

SAS-file(s)
specifies one or more SAS data sets or catalogs in the procedure input library. You can also use a numbered range list or colon list.

See "Data Set Name Lists" in *SAS Programmer's Guide: Essentials*

Optional Arguments

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files that are named in the REPAIR statement. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

See "Using Passwords with the DATASETS Procedure" on page 665

ENCRYPTKEY=*key-value*
specifies a key value for AES encryption.

Requirement ENCRYPTKEY= data set option is required if the data file has AES encryption.

GENNUM=*integer*
restricts processing for generation data sets. You can use the option either in parentheses after the name of each SAS file or after a forward slash. Valid value is *integer*, which is a number that references a specific version from a generation group. Specifying a positive number is an absolute reference to a specific generation number that is appended to a data set's name (that is, `gennum=2` specifies MYDATA#002). Specifying a negative number is a relative reference to a historical version in relation to the base version, from the youngest to the oldest (that is, `gennum=-1` refers to the youngest historical version). Specifying 0, which is the default, refers to the base version.

See "Restricting Processing for Generation Data Sets" on page 667 and "Understanding Generation Data Sets" in *SAS Language Reference: Concepts*

MEMTYPE=*member-type*
restricts processing to one member type.

Aliases MTYPE=

MT=

Default If you do not specify the MEMTYPE= option in the PROC DATASETS statement or in the REPAIR statement, the default is MEMTYPE=ALL.

See "Restricting Member Types for Processing" on page 668

Details

CAUTION
If you have extensive damage to your data set, the REPAIR statement will not correct it. If the device on which a SAS data set or an auxiliary file (index, audit, or

extended attribute file) resides is damaged, then you must restore the damaged data set and auxiliary files from a backup device.

The most common situations where the REPAIR statement might be helpful are as follows:

- A system failure occurs while you are updating a SAS data set or catalog.

  When you use the REPAIR statement for SAS data sets, it re-creates all indexes for the data set. It also attempts to restore the data set to a usable condition, but the restored data set might not include the last several updates that occurred before the system failed. You cannot use the REPAIR statement to re-create indexes that were destroyed by using the FORCE option in a PROC SORT step.

- An I/O error occurs while you are writing a SAS data set or catalog entry.

  If the disk that stores the SAS data set becomes full before the file is completely written to disk, the step that writes the data set will fail, and an error is written to the SAS log. The REPAIR statement can repair the data set header and perhaps offer a workable data set. The data set will likely be incomplete and its integrity questionable. The best recourse is to re-create the data set from a backup.

Note that observations might be lost during the repair process.

When you use the REPAIR statement for a catalog, you receive a message stating whether the REPAIR statement restored the entry. If the entire catalog is potentially damaged, the REPAIR statement attempts to restore all the entries in the catalog. If only a single entry is potentially damaged, for example, when a single entry is being updated and a disk-full condition occurs, on most systems only the entry that is open when the problem occurs is potentially damaged. In this case, the REPAIR statement attempts to repair only that entry. Some entries within the restored catalog might not include the last updates that occurred before a system crash or an I/O error. The REPAIR statement issues warning messages for entries that might have truncated data.

To repair a damaged catalog, you must use a version of SAS that can update the catalog. A damaged SAS 9 catalog can be repaired with SAS 9 only.

If you issue a REPAIR statement for a SAS file that does not exist in the specified library, PROC DATASETS stops processing the run group that contains the REPAIR statement, and issues an error message. To override this behavior, use the NOWARN option in the PROC DATASETS statement.

If you are using Cross-Environment Data Access (CEDA) to process a foreign SAS data set that has become damaged, you must move the data set back to its native environment before you attempt to repair it using the PROC DATASETS REPAIR statement. CEDA does not support update processing, which is required in order to repair a damaged data set.

For more information about CEDA, see “Definitions for Cross-Environment Data Access (CEDA)” in *SAS Programmer’s Guide: Essentials*.

RESUME Statement

resumes event logging to the audit file, if it was suspended.

Restriction: The RESUME statement must appear in an AUDIT RUN group.

Example: "Example 8: Initiating an Audit File" on page 715

Syntax

RESUME;

Details

No other audit-related statement, such as RESUME, SUSPEND, TERMINATE, USER_VAR, or LOG, will be valid for an audit file until the INITIATE statement has been submitted. For more information, see "INITIATE Statement" on page 641.

The RESUME statement requires the LOG statement ADMIN_IMAGE=YES option. This option specifies whether the administrative events are logged to the audit file (that is, the SUSPEND and RESUME actions). For more information, see "LOG Statement" on page 642.

SAVE Statement

Deletes all the SAS files in a library except the ones listed in the SAVE statement.

Example: "Example 3: Saving SAS Files from Deletion" on page 701

Syntax

SAVE *SAS-file(s)* </ MEMTYPE=*member-type*>;

Required Argument

SAS-file(s)
specifies one or more SAS files that you do not want to delete from the SAS library.

Note: If a SAS file has an ALTER= password assigned, it must be specified in order to delete the SAS file.

Optional Argument

MEMTYPE=*member-type*
restricts processing to one member type. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

Aliases MTYPE=

MT=

Default If you do not specify the MEMTYPE= option in the PROC DATASETS statement or in the SAVE statement, the default is MEMTYPE=ALL.

See "Restricting Member Types for Processing" on page 668

Example "Example 3: Saving SAS Files from Deletion" on page 701

Details

If one of the SAS files in *SAS-file* does not exist in the procedure input library, PROC DATASETS stops processing the RUN group containing the SAVE statement and issues an error message. To override this behavior, specify the NOWARN option in the PROC DATASETS statement.

When the SAVE statement deletes SAS data sets, it also deletes any indexes associated with those data sets. (If the SAS data set that is to be deleted has an ALTER= password assigned to it, the ALTER= password must be specified in order to delete the SAS data set.)

CAUTION
SAS immediately deletes libraries and library members when you submit a RUN group. You are not asked to verify the Delete operation before it begins. The SAVE statement deletes many SAS files in one operation. Make sure that you understand how the MEMTYPE= option affects which types of SAS files are saved and which types are deleted.

When you use the SAVE statement with generation groups, the SAVE statement treats the base version and all historical versions as a unit. You cannot save a specific version.

SELECT Statement

Selects SAS files for copying.

Restrictions: The SELECT statement must follow a COPY statement

The SELECT statement cannot appear with an EXCLUDE statement in the same COPY step

Example: "Example 2: Manipulating SAS Files" on page 696

Syntax

SELECT *SAS-file(s)*
</ <ENCRYPTKEY=*key-value*> <ALTER=*alter-password*> <MEMTYPE=*member-type*>>;

Required Argument

SAS-file(s)
specifies one or more SAS files that you want to copy. All of the SAS files that you name must be in the data library that is referenced by the libref named in the IN= option in the COPY statement. If the SAS files have generation groups, all the generations are copied because the SELECT statement does not allow you to select specific versions.

Optional Arguments

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files that you are moving from one data library to another. Because you are moving and thus deleting a SAS file from a SAS library, you need Alter access. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

See "Using Passwords with the DATASETS Procedure" on page 665

ENCRYPTKEY=*key-value*
specifies the key value for AES encryption.

See "Appending AES-Encrypted Data Sets" on page 592

MEMTYPE=*member-type*
restricts processing to one member type. You can use the option either in parentheses after the name of each SAS file or after a forward slash.

Aliases MTYPE=

MT=

Default If you do not specify the MEMTYPE= option in the PROC DATASETS statement, in the COPY statement, or in the SELECT statement, the default is MEMTYPE=ALL.

See "Specifying Member Types When Copying or Moving SAS Files" on page 620 and "Restricting Member Types for Processing" on page 668

Example “Example 2: Manipulating SAS Files” on page 696

Details

Selecting Several Like-Named Files

You can use shortcuts for listing several SAS files in the SELECT statement:

Table 17.13 *Using the SELECT Statement*

Notation	Meaning
x1–xn	Specifies files X1 through Xn. The numbers must be consecutive.
x:	Specifies all files that begin with the letter X.

SUSPEND Statement

suspends event logging to the audit file, but does not delete the audit file.

Restriction: The SUSPEND statement must appear in an AUDIT RUN group.

Example: “Example 8: Initiating an Audit File” on page 715

Syntax

SUSPEND;

Details

No other audit-related statement, such as SUSPEND, RESUME, TERMINATE, USER_VAR, or LOG, will be valid for an audit file until the INITIATE statement has been submitted. For more information, see “INITIATE Statement” on page 641.

The SUSPEND statement requires the LOG statement ADMIN_IMAGE=YES option. This option specifies whether the administrative events are logged to the audit file (that is, the SUSPEND and RESUME actions). For more information, see “LOG Statement” on page 642.

TERMINATE Statement

terminates event logging and deletes the audit file.

Restriction: The TERMINATE statement must appear in an AUDIT RUN group.

Example: "Example 8: Initiating an Audit File" on page 715

Syntax

TERMINATE;

Details

No other audit-related statement, such as TERMINATE, SUSPEND, RESUME, USER_VAR, or LOG, will be valid for an audit file until the INITIATE statement has been submitted. For more information, see "INITIATE Statement" on page 641.

USER_VAR Statement

defines optional variables to be logged in the audit file with each update to an observation. When you use USER_VAR, it must follow an INITIATE statement.

Restrictions: The USER_VAR statement must appear in an AUDIT RUN group.

The USER_VAR statement is optional. If specified, the USER_VAR statement must immediately follow the INITIATE statement for the applicable audit file.

Example: "Example 8: Initiating an Audit File" on page 715

Syntax

USER_VAR *variable-name-1* <$> <*length*> <LABEL='*variable-label*' > <*variable-name-2* <$> <*length*> <LABEL='*variable-label*' > ...>;

Required Argument

variable-name
is a name for the variable.

Optional Arguments

$
indicates that the variable is a character variable.

length
specifies the length of the variable.

Default 8

LABEL='*variable-label*'
specifies a label for the variable.

XATTR ADD Statement

Adds an extended attribute to a variable or a data set.

Restrictions: The XATTR ADD statement must appear in a MODIFY RUN group

Generation data sets do not support extended attributes.

Supports: V9 engine only

Notes: An extended attribute can have numeric or character values.

A blank space in a character value indicates a missing value. Missing numeric values are also allowed.

An extended attribute name must conform to SAS naming rules. A SAS name can be up to 32 characters long. For more information, see "Rules for User-Supplied SAS Names" in *SAS Language Reference: Concepts* and "SAS Variable Attributes" in *SAS Language Reference: Concepts*.

Example: "Example 9: Extended Attributes" on page 721

Syntax

XATTR ADD DS *attribute-name-1=attribute-value-1*
<*attribute-name-2=attribute-value-2 ...*>;

or

XATTR ADD VAR *variable-name-1* (*attribute-name-1=attribute-value-1*
< attribute-name-2=attribute-value-2 ...>)
<*variable-name-2* (*attribute-name-1=attribute-value-1*
<*attribute-name-2=attribute-value-2 ...*>) >;

Required Arguments

Note that for character values, *attribute-value* must be in quotation marks, such as *"attribute-value"*.

XATTR ADD DS *attribute-name-1=attribute-value-1 <attribute-name-2=attribute-value-2 ...>*
adds an extended attribute to a data set. If the extended attribute already exists, an error will be returned.

XATTR ADD VAR *variable-name-1 (attribute-name-1=attribute-value-1 <attribute-name-2=attribute-value-2 ...>) <variable-name-2 (attribute-name-1=attribute-value-1 <attribute-name-2=attribute-value-2 ...>)>*
adds an extended attribute to a variable. If the extended attribute already exists, an error will be returned.

Details

Extended attributes are organized into (name, value) pairs. If you try to add a new attribute and the attribute already exists, an error is written to the SAS log.

XATTR DELETE Statement

Deletes all extended attributes from a SAS file.

Restriction: The XATTR DELETE statement must appear in a MODIFY RUN group

Supports: V9 engine only

Example: "Example 9: Extended Attributes" on page 721

Syntax

XATTR DELETE;

Required Argument

XATTR DELETE
deletes all extended attributes from a data set.

Details

Use the XATTR DELETE statement to delete all of the extended attributes from a data set. None of the extended attributes will exist after using this command. The following example deletes all extended attributes from a data set:

```
proc datasets lib=library_name nolist;
   modify dataset_name;
      xattr delete;
   run;
quit;
```

XATTR OPTIONS Statement

Specifies options as needed for extended attributes. Currently, only SEGLEN= is a valid option.

Restriction: The XATTR OPTIONS statement must appear in a MODIFY RUN group

Supports: V9 engine only

Example: "Example 9: Extended Attributes" on page 721

Syntax

XATTR OPTIONS <SEGLEN=*number-of-bytes*>;

Required Argument

XATTR OPTIONS SEGLEN=*number-of-bytes*
Indicates the length of the storage element that will hold the character extended attribute value. The value can be 1 to 32,760 bytes.

Default 256

XATTR REMOVE Statement

Removes an extended attribute from a variable or a data set.

Restriction: The XATTR REMOVE statement must appear in a MODIFY RUN group

Supports: V9 engine only

Example: "Example 9: Extended Attributes" on page 721

Syntax

XATTR REMOVE DS *attribute-name(s)* ;

or

XATTR REMOVE VAR *variable-name-1* (*attribute-name(s)*)

<variable-name-2 (attribute-name(s) ...)>;

Required Arguments

XATTR REMOVE DS *attribute-name(s)*
removes an extended attribute from a data set.

XATTR REMOVE VAR *variable-name-1* (*attribute-name(s)*) <*variable-name-2* (*attribute-name(s)*)>
removes an extended attribute from a variable.

Details

If you no longer need an extended attribute that you created, use the XATTR REMOVE statement to remove it from a variable or a data set. The XATTR REMOVE statement deletes only the extended attribute that you specify.

XATTR SET Statement

Updates or adds extended attributes to variables or data sets.

Restrictions: The XATTR SET statement must appear in a MODIFY RUN group

Generation data sets do not support extended attributes.

Supports: V9 engine only

Notes: An extended attribute can have numeric or character values.

A blank space in a character value indicates a missing value. Missing numeric values are also allowed.

An extended attribute name must conform to SAS naming rules. A SAS name can be up to 32 characters long. For more information, see "Rules for User-Supplied SAS Names" in *SAS Language Reference: Concepts* and "SAS Variable Attributes" in *SAS Language Reference: Concepts*.

Example: "Example 9: Extended Attributes" on page 721

Syntax

XATTR SET DS *attribute-name-1=attribute-value-1*
<attribute-name-2="attribute-value-2" ...>;

or

XATTR SET VAR *variable-name-1 (attribute-name-1=attribute-value-1*
<attribute-name-2=attribute-value-2 ... >)
<variable-name-2 (attribute-name-1=attribute-value-1
<attribute-name-2=attribute-value-2> ...)>;

Required Arguments

Note that for character values, *attribute-value* must be in quotation marks, such as *"attribute-value"*.

XATTR SET DS *attribute-name-1=attribute-value-1 <attribute-name-2=attribute-value-2 ...>*
updates or adds an extended attribute to a data set. If the data set extended attribute does not exist, it will be added. If it does exist, it will be updated with the value specified.

XATTR SET VAR *variable-name-1* (*attribute-name-1=attribute-value-1 <attribute-name-2=attribute-value-2 ...>*) *<variable-name-2* (*attribute-name-1=attribute-value-1 <attribute-name-2=attribute-value-2 ...>*)>
updates or adds an extended attribute to a variable. If the variable and extended attribute combination does not exist, the extended attribute will be added. If it does exist, the extended attribute will be updated with the one specified.

Details

Use the XATTR SET statement if you are not sure if an extended attribute exists. If an extended attribute does exist, it will be updated. If the extended attribute does not exist, it added. The XATTR SET statement defines the variable or data set extended attribute even if it does not exist yet. When using XATTR ADD, an error occurs if there is an existing extended attribute using that value. You also get an error if you try to use XATTR UPDATE on an extended attribute that does not exist yet. Using XATTR SET defines the variable or data set extended attributes. If the extended attribute did not exist, it does now. If the extended attribute did exist, then it has a new value.

XATTR UPDATE Statement

Updates an extended attribute to a variable or a data set.

Restriction: The XATTR UPDATE statement must appear in a MODIFY RUN group

Supports: V9 engine only

Notes: A blank space in a character value indicates a missing value. Missing numeric values are also allowed.

An extended attribute name must conform to SAS naming rules. A SAS name can be up to 32 characters long. For more information, see "Rules for User-Supplied SAS Names" in *SAS Language Reference: Concepts* and "SAS Variable Attributes" in *SAS Language Reference: Concepts*.

Example: "Example 9: Extended Attributes" on page 721

Syntax

XATTR UPDATE DS *attribute-name-1=attribute-value-1*
<attribute-name-2=attribute-value-2 ...>;

or

XATTR UPDATE VAR *variable-name-1 (attribute-name-1=attribute-value-1*
<attribute-name-2=attribute-value-2 ...>)
<variable-name-2 (attribute-name-1=attribute-value-1
<attribute-name-2=attribute-value-2 ...>)>;

Required Arguments

Note that for character values, *attribute-value* must be in quotation marks, such as *"attribute-value"*.

XATTR UPDATE DS *attribute-name-1=attribute-value-1 <attribute-name-2=attribute-value-2 ...>*
updates an extended attribute in a data set. If the extended attribute does not exist, an error is written to the SAS log.

XATTR UPDATE VAR *variable-name-1 (attribute-name-1=attribute-value-1 <attribute-name-2=attribute-value-2 ...>) <variable-name-2 (attribute-name-1=attribute-value-1 <attribute-name-2=attribute-value-2 ...>)>*
updates an extended attribute for a variable. If the variable and extended attribute combination is not found, an error message is written to the SAS log.

Details

To make changes to an existing extended attribute, use the XATTR UPDATE statement. If you try to update an extended attribute that does not exist, an error is written to the SAS log.

Usage: DATASETS Procedure

Using Passwords with the DATASETS Procedure

Several statements in the DATASETS procedure support options that manipulate passwords on SAS files. These options, ALTER=, PW=, READ=, and WRITE=, are also data set options.[1] If you do not know how passwords affect SAS files, see "Assigning Passwords" in *SAS Programmer's Guide: Essentials*.

When you are working with password-protected SAS files in the AGE, CHANGE, DELETE, EXCHANGE, REPAIR, or SELECT statement, you can specify ALTER= and PW= password options in the PROC DATASETS statement or in the subordinate statement.

Note: The ALTER= option works slightly different for the COPY (when moving a file) and MODIFY statements. For more information, see COPY statement on page 610 and the MODIFY statement on page 644.

SAS searches for passwords in the following order:

1 in parentheses after the name of the SAS file in a subordinate statement. When used in parentheses, the option refers only to the name immediately preceding the option. If you are working with more than one SAS file in a data library and each SAS file has a different password, you must specify password options in parentheses after individual names.

   In the following statement, the ALTER= option provides the password `red` for the SAS file Bones only:

```
delete xplant bones(alter=red);
```

2 after a forward slash (/) in a subordinate statement. When you use a password option following a slash, the option refers to all SAS files named in the statement unless the same option appears in parentheses after the name of a SAS file. This method is convenient when you are working with more than one SAS file and they all have the same password.

   In the following statement, the ALTER= option in parentheses provides the password `red` for the SAS file Chest, and the ALTER= option after the slash provides the password `blue` for the SAS file Virus:

```
delete chest(alter=red) virus / alter=blue;
```

3 in the PROC DATASETS statement. Specifying the password in the PROC DATASETS statement can be useful if all the SAS files that you are working with in the library have the same password. Do not specify the option in parentheses.

   In the following PROC DATASETS step, the PW= option provides the password `red` for the SAS files Insulin and Abneg:

```
proc datasets pw=red;
   delete insulin;
   contents data=abneg;
run;
```

Note: For the password for a SAS file in a SELECT statement, SAS looks in the COPY statement before it looks in the PROC DATASETS statement.

1. In the APPEND and CONTENTS statements, you use these options just as you use any SAS data set option, in parentheses after the SAS data set name.

Restricting Processing for Generation Data Sets

Several statements in the DATASETS procedure support the GENNUM= option to restrict processing for generation data sets. GENNUM= is also a data set option.[1] If you do not know how to request and use generation data sets, see "Generation Data Sets" in "Understanding Generation Data Sets" in *SAS Language Reference: Concepts*.

When you are working with a generation group for the AUDIT, CHANGE, DELETE, MODIFY, and REPAIR statements, you can restrict processing in the PROC DATASETS statement or in the subordinate statement to a specific version.

Note: The GENNUM= option works slightly different for the MODIFY statement. See MODIFY statement on page 644.

Note: You cannot restrict processing to a specific version for the AGE, COPY, EXCHANGE, and SAVE statements. These statements apply to the entire generation group.

SAS searches for a generation specification in the following order:

1. in parentheses after the name of the SAS data set in a subordinate statement. When used in parentheses, the option refers only to the name immediately preceding the option. If you are working with more than one SAS data set in a data library and you want a different generation version for each SAS data set, then you must specify GENNUM= in parentheses after individual names.

   In the following statement, the GENNUM= option specifies the version of a generation group for the SAS data set Bones only:

   ```
   delete xplant bones (gennum=2);
   ```

2. after a forward slash (/) in a subordinate statement. When you use the GENNUM= option following a slash, the option refers to all SAS data sets named in the statement unless the same option appears in parentheses after the name of a SAS data set. This method is convenient when you are working with more than one file and you want the same version for all files.

   In the following statement, the GENNUM= option in parentheses specifies the generation version for SAS data set Chest, and the GENNUM= option after the slash specifies the generation version for SAS data set Virus:

   ```
   delete chest (gennum=2) virus / gennum=1;
   ```

3. in the PROC DATASETS statement. Specifying the generation version in the PROC DATASETS statement can be useful if you want the same version for all

1. For the APPEND and CONTENTS statements, use GENNUM= just as you use any SAS data set option, in parentheses after the SAS data set name.

of the SAS data sets you are working with in the library. Do not specify the option in parentheses.

In the following PROC DATASETS step, the GENNUM= option specifies the generation version for the SAS files Insulin and Abneg:

```
proc datasets gennum=2;
   delete insulin;
   contents data=abneg;
run;
```

Note: For the generation version for a SAS file in a SELECT statement, SAS looks in the COPY statement before it looks in the PROC DATASETS statement.

Restricting Member Types for Processing

In the PROC DATASETS Statement

If you reference more than one member type in subordinate statements and you have a specified member type in the PROC DATASETS statement, then include all of the member types in the PROC DATASETS statement. Only the member type or types in the original PROC DATASETS statement is in effect. The following example lists multiple member types:

```
proc datasets lib=library memtype=(data view);
```

In Subordinate Statements

Use the MEMTYPE= option in the following subordinate statements to limit the member types that are available for processing:

AGE CHANGE DELETE EXCHANGE

EXCLUDE REPAIR SAVE SELECT

Note: The MEMTYPE= option works slightly differently for the CONTENTS, COPY, and MODIFY statements. For more information, see CONTENTS statement on page 603, COPY Statement on page 610, and MODIFY statement on page 644.

The procedure searches for MEMTYPE= in the following order:

1 in parentheses immediately after the name of a SAS file. When used in parentheses, the MEMTYPE= option refers only to the SAS file immediately preceding the option. For example, the following statement deletes House.data,

Lot.catalog, and Sales.data because the default member type for the DELETE statement is DATA. (For more information, see Table 17.52 on page 670 for the default types for each statement.)

```
delete house lot(memtype=catalog) sales;
```

2 after a slash (/) at the end of the statement. When used following a slash, the MEMTYPE= option refers to all SAS files named in the statement unless the option appears in parentheses after the name of a SAS file. For example, the following statement deletes Lotpix.catalog, Regions.data, and Appl.catalog:

```
delete lotpix regions(memtype=data) appl / memtype=catalog;
```

3 in the PROC DATASETS statement. For example, this DATASETS procedure deletes Appl.catalog:

```
proc datasets memtype=catalog;
   delete appl;
run;
```

Note: When you use the EXCLUDE and SELECT statements, the procedure looks in the COPY statement for the MEMTYPE= option before it looks in the PROC DATASETS statement. For more information, see "Specifying Member Types When Copying or Moving SAS Files" on page 620.

4 for the default value. If you do not specify a MEMTYPE= option in the subordinate statement or in the PROC DATASETS statement, the default value for the subordinate statement determines the member type available for processing.

Member Types

The following list gives the possible values for the MEMTYPE= option:

ACCESS
: access descriptor files (created by SAS/ACCESS software)

ALL
: all member types

CATALOG
: SAS catalogs

DATA
: SAS data files

FDB
: financial database

MDDB
: multidimensional database

PROGRAM
: stored compiled SAS programs

VIEW
SAS views

The following table shows the member types that you can use in each statement:

Table 17.14 *Subordinate Statements and Appropriate Member Types*

Statement	Appropriate Member Types	Default Member Type
AGE	ACCESS, CATALOG, DATA, FDB, MDDB, PROGRAM, VIEW	DATA
CHANGE	ACCESS, ALL, CATALOG, DATA, FDB, MDDB, PROGRAM, VIEW	ALL
CONTENTS	ALL, DATA, VIEW	DATA [1]
COPY	ACCESS, ALL, CATALOG, DATA, FDB, MDDB, PROGRAM, VIEW	ALL
DELETE	ACCESS, ALL, CATALOG, DATA, FDB, MDDB, PROGRAM, VIEW	DATA
EXCHANGE	ACCESS, ALL, CATALOG, DATA, FDB, MDDB, PROGRAM, VIEW	ALL
EXCLUDE	ACCESS, ALL, CATALOG, DATA, FDB, MDDB, PROGRAM, VIEW	ALL
MODIFY	ACCESS, DATA, VIEW	DATA
REPAIR	ALL, CATALOG, DATA	ALL [2]
SAVE	ACCESS, ALL, CATALOG, DATA, FDB, MDDB, PROGRAM, VIEW	ALL
SELECT	ACCESS, ALL, CATALOG, DATA, FDB, MDDB, PROGRAM, VIEW	ALL

1 When DATA=_ALL_ in the CONTENTS statement, the default is ALL. ALL includes only DATA and VIEW.
2 ALL includes only DATA and CATALOG.

Sample PROC DATASETS Output

The DATASETS procedure includes the following:

- copies all data sets from the Control library to the Health library
- lists the contents of the Health library
- deletes the Syndrome data set from the Health library
- changes the name of the Prenat data set to Infant

The SAS log is shown in the following output.

```
LIBNAME control 'SAS-library-1';
LIBNAME health 'SAS-library-2';

proc datasets memtype=data;
   copy in=control out=health;
run;

proc datasets library=health memtype=data details;
   delete syndrome;
   change prenat=infant;
run;
quit;
```

Example Code 17.1 *Log from PROC DATASETS*

```
744  proc datasets library=health memtype=data details;
                                Directory

Libref         HEALTH
Engine         V9
Physical Name  c:\Documents and Settings\myfile\My Documents\procdatasets\health
Filename       c:\Documents and Settings\myfile\My Documents\procdatasets\health


             Member  Obs, Entries                                  File
 #  Name     Type     or Indexes   Vars  Label                     Size  Last Modified

 1  ALL      DATA         23        17                            13312  12Sep07:10:57:50
 2  BODYFAT  DATA         83        13   California Results       13312  12Sep07:10:57:54
 3  CONFOUND DATA          8         4                             5120  12Sep07:10:57:50
 4  CORONARY DATA         39         4                             5120  12Sep07:10:57:50
 5  DRUG1    DATA          6         2   JAN2005 DATA              5120  12Sep07:10:57:50
 6  DRUG2    DATA         13         2   MAY2005 DATA              5120  12Sep07:10:57:50
 7  DRUG3    DATA         11         2   JUL2005 DATA              5120  12Sep07:10:57:50
 8  DRUG4    DATA          7         2   JAN2002 DATA              5120  12Sep07:10:57:50
 9  DRUG5    DATA          1         2   JUL2002 DATA              5120  12Sep07:10:57:50
10  GROUP    DATA        148        11   Test Subjects            33792  12Sep07:13:01:16
    GROUP    INDEX         1                                      9216  12Sep07:13:01:16
11  GRPOUT   DATA         11        40                            17408  13Dec10:11:40:24
12  GRPOUT1  DATA         11        40                            17408  13Dec10:10:28:32
13  INFANT   DATA        149         6                            17408  12Sep07:10:57:52
14  MLSCL    DATA         32         4   Multiple Sclerosis Data   5120  12Sep07:10:57:52
15  NAMES    DATA          7         4                             5120  12Sep07:10:57:52
16  OXYGEN   DATA         31         7                            17408  12Sep07:13:01:16
17  PERSONL  DATA        148        11                            25600  12Sep07:10:57:52
18  PHARM    DATA          6         3   Sugar Study               5120  12Sep07:10:57:52
19  POINTS   DATA          6         6                             5120  12Sep07:10:57:52
20  RESULTS  DATA         10         5                             5120  12Sep07:10:57:54
21  SLEEP    DATA        108         6                             9216  12Sep07:10:57:54
22  TEST2    DATA         15         5                             5120  12Sep07:10:57:54
23  TRAIN    DATA          7         2                             5120  12Sep07:10:57:54
24  VISION   DATA         16         3                             5120  12Sep07:10:57:54
25  WEIGHT   DATA          1         2                             5120  12Sep07:10:57:50
26  WGHT     DATA         83        13                            13312  12Sep07:10:57:54
745     delete syndrome;
746     change prenat=infant;
747  run;
ERROR: The file HEALTH.PRENAT (memtype=DATA) was not found, but appears on a CHANGE statement.
748  quit;
749
750  proc datasets memtype=data;
```

Results: DATASETS Procedure

Directory Listing to the SAS Log

The PROC DATASETS statement lists the SAS files in the procedure input library unless the NOLIST option is specified. The NOLIST option prevents the creation of the procedure results that go to the log. If you specify the MEMTYPE= option, only specified types are listed. If you specify the DETAILS option, PROC DATASETS prints these additional columns of information: **`Obs, Entries or Indexes`**, **`Vars`**, and **`Label`**.

Directory Listing as SAS Output

The CONTENTS statement lists the directory of the procedure input library if you use the DIRECTORY option or specify DATA=_ALL_.

If you want only a directory, use the NODS option and the _ALL_ keyword in the DATA= option. The NODS option suppresses the description of the SAS data sets; only the directory appears in the output.

Note: The CONTENTS statement does not put a directory in an output data set. If you try to create an output data set using the NODS option, you receive an empty output data set. Use the SQL procedure to create a SAS data set that contains information about a SAS library.

Note: If you specify the ODS RTF destination, the PROC DATASETS output goes to both the SAS log and the ODS output area. The NOLIST option suppresses output to both. To see the output only in the SAS log, use the ODS EXCLUDE statement by specifying the member directory as the exclusion.

Procedure Output

The CONTENTS Statement

The only statement in PROC DATASETS that produces procedure output is the CONTENTS statement. This section shows the output from the CONTENTS statement for the Health library and the Group data set, which is shown in the following output.

Only the items in the output that require explanation are discussed.

The Health Library Contents

The following is the list of all the files and catalogs in the Health library.

Directory	
Libref	HEALTH
Engine	V9
Physical Name	c:\procdatasets1\health
Filename	c:\procdatasets1\health
Owner Name	BUILTIN\Administrators
File Size	12KB
File Size (bytes)	12288

#	Name	Member Type	File Size	Last Modified
1	BODYFAT	DATA	8KB	09/03/2014 10:35:01
2	CONFOUND	DATA	8KB	09/03/2014 10:35:01
3	CORONARY	DATA	8KB	09/03/2014 10:35:01
4	FORMATS	CATALOG	17KB	11/16/2011 13:53:09
5	GROUP	DATA	32KB	09/03/2014 10:35:02
6	GRPOUT	DATA	144KB	01/15/2016 15:37:10
7	GRPOUT1	DATA	144KB	08/06/2015 09:54:32
8	INFANT	DATA	17KB	09/12/2007 10:57:52
9	MLSCL	DATA	8KB	09/03/2014 10:35:02
10	NAMES	DATA	8KB	09/03/2014 10:35:02
11	OXYGEN	DATA	16KB	09/03/2014 10:35:02
12	PERSONL	DATA	32KB	09/03/2014 10:35:02
13	PHARM	DATA	8KB	09/03/2014 10:35:02
14	POINTS	DATA	8KB	09/03/2014 10:35:02
15	POSTDRUG	CATALOG	61KB	11/16/2011 13:53:08
16	PRENAT	DATA	24KB	09/03/2014 10:35:02
17	RESULTS	DATA	8KB	09/03/2014 10:35:03
18	SLEEP	DATA	12KB	09/03/2014 10:35:03
19	SPDATA	VIEW	5KB	03/24/2005 13:12:22
20	SYNDROME	DATA	16KB	09/03/2014 10:35:03
21	TENSION	DATA	8KB	09/03/2014 10:35:03
22	TRAIN	DATA	8KB	09/03/2014 10:35:03
23	VISION	DATA	8KB	09/03/2014 10:35:03
24	WEIGHT	DATA	24KB	09/03/2014 10:35:03
25	WGHT	DATA	24KB	09/03/2014 10:35:03

Data Set Attributes

Here are descriptions of selected fields shown in the following output:

Member Type
is the type of library member (DATA or VIEW).

Created
indicates the date and time that the data set was created. The date and time reflect the setting of the TIMEZONE= system option. If the TIMEZONE= system option is not set, then the local time zone in which the SAS session is running is used.

Last Modified
indicates the date and time that the data set was last modified. The date and time reflect the setting of the TIMEZONE= system option. If the TIMEZONE= system option is not set, then the local time zone in which the SAS session is running is used.

Protection
indicates whether the SAS data set is Read, Write, or Alter password protected.

Data Set Type
names the special data set type (such as CORR, COV, SSPC, EST, or FACTOR), if any.

Observations
is the total number of observations currently in the file. Note that for a very large data set, if the number of observations exceeds the largest integer value that can be represented in a double precision floating point number, the count is shown as missing.

Deleted Observations
is the number of observations marked for deletion. These observations are not included in the total number of observations, shown in the **Observations** field. Note that for a very large data set, if the number of deleted observations exceeds the number that can be stored in a double-precision integer, the count is shown as missing. Also, the count for **Deleted Observations** shows a missing value if you use the COMPRESS=YES option with one or both of the REUSE=YES and POINTOBS=NO options.

Compressed
indicates whether the data set is compressed. If the data set is compressed, the output includes an additional item, **Reuse Space** (with a value of YES or NO). This item indicates whether to reuse space that is made available when observations are deleted.

Sorted
indicates whether the data set is sorted. If you sort the data set with PROC SORT, PROC SQL, or specify sort information with the SORTEDBY= data set option, a value of YES appears here, and there is an additional section to the output. See "Sort Information" on page 680 for details.

Data Representation
is the format in which data is represented on a computer architecture or in an operating environment. For example, on an IBM PC, character data is represented by its ASCII encoding and byte-swapped integers. Native data representation refers to an environment for which the data representation compares with the CPU that is accessing the file. For example, a file that is in Windows data representation is native to the Windows operating environment.

Encoding
is the encoding value. Encoding is a set of characters (letters, logograms, digits, punctuation, symbols, control characters, and so on) that have been mapped to numeric values (called code points) that can be used by computers. The code points are assigned to the characters in the character set when you apply an encoding method.

Output 17.4 *Attributes of the Group Data Set*

Data Set Name	HEALTH.GROUP	Observations	148
Member Type	DATA	Variables	11
Engine	V9	Indexes	0
Created	09/03/2014 10:35:02	Observation Length	96
Last Modified	09/03/2014 10:35:02	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine and Operating Environment-Dependent Information

The CONTENTS statement produces operating environment-specific and engine-specific information. This information differs depending on the operating environment. The following output is from the Windows operating environment.

Output 17.5 *Engine/Host Dependent Information for the Group Data Set*

Engine/Host Dependent Information	
Data Set Page Size	8192
Number of Data Set Pages	3
First Data Page	1
Max Obs per Page	84
Obs in First Data Page	63
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\procdatasets\health\group.sas7bdat
Release Created	9.0401M3
Host Created	W32_7PRO
Owner Name	BUILTIN\Administrators
File Size	32KB
File Size (bytes)	32768

Alphabetic List of Variables and Attributes

Here are descriptions of selected columns in the following output:

#
is the logical position of each variable in the observation. This number is assigned to the variable when the variable is defined.

Variable
is the name of each variable. By default, variables appear alphabetically.

Note: Variable names are sorted such that X1, X2, and X10 appear in that order and not in the true collating sequence of X1, X10, and X2. Variable names that contain an underscore and digits might appear in a nonstandard sort order. For example, P25 and P75 appear before P2_5.

Type
specifies the type of variable: character or numeric.

Len
specifies the variable's length, which is the number of bytes used to store each of a variable's values in a SAS data set.

Transcode
specifies whether a character variable is transcoded. If the attribute is NO, then transcoding is suppressed. By default, character variables are transcoded when

required. For more information about transcoding, see *SAS National Language Support (NLS): Reference Guide*.

Note: If none of the variables in the SAS data set has a format, informat, or label associated with it, or if all of the variables are set to TRANSCODE=YES, then the column for the attribute is NOT displayed.

Output 17.6 *Listing of Variables and Attributes of the Group Data Set*

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Informat
9	BIRTH	Num	8		
4	CITY	Char	15		
3	FNAME	Char	15		
10	HIRED	Num	8	DATE7.	DATE7.
11	HPHONE	Char	12		
1	IDNUM	Char	4		
7	JOBCODE	Char	4		
2	LNAME	Char	15		
8	SALARY	Num	8	COMMA8.	
6	SEX	Char	2		
5	STATE	Char	3		

Alphabetic List of Indexes and Attributes

The section shown in the following output appears only if the data set has indexes associated with it.

#
indicates the number of each index. The indexes are numbered sequentially as they are defined.

Index
displays the name of each index. For simple indexes, the name of the index is the same as a variable in the data set.

Unique Option
indicates whether the index must have unique values. If the column contains YES, the combination of values of the index variables is unique for each observation.

Nomiss Option
indicates whether the index excludes missing values for all index variables. If the column contains YES, the index does not contain observations with missing values for all index variables.

# of Unique Values
gives the number of unique values in the index.

Variables
names the variables in a composite index.

Output 17.7 *Listing of Indexes and Attributes of the Group Data Set*

Alphabetic List of Indexes and Attributes

#	Index	Unique Option	NoMiss Option	# of Unique Values	Variables
1	vital	YES	YES	148	BIRTH SALARY

Sort Information

The section shown in the following output appears only if the **Sorted** field has a value of YES.

Sortedby
indicates how the data are currently sorted. This field contains either the variables and options that you use in the BY statement in PROC SORT, the column name in PROC SQL, or the values that you specify in the SORTEDBY= option.

Validated
indicates whether the data was sorted using PROC SORT or SORTEDBY. If PROC SORT or PROC SQL sorted the data set, the value is YES. If you assigned the sort indicator with the SORTEDBY= data set option, the value is NO.

Character Set
is the character set used to sort the data. The value for this field can be ASCII, EBCDIC, or PASCII.

Collating Sequence
is the collating sequence used to sort the data set, which can be a translation table name, an encoding value, or LINGUISTIC if the data set is sorted linguistically. This field does not appear if you do not specify a collating sequence that is different from the character set.

If the data set is sorted linguistically, additional linguistic collating sequence information appears after **Collating Sequence**, such as the locale, collation style, and so on. For a list of the collation rules that can be specified for linguistic collation.

Sort Option
indicates whether PROC SORT used the NODUPKEY option when sorting the data set. This field does not appear if you did not use this option in a PROC SORT statement (not shown).

Output 17.8 *Group Data Set Sort Information*

Sort Information	
Sortedby	LNAME
Validated	NO
Character Set	ANSI

PROC DATASETS and the Output Delivery System (ODS)

Most SAS procedures send their messages to the SAS log and their procedure results to the output. PROC DATASETS is unique because it sends procedure results to both the SAS log and the procedure output file. When the interface to ODS was created, it was decided that all procedure results (from both the log and the procedure output file) should be available to ODS. In order to implement this feature and maintain compatibility with earlier releases, the interface to ODS had to be slightly different from the usual interface.

By default, the PROC DATASETS statement itself produces two output objects: Members and Directory. These objects are routed to the SAS log. The CONTENTS statement produces three output objects by default: Attributes, EngineHost, and Variables. (The use of various options adds other output objects.) These objects are routed to the procedure output file. If you open an ODS destination (such as HTML, RTF, or PRINTER), all of these objects are, by default, routed to that destination.

You can use ODS SELECT and ODS EXCLUDE statements to control which objects go to which destination, just as you can for any other procedure. However, because of the unique interface between PROC DATASETS and ODS, when you use the keyword LISTING in an ODS SELECT or ODS EXCLUDE statement, you affect both the log and the listing.

ODS Table Names

PROC DATASETS and PROC CONTENTS assign a name to each table that they create. You can use these names to reference the table when using the Output Delivery System (ODS) to select tables and create output data sets.

PROC CONTENTS generates the same ODS tables as PROC DATASETS with the CONTENTS statement.

Table 17.15 *ODS Tables Produced by the DATASETS Procedure without the CONTENTS Statement*

ODS Table	Description	Generates Table
Directory	General library information	Unless you specify the NOLIST option
Members	Library member information	Unless you specify the NOLIST option

Table 17.16 *ODS Table Names Produced by PROC CONTENTS and PROC DATASETS with the CONTENTS Statement*

ODS Table	Description	Generates Table
Attributes	Data set attributes	Unless you specify the SHORT option
Directory	General library information	If you specify DATA=<*libref*.>_ALL_ or the DIRECTORY option [1]
EngineHost	Engine and operating environment information	Unless you specify the SHORT option
IntegrityConstraints	A detailed listing of integrity constraints	If the data set has integrity constraints and you do not specify the SHORT option
IntegrityConstraintsShort	A concise listing of integrity constraints	If the data set has integrity constraints and you specify the SHORT option
Indexes	A detailed listing of indexes	If the data set is indexed and you do not specify the SHORT option
IndexesShort	A concise listing of indexes	If the data set is indexed and you specify the SHORT option
Members	Library member information	If you specify DATA=<*libref*.>_ALL_ or the DIRECTORY option [1]
Position	A detailed listing of variables by logical position in the data set	If you specify the VARNUM option and you do not specify the SHORT option
PositionShort	A concise listing of variables by logical position in the data set	If you specify the VARNUM option and the SHORT option

ODS Table	Description	Generates Table
PositionVarchar	Position including varchar type	If a varchar is in the data set, you specify VARNUM and you do not specify the SHORT option
Sortedby	Detailed sort information	If the data set is sorted and you do not specify the SHORT option
SortedbyShort	Concise Sort information	If the data set is sorted and you specify the SHORT option
Variables	A detailed listing of variables in alphabetical order	Unless you specify the SHORT option
VariablesShort	A concise listing of variables in alphabetical order	If you specify the SHORT option
VariablesVarchar	Variables including varchar type	If a varchar is in the data set, unless the SHORT option is specified

1 For PROC DATASETS, if both the NOLIST option and either the DIRECTORY option or DATA=<*libref*.>_ALL_ are specified, then the NOLIST option is ignored.

Output Data Sets

The CONTENTS Statement

The CONTENTS statement is the only statement in the DATASETS procedure that generates output data sets.

The OUT= Data Set

The OUT= option in the CONTENTS statement creates an output data set. Each variable in each DATA= data set has one observation in the OUT= data set. Here are the variables in the output data set:

CHARSET
: the character set used to sort the data set. The value is ASCII, EBCDIC, or PASCII. A blank appears if the data set does not have a sort indicator stored with it.

COLLATE
the collating sequence used to sort the data set. A blank appears if the sort indicator for the input data set does not include a collating sequence.

COMPRESS
indicates whether the data set is compressed.

CRDATE
date the data set was created.

DELOBS
number of observations marked for deletion in the data set. (Observations can be marked for deletion but not actually deleted when you use the FSEDIT procedure of SAS/FSP software.)

ENCRYPT
indicates whether the data set is encrypted.

ENGINE
name of the method used to read from and write to the data set.

FLAGS
indicates whether the variables in an SQL view are protected (**P**) or contribute (**C**) to a derived variable.

P
indicates the variable is protected. The value of the variable can be displayed but not updated.

C
indicates whether the variable contributes to a derived variable.

The value of FLAG is blank if **P** or **C** does not apply to an SQL view or if it is a data set view.

FORMAT
variable format. The value of FORMAT is a blank if you do not associate a format with the variable.

FORMATD
number of decimals that you specify when you associate the format with the variable. The value of FORMATD is 0 if you do not specify decimals in the format.

FORMATL
format length. If you specify a length for the format when you associate the format with a variable, the length that you specify is the value of FORMATL. If you do not specify a length for the format when you associate the format with a variable, the value of FORMATL is the default length of the format if you use the FMTLEN option and 0 if you do not use the FMTLEN option.

GENMAX
maximum number of versions for the generation group.

GENNEXT
the next generation number for a generation group.

GENNUM
the version number.

IDXCOUNT
number of indexes for the data set.

IDXUSAGE
use of the variable in indexes. Possible values are

NONE
the variable is not part of an index.

SIMPLE
the variable has a simple index. No other variables are included in the index.

COMPOSITE
the variable is part of a composite index.

BOTH
the variable has a simple index and is part of a composite index.

INFORMAT
variable informat. The value is a blank if you do not associate an informat with the variable.

INFORMD
number of decimals that you specify when you associate the informat with the variable. The value is 0 if you do not specify decimals when you associate the informat with the variable.

INFORML
informat length. If you specify a length for the informat when you associate the informat with a variable, the length that you specify is the value of INFORML. If you do not specify a length for the informat when you associate the informat with a variable, the value of INFORML is the default length of the informat if you use the FMTLEN option and 0 if you do not use the FMTLEN option.

JUST
justification (0=left, 1=right).

LABEL
variable label (blank if none given).

LENGTH
variable length.

LIBNAME
libref used for the data library.

MEMLABEL
label for this SAS data set (blank if no label).

MEMNAME
SAS data set that contains the variable.

MEMTYPE
library member type (DATA or VIEW).

MODATE
date the data set was last modified.

NAME
variable name.

NOBS
number of observations in the data set.

NODUPKEY
indicates whether the NODUPKEY option was used in a PROC SORT statement to sort the input data set.

NODUPREC
indicates whether the NODUPREC option was used in a PROC SORT statement to sort the input data set.

NPOS
physical position of the first character of the variable in the data set.

POINTOBS
indicates whether the data set can be addressed by observation.

PROTECT
the first letter of the level of protection. The value for PROTECT is one or more of the following:

A
indicates the data set is alter-protected.

R
indicates the data set is read-protected.

W
indicates the data set is write-protected.

REUSE
indicates whether the space made available when observations are deleted from a compressed data set should be reused. If the data set is not compressed, the REUSE variable has a value of NO.

SORTED
the value depends on the sorting characteristics of the input data set. Here are the possible values:

. (period)
for not sorted.

0
for sorted but not validated.

1
for sorted and validated.

SORTEDBY
the value depends on that variable's role in the sort. Here are the possible values:

. (period)
if the variable was not used to sort the input data set.

n
where *n* is an integer that denotes the position of that variable in the sort. A negative value of *n* indicates that the data set is sorted by the descending order of that variable.

TRANSCOD
indicates whether the variable is transcoded.

TYPE
type of the variable (1=numeric, 2=character).

TYPEMEM
special data set type (blank if no TYPE= value is specified).

VARNUM
variable number in the data set. Variables are numbered in the order in which they appear.

The output data set is sorted by the variables LIBNAME and MEMNAME.

Note: The variable names are sorted so that the values X1, X2, and X10 are listed in that order, not in the true collating sequence of X1, X10, X2. Therefore, if you want to use a BY statement on MEMNAME in subsequent steps, run a PROC SORT step on the output data set first. You can also use the NOTSORTED option in the BY statement.

Here is an example of an output data set created from the Group data set, which is shown in "Example 5: Describing a SAS Data Set" on page 707 and in "Procedure Output" on page 674.

Due to the size of the Health.Grpout, the following output is in five sections.

Output 17.9 *An Example of an Output Data Set — Section 1*

Obs	LIBNAME	MEMNAME	MEMLABEL	TYPEMEM	NAME	TYPE	LENGTH	VARNUM
1	HEALTH	GROUP			BIRTH	1	8	9
2	HEALTH	GROUP			CITY	2	15	4
3	HEALTH	GROUP			FNAME	2	15	3
4	HEALTH	GROUP			HIRED	1	8	10
5	HEALTH	GROUP			HPHONE	2	12	11
6	HEALTH	GROUP			IDNUM	2	4	1
7	HEALTH	GROUP			JOBCODE	2	4	7
8	HEALTH	GROUP			LNAME	2	15	2
9	HEALTH	GROUP			SALARY	1	8	8
10	HEALTH	GROUP			SEX	2	2	6
11	HEALTH	GROUP			STATE	2	3	5

Output 17.10 *An Example of an Output Data Set — Section 2*

LABEL	FORMAT	FORMATL	FORMATD	INFORMAT	INFORML	INFORMD
		0	0		0	0
		0	0		0	0
		0	0		0	0
	DATE	7	0	DATE	7	0
		0	0		0	0
		0	0		0	0
		0	0		0	0
		0	0		0	0
	COMMA	8	0		0	0
		0	0		0	0
		0	0		0	0

Output 17.11 *An Example of an Output Data Set — Section 3*

JUST	NPOS	NOBS	ENGINE	CRDATE	MODATE	DELOBS
1	8	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0
0	58	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0
0	43	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0
1	16	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0
0	82	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0
0	24	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0
0	78	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0
0	28	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0
1	0	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0
0	76	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0
0	73	148	V9	03SEP14:10:35:02	03SEP14:10:35:02	0

Output 17.12 *An Example of an Output Data Set — Section 4*

IDXUSAGE	MEMTYPE	IDXCOUNT	PROTECT	FLAGS	COMPRESS	REUSE	SORTED	SORTEDBY
NONE	DATA	0	---	---	NO	NO	.	.
NONE	DATA	0	---	---	NO	NO	.	.
NONE	DATA	0	---	---	NO	NO	.	.
NONE	DATA	0	---	---	NO	NO	.	.
NONE	DATA	0	---	---	NO	NO	.	.
NONE	DATA	0	---	---	NO	NO	.	.
NONE	DATA	0	---	---	NO	NO	.	.
NONE	DATA	0	---	---	NO	NO	.	.
NONE	DATA	0	---	---	NO	NO	.	.
NONE	DATA	0	---	---	NO	NO	.	.
NONE	DATA	0	---	---	NO	NO	.	.

Output 17.13 *An Example of an Output Data Set — Section 5*

CHARSET	COLLATE	NODUPKEY	NODUPREC	ENCRYPT	POINTOBS	GENMAX	GENNUM	GENNEXT	TRANSCOD
		NO	NO	NO	YES	0	.	.	YES
		NO	NO	NO	YES	0	.	.	YES
		NO	NO	NO	YES	0	.	.	YES
		NO	NO	NO	YES	0	.	.	YES
		NO	NO	NO	YES	0	.	.	YES
		NO	NO	NO	YES	0	.	.	YES
		NO	NO	NO	YES	0	.	.	YES
		NO	NO	NO	YES	0	.	.	YES
		NO	NO	NO	YES	0	.	.	YES
		NO	NO	NO	YES	0	.	.	YES
		NO	NO	NO	YES	0	.	.	YES

The OUT2= Data Set

The OUT2= option in the CONTENTS statement creates an output data set that contains information about indexes and integrity constraints. Here are the variables in the output data set:

IC_OWN
: contains YES if the index is owned by the integrity constraint.

INACTIVE
: contains YES if the integrity constraint is inactive.

LIBNAME
libref used for the data library.

MEMNAME
SAS data set that contains the variable.

MG
the value of MESSAGE=, if it is used, in the IC CREATE statement.

MSGTYPE
the value is blank unless an integrity constraint is violated and you specified a message.

NAME
the name of the index or integrity constraint.

NOMISS
contains YES if the NOMISS option is defined for the index.

NUMVALS
the number of distinct values in the index (displayed for centiles).

NUMVARS
the number of variables involved in the index or integrity constraint.

ONDELETE
for a foreign key integrity constraint, contains RESTRICT or SET NULL if applicable (the ON DELETE option in the IC CREATE statement).

ONUPDATE
for a foreign key integrity constraint, contains RESTRICT or SET NULL if applicable (the ON UPDATE option in the IC CREATE statement).

RECREATE
the SAS statement necessary to re-create the index or integrity constraint.

REFERENCE
for a foreign key integrity constraint, contains the name of the referenced data set.

TYPE
the type. For an index, the value is “Index” while for an integrity constraint, the value is the type of integrity constraint (Not Null, Check, Primary Key, and so on).

UNIQUE
contains YES if the UNIQUE option is defined for the index.

UPERC
the percentage of the index that has been updated since the last refresh (displayed for centiles).

UPERCMX
the percentage of the index update that triggers a refresh (displayed for centiles).

WHERE
for a check integrity constraint, contains the WHERE statement.

Examples: DATASETS Procedure

Example 1: Removing All Labels and Formats in a Data Set

Features:

PROC DATASETS statement options
- LIB=
- MEMTYPE=

CONTENTS statement

MODIFY statement

CONTENTS procedure

FORMAT procedure

OPTIONS statement

TITLE statement

Details

This example demonstrates the following tasks:

- sets system options
- creates a user defined FORMAT
- creates a data set
- deletes labels and format from the data set
- uses PROC CONTENTS to show data set with and without labels and format

Program

```
options ls=79 nodate center;
title ;

libname mylib 'c:\mylib';

proc format;
   value clsfmt 1='Freshman' 2='Sophomore' 3='Junior' 4='Senior';
```

```
run;

data mylib.class;
   format z clsfmt.;
   label x='ID NUMBER'
      y='AGE'
      z='CLASS STATUS';
   input x y z;
datalines;
1 20 4
2 18 1
;

proc contents data=mylib.class;
run;

proc datasets lib=mylib memtype=data;
   modify class;
     attrib _all_ label=' ';
     attrib _all_ format=;
contents data=mylib.class;
run;
quit;
```

Program Description

Set the system options and the LIBNAME statement. In this example, the LIBNAME is MyLib. The CENTER option specifies to align SAS procedure output in the center. The NODATE option specifies that the date and the time are not printed. The LS= option specifies the line size for the SAS log and for the output. The TITLE statement followed by a blank space removes any existing title in your SAS session.

```
options ls=79 nodate center;
title ;

libname mylib 'c:\mylib';
```

Create a user-defined format with a value of CLSFMT.

```
proc format;
   value clsfmt 1='Freshman' 2='Sophomore' 3='Junior' 4='Senior';
run;
```

Create a data set named Class. Use the CLSFMT format on variable Z. Create labels for variables, X, Y, and Z.

```
data mylib.class;
   format z clsfmt.;
   label x='ID NUMBER'
      y='AGE'
      z='CLASS STATUS';
   input x y z;
datalines;
1 20 4
2 18 1
;
```

Use PROC CONTENTS to view the contents of the data set before removing the labels and format.

```
proc contents data=mylib.class;
run;
```

Within PROC DATASETS, remove all the labels and formats using the MODIFY statement and the ATTRIB option. Use the CONTENTS statement within PROC DATASETS to view the contents of the data set without the labels and format.

```
proc datasets lib=mylib memtype=data;
   modify class;
     attrib _all_ label=' ';
     attrib _all_ format=;
contents data=mylib.class;
run;
quit;
```

Output Examples

Output 17.14 *CONTENTS Procedure for Class Data Set with Labels and Format*

The CONTENTS Procedure

Data Set Name	MYLIB.CLASS	**Observations**	2
Member Type	DATA	**Variables**	3
Engine	V9	**Indexes**	0
Created	08/16/2016 14:48:34	**Observation Length**	24
Last Modified	08/16/2016 14:48:34	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	WINDOWS_64		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	2715
Obs in First Data Page	2
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\mylib\class.sas7bdat
Release Created	9.0401M4
Host Created	X64_7PRO
Owner Name	BUILTIN\Administrators
File Size	128KB
File Size (bytes)	131072

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Label
2	x	Num	8		ID NUMBER
3	y	Num	8		AGE
1	z	Num	8	CLSFMT.	CLASS STATUS

Output 17.15 *CONTENTS Statement for Class Data Set without Labels and Format*

The DATASETS Procedure

Data Set Name	MYLIB.CLASS	Observations	2
Member Type	DATA	Variables	3
Engine	V9	Indexes	0
Created	08/16/2016 14:48:34	Observation Length	24
Last Modified	08/16/2016 14:48:34	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	WINDOWS_64		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	2715
Obs in First Data Page	2
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\mylib\class.sas7bdat
Release Created	9.0401M4
Host Created	X64_7PRO
Owner Name	BUILTIN\Administrators
File Size	128KB
File Size (bytes)	131072

Alphabetic List of Variables and Attributes			
#	Variable	Type	Len
2	x	Num	8
3	y	Num	8
1	z	Num	8

Example 2: Manipulating SAS Files

Features:

PROC DATASETS statement options
- DETAILS
- LIBRARY=
- COPY statement
- CHANGE statement
- DELETE statement
- EXCHANGE statement

COPY procedure

EXCLUDE statement

OPTIONS statement

Details

This example demonstrates the following tasks:

- changes the names of SAS files
- copies SAS files between SAS libraries
- deletes SAS files
- selects SAS files to copy
- exchanges the names of SAS files
- excludes SAS files from a copy operation

Program

```
options pagesize=60 linesize=80 nodate pageno=1 source;

LIBNAME dest1 'SAS-library-1';
LIBNAME dest2 'SAS-library-2';
LIBNAME health 'SAS-library-3';

proc datasets library=health details;
```

```
   delete tension a2(mt=catalog);
   change a1=postdrug;
   exchange weight=bodyfat;

   copy out=dest1 move memtype=view;

      select spdata;

      select etest1-etest5 / memtype=catalog;

   copy out=dest2;
      exclude d: mlscl oxygen test2 vision weight;
quit;
```

Program Description

Set the system options. The SOURCE system option writes the programming statements to the SAS log. PAGESIZE= option specifies the number of lines that compose a page of the SAS log and SAS output. LINESIZE= option specifies the line size for the SAS log and for SAS procedure output. NODATE option specifies that the date and the time are not printed. PAGENO= option specifies a beginning page number for the next page of output.

```
options pagesize=60 linesize=80 nodate pageno=1 source;

LIBNAME dest1 'SAS-library-1';
LIBNAME dest2 'SAS-library-2';
LIBNAME health 'SAS-library-3';
```

Specify the procedure input library, and add more details to the directory. DETAILS prints these additional columns in the directory: **Obs**, **Entries** or **Indexes**, **Vars**, and **Label**. All member types are available for processing because the MEMTYPE= option does not appear in the PROC DATASETS statement.

```
proc datasets library=health details;
```

Delete two files in the library, and modify the names of a SAS data set and a catalog. The DELETE statement deletes the Tension data set and the A2 catalog. MT=CATALOG applies only to A2 and is necessary because the default member type for the DELETE statement is DATA. The CHANGE statement changes the name of the A1 catalog to Postdrug. The EXCHANGE statement exchanges the names of the Weight and Bodyfat data sets. MEMTYPE= is not necessary in the CHANGE or EXCHANGE statement because the default is MEMTYPE=ALL for each statement.

```
   delete tension a2(mt=catalog);
   change a1=postdrug;
   exchange weight=bodyfat;
```

Restrict processing to one member type and delete and move data views. MEMTYPE=VIEW restricts processing to SAS views. MOVE specifies that all SAS views named in the SELECT statements in this step be deleted from the Health data library and moved to the Dest1 data library.

```
   copy out=dest1 move memtype=view;
```

Move the SAS view Spdata from the Health data library to the Dest1 data library.

```
      select spdata;
```

Move the catalogs to another data library. The SELECT statement specifies that the catalogs Etest1 through Etest5 be moved from the Health data library to the Dest1 data library. MEMTYPE=CATALOG overrides the MEMTYPE=VIEW option in the COPY statement.

```
      select etest1-etest5 / memtype=catalog;
```

Exclude all files with specified criteria from processing. The EXCLUDE statement excludes from the COPY operation all SAS files that begin with the letter D and the other SAS files listed. All remaining SAS files in the Health data library are copied to the Dest2 data library.

```
   copy out=dest2;
      exclude d: mlscl oxygen test2 vision weight;
quit;
```

Log Examples

Example Code 17.2 *SAS Log for Dest1*

```
117    options pagesize=60 linesize=80 nodate pageno=1 source;
118  LIBNAME dest1 'SAS-library-1';
NOTE: Libref DEST1 was successfully assigned as follows:
      Engine:        V9
      Physical Name: SAS-library-1\dest1
119  LIBNAME dest2 'SAS-library-2';
NOTE: Libref DEST2 was successfully assigned as follows:
      Engine:        V9
      Physical Name: SAS-library-2\dest2
120  LIBNAME health 'SAS-library-3';
NOTE: Libref HEALTH was successfully assigned as follows:
      Engine:        V9
      Physical Name: SAS-library-3\health


121  proc datasets library=health details;
                                Directory

Libref         HEALTH
Engine         V9
Physical Name  \myfiles\health
Filename       \myfiles\health


                  Member   Obs, Entries
        #  Name   Type      or Indexes   Vars  Label

        1  A1     CATALOG       23
        2  ALL    DATA          23        17
        3  BODYFAT DATA          1         2
        4  CONFOUND DATA         8         4
        5  CORONARY DATA        39         4
        6  DRUG1  DATA           6         2   JAN2005 DATA
        7  DRUG2  DATA          13         2   MAY2005 DATA
        8  DRUG3  DATA          11         2   JUL2005 DATA
        9  DRUG4  DATA           7         2   JAN2002 DATA
       10  DRUG5  DATA           1         2   JUL2002 DATA
       11  ETEST1 CATALOG        1
       12  ETEST2 CATALOG        1
       13  ETEST3 CATALOG        1
       14  ETEST4 CATALOG        1
       15  ETEST5 CATALOG        1
       16  ETESTS CATALOG        1
       17  FORMATS CATALOG       6
       18  GROUP  DATA         148        11
       19  GRPOUT DATA          11        40
       20  INFANT DATA         149         6
       21  MLSCL  DATA          32         4   Multiple Sclerosis Data
       22  NAMES  DATA           7         4
       23  OXYGEN DATA          31         7
       24  PERSONL DATA        148        11
       25  PHARM  DATA           6         3   Sugar Study
       26  POINTS DATA           6         6
       27  RESULTS DATA         10         5
       28  SLEEP  DATA         108         6
       29  SPDATA VIEW           .         2
       30  TEST2  DATA          15         5
       31  TRAIN  DATA           7         2
       32  VISION DATA          16         3
       33  WEIGHT DATA          83        13   California Results
       34  WGHT   DATA          83        13
```

```
                        File
                    #    Size  Last Modified

                    1   62464  07Mar05:14:36:20
                    2   13312  12Sep07:13:57:48
                    3    5120  12Sep07:13:57:48
                    4    5120  12Sep07:13:57:48
                    5    5120  12Sep07:13:57:48
                    6    5120  12Sep07:13:57:49
                    7    5120  12Sep07:13:57:49
                    8    5120  12Sep07:13:57:49
                    9    5120  12Sep07:13:57:49
                   10    5120  12Sep07:13:57:49
                   11   17408  04Jan02:14:20:16
                   12   17408  04Jan02:14:20:16
                   13   17408  04Jan02:14:20:16
                   14   17408  04Jan02:14:20:16
                   15   17408  04Jan02:14:20:16
                   16   17408  24Mar05:16:12:20
                   17   17408  24Mar05:16:12:20
                   18   25600  12Sep07:13:57:50
                   19   17408  24Mar05:15:33:31
                   20   17408  12Sep07:13:57:51
                   21    5120  12Sep07:13:57:50
                   22    5120  12Sep07:13:57:50
                   23    9216  12Sep07:13:57:50
                   24   25600  12Sep07:13:57:51
                   25    5120  12Sep07:13:57:51
                   26    5120  12Sep07:13:57:51
                   27    5120  12Sep07:13:57:52
                   28    9216  12Sep07:13:57:52
                   29    5120  24Mar05:16:12:21
                   30    5120  12Sep07:13:57:52
                   31    5120  12Sep07:13:57:53
                   32    5120  12Sep07:13:57:53
                   33   13312  12Sep07:13:57:53
                   34   13312  12Sep07:13:57:53122  delete tension
a2(mt=catalog);
123  change a1=postdrug;
124  exchange weight=bodyfat;
NOTE: Changing the name HEALTH.A1 to HEALTH.POSTDRUG (memtype=CATALOG).
NOTE: Exchanging the names HEALTH.WEIGHT and HEALTH.BODYFAT (memtype=DATA).
125  copy out=dest1 move memtype=view;
126  select spdata;
127
128  select etest1-etest5 / memtype=catalog;
NOTE: Moving HEALTH.SPDATA to DEST1.SPDATA (memtype=VIEW).
NOTE: Moving HEALTH.ETEST1 to DEST1.ETEST1 (memtype=CATALOG).
NOTE: Moving HEALTH.ETEST2 to DEST1.ETEST2 (memtype=CATALOG).
NOTE: Moving HEALTH.ETEST3 to DEST1.ETEST3 (memtype=CATALOG).
NOTE: Moving HEALTH.ETEST4 to DEST1.ETEST4 (memtype=CATALOG).
NOTE: Moving HEALTH.ETEST5 to DEST1.ETEST5 (memtype=CATALOG).
```

```
129  copy out=dest2;
130  exclude d: mlscl oxygen test2 vision weight;
131  quit;

NOTE: Copying HEALTH.ALL to DEST2.ALL (memtype=DATA).
NOTE: There were 23 observations read from the data set HEALTH.ALL.
NOTE: The data set DEST2.ALL has 23 observations and 17 variables.
NOTE: Copying HEALTH.BODYFAT to DEST2.BODYFAT (memtype=DATA).
NOTE: There were 83 observations read from the data set HEALTH.BODYFAT.
NOTE: The data set DEST2.BODYFAT has 83 observations and 13 variables.
NOTE: Copying HEALTH.CONFOUND to DEST2.CONFOUND (memtype=DATA).
NOTE: There were 8 observations read from the data set HEALTH.CONFOUND.
NOTE: The data set DEST2.CONFOUND has 8 observations and 4 variables.
NOTE: Copying HEALTH.CORONARY to DEST2.CORONARY (memtype=DATA).
NOTE: There were 39 observations read from the data set HEALTH.CORONARY.
NOTE: The data set DEST2.CORONARY has 39 observations and 4 variables.
NOTE: Copying HEALTH.ETESTS to DEST2.ETESTS (memtype=CATALOG).
NOTE: Copying HEALTH.FORMATS to DEST2.FORMATS (memtype=CATALOG).
NOTE: Copying HEALTH.GROUP to DEST2.GROUP (memtype=DATA).
NOTE: There were 148 observations read from the data set HEALTH.GROUP.
NOTE: The data set DEST2.GROUP has 148 observations and 11 variables.
NOTE: Copying HEALTH.GRPOUT to DEST2.GRPOUT (memtype=DATA).
NOTE: There were 11 observations read from the data set HEALTH.GRPOUT.
NOTE: The data set DEST2.GRPOUT has 11 observations and 40 variables.
NOTE: Copying HEALTH.INFANT to DEST2.INFANT (memtype=DATA).
NOTE: There were 149 observations read from the data set HEALTH.INFANT.
NOTE: The data set DEST2.INFANT has 149 observations and 6 variables.
NOTE: Copying HEALTH.NAMES to DEST2.NAMES (memtype=DATA).
NOTE: There were 7 observations read from the data set HEALTH.NAMES.
NOTE: The data set DEST2.NAMES has 7 observations and 4 variables.
NOTE: Copying HEALTH.PERSONL to DEST2.PERSONL (memtype=DATA).
NOTE: There were 148 observations read from the data set HEALTH.PERSONL.
NOTE: The data set DEST2.PERSONL has 148 observations and 11 variables.
NOTE: Copying HEALTH.PHARM to DEST2.PHARM (memtype=DATA).
NOTE: There were 6 observations read from the data set HEALTH.PHARM.
NOTE: The data set DEST2.PHARM has 6 observations and 3 variables.
NOTE: Copying HEALTH.POINTS to DEST2.POINTS (memtype=DATA).
NOTE: There were 6 observations read from the data set HEALTH.POINTS.
NOTE: The data set DEST2.POINTS has 6 observations and 6 variables.
NOTE: Copying HEALTH.POSTDRUG to DEST2.POSTDRUG (memtype=CATALOG).
NOTE: Copying HEALTH.RESULTS to DEST2.RESULTS (memtype=DATA).
NOTE: There were 10 observations read from the data set HEALTH.RESULTS.
NOTE: The data set DEST2.RESULTS has 10 observations and 5 variables.
NOTE: Copying HEALTH.SLEEP to DEST2.SLEEP (memtype=DATA).
NOTE: There were 108 observations read from the data set HEALTH.SLEEP.
NOTE: The data set DEST2.SLEEP has 108 observations and 6 variables.
NOTE: Copying HEALTH.TRAIN to DEST2.TRAIN (memtype=DATA).
NOTE: There were 7 observations read from the data set HEALTH.TRAIN.
NOTE: The data set DEST2.TRAIN has 7 observations and 2 variables.
NOTE: Copying HEALTH.WGHT to DEST2.WGHT (memtype=DATA).
NOTE: There were 83 observations read from the data set HEALTH.WGHT.
NOTE: The data set DEST2.WGHT has 83 observations and 13 variables.
NOTE: PROCEDURE DATASETS used (Total process time):
      real time           44.04 seconds
      cpu time            0.60 seconds
```

Example 3: Saving SAS Files from Deletion

Features: PROC DATASETS statement options
LIB=

SAVE statement
OPTIONS statement

Details

This example demonstrates how to use the SAVE statement to save some SAS files from deletion and to delete other SAS files.

Program

```
options pagesize=40 linesize=80 nodate pageno=1 source;
LIBNAME elder 'SAS-library';
proc datasets lib=elder;
      save chronic aging clinics / memtype=data;
   run;
```

Program Description

Set the system options and the LIBNAME statement. The SOURCE system option writes the programming statements to the SAS log. LINESIZE= option specifies the line size for the SAS log and for SAS procedure output. NODATE option specifies that the date and the time are not printed.

```
options pagesize=40 linesize=80 nodate pageno=1 source;
LIBNAME elder 'SAS-library';
```

Specify the procedure input library to process.

```
proc datasets lib=elder;
```

Save the data sets Chronic, Aging, and Clinics, and delete all other SAS files (of all types) in the Elder library. MEMTYPE=DATA is necessary because the Elder library has a catalog named Clinics and a data set named Clinics.

```
      save chronic aging clinics / memtype=data;
   run;
```

Log Examples

Example Code 17.3 *SAS Log for Elder Library*

```
6    options pagesize=40 linesize=80 nodate pageno=1 source;
7    LIBNAME elder 'c:\procdatasets\elder';
NOTE: Libref ELDER was successfully assigned as follows:
      Engine:        V9
      Physical Name: c:\procdatasets\elder
8    proc datasets lib=elder;
9       save chronic aging clinics / memtype=data;
10   run;

NOTE: Saving ELDER.CHRONIC (memtype=DATA).
NOTE: Saving ELDER.AGING (memtype=DATA).
NOTE: Saving ELDER.CLINICS (memtype=DATA).
11   quit;

NOTE: PROCEDURE DATASETS used (Total process time):
      real time           0.06 seconds
      cpu time            0.01 seconds
```

Output 17.16 *Elder Library before and After Using the SAVE Statement*

Directory	
Libref	ELDER
Engine	V9
Physical Name	c:\procdatasets\elder
Filename	c:\procdatasets\elder
Owner Name	BUILTIN\Administrators
File Size	4KB
File Size (bytes)	4096

#	Name	Member Type	File Size	Last Modified
1	AGING	DATA	8KB	04/17/2014 12:59:39
2	CHRONIC	DATA	8KB	04/17/2014 12:59:39
3	CLINICS	DATA	8KB	04/17/2014 12:59:39

Directory	
Libref	ELDER
Engine	V9
Physical Name	c:\procdatasets\elder
Filename	c:\procdatasets\elder
Owner Name	BUILTIN\Administrators
File Size	4KB
File Size (bytes)	4096

#	Name	Member Type	File Size	Last Modified
1	AGING	DATA	8KB	04/17/2014 12:59:39
2	CHRONIC	DATA	8KB	04/17/2014 12:59:39
3	CLINICS	DATA	8KB	04/17/2014 12:59:39

Example 4: Modifying SAS Data Sets

Features:

PROC DATASETS statement options
- LIB=
- NOLIST
- MODIFY statement

OPTIONS statement

Details

This example modifies two SAS data sets using the MODIFY statement and statements subordinate to it. "Example 5: Describing a SAS Data Set" on page 707 shows the modifications to the Group data set.

This example demonstrates the following tasks:

- modifying SAS files
- labeling a SAS data set
- adding a Read password to a SAS data set
- indicating how a SAS data set is currently sorted
- creating an index for a SAS data set
- assigning informats and formats to variables in a SAS data set
- renaming variables in a SAS data set

- labeling variables in a SAS data set

Program

```
options pagesize=40 linesize=80 nodate pageno=1 source;

LIBNAME health 'SAS-library';

proc datasets library=health nolist;

   modify group (label='Test Subjects' read=green sortedby=lname);

      index create vital=(birth salary) / nomiss unique;

      informat birth date7.;
      format birth date7.;

      label salary='current salary excluding bonus';

   modify oxygen;
      rename oxygen=intake;
      label intake='Intake Measurement';
quit;
```

Program Description

Set the system options and LIBNAME statement. The SOURCE system option writes the programming statements to the SAS log. PAGESIZE= option specifies the number of lines that compose a page of the SAS log and SAS output. LINESIZE= option specifies the line size for the SAS log and for SAS procedure output. NODATE option specifies that the date and the time are not printed. PAGENO= option specifies a beginning page number for the next page of output.

```
options pagesize=40 linesize=80 nodate pageno=1 source;

LIBNAME health 'SAS-library';
```

Specify Health as the procedure input library to process. NOLIST suppresses the directory listing for the Health data library.

```
proc datasets library=health nolist;
```

Add a label to a data set, assign a Read password, and specify how to sort the data. LABEL= adds a data set label to the data set Group. READ= assigns `green` as the Read password. The password appears as Xs in the SAS log. SAS issues a warning message if you specify a level of password protection on a SAS file that does not include alter protection. SORTEDBY= specifies how the data is sorted.

```
   modify group (label='Test Subjects' read=green sortedby=lname);
```

Create the composite index VITAL on the variables BIRTH and SALARY for the Group data set. NOMISS excludes all observations that have missing values for BIRTH and SALARY from the index. UNIQUE specifies that the index is created only if each observation has a unique combination of values for BIRTH and SALARY.

```
        index create vital=(birth salary) / nomiss unique;
```

Assign an informat and format, respectively, to the BIRTH variable.

```
        informat birth date7.;
        format birth date7.;
```

Assign a label to the variable SALARY.

```
        label salary='current salary excluding bonus';
```

Rename a variable, and assign a label. Modify the data set Oxygen by renaming the variable OXYGEN to INTAKE and assigning a label to the variable INTAKE.

```
    modify oxygen;
       rename oxygen=intake;
       label intake='Intake Measurement';
quit;
```

Log Examples

Example Code 17.4 *SAS Log for Health Library*

```
169  options pagesize=40 linesize=80 nodate pageno=1 source;
170  LIBNAME health 'SAS-library';
NOTE: Libref HEALTH was successfully assigned as follows:
      Engine:        V9
      Physical Name: SAS-library\health

NOTE: PROCEDURE DATASETS used (Total process time):
      real time           8:06.11
      cpu time            0.54 seconds


171  proc datasets library=health nolist;
172   modify group (label='Test Subjects' read=XXXXX sortedby=lname);
WARNING: The file HEALTH.GROUP.DATA is not ALTER protected.  It could be
         deleted or replaced without knowing the password.
173   index create vital=(birth salary) / nomiss unique;
NOTE: Composite index vital has been defined.
NOTE: MODIFY was successful for HEALTH.GROUP.DATA.
174  informat birth date7.;
175  format birth date7.;
176  label salary='current salary excluding bonus';
177  modify oxygen;
178  rename oxygen=intake;
NOTE: Renaming variable oxygen to intake.
179  label intake='Intake Measurement';
180  quit;

NOTE: MODIFY was successful for HEALTH.OXYGEN.DATA.
NOTE: PROCEDURE DATASETS used (Total process time):
      real time           15.09 seconds
      cpu time            0.06 seconds
```

Example 5: Describing a SAS Data Set

Features:

PROC DATASETS statement options
- LIB=
- NOLIST
- CONTENTS statement

OPTIONS statement

Details

This example demonstrates the output from the CONTENTS statement for the Group data set. The output shows the modifications made to the Group data set in "Example 4: Modifying SAS Data Sets" on page 704.

Program

```
options pagesize=40 linesize=80 nodate pageno=1;

LIBNAME health 'SAS-library';

proc datasets library=health nolist;

   contents data=group (read=green) out=grpout;
   title  'The Contents of the GROUP Data Set';
run;
quit;
```

Program Description

Set the system options and LIBNAME statement. PAGESIZE= option specifies the number of lines that compose a page of the SAS log and SAS output. LINESIZE= option specifies the line size for the SAS log and for SAS procedure output. NODATE option specifies that the date and the time are not printed. PAGENO= option specifies a beginning page number for the next page of output.

```
options pagesize=40 linesize=80 nodate pageno=1;

LIBNAME health 'SAS-library';
```

Specify Health as the procedure input library, and suppress the directory listing with the NOLIST option.

```
proc datasets library=health nolist;
```

Create the output data set Grpout from the data set Group. Specify Group as the data set to describe, give Read access to the Group data set, and create the output data set Grpout, which appears in the OUT= data set.

```
   contents data=group (read=green) out=grpout;
   title  'The Contents of the GROUP Data Set';
run;
quit;
```

Output Examples

Output 17.17 *Contents of Group Data Set*

The Contents of the GROUP Data Set

The DATASETS Procedure

Data Set Name	HEALTH.GROUP	**Observations**	148
Member Type	DATA	**Variables**	11
Engine	V9	**Indexes**	0
Created	09/03/2014 10:35:02	**Observation Length**	96
Last Modified	09/03/2014 10:35:02	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Output 17.18 *Engine Host Dependent Information*

Engine/Host Dependent Information	
Data Set Page Size	8192
Number of Data Set Pages	3
First Data Page	1
Max Obs per Page	84
Obs in First Data Page	63
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	c:\procdatasets\health\group.sas7bdat
Release Created	9.0401M3
Host Created	W32_7PRO
Owner Name	BUILTIN\Administrators
File Size	32KB
File Size (bytes)	32768

Output 17.19 *Alphabetic List of Variables and Attributes*

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Informat
9	BIRTH	Num	8		
4	CITY	Char	15		
3	FNAME	Char	15		
10	HIRED	Num	8	DATE7.	DATE7.
11	HPHONE	Char	12		
1	IDNUM	Char	4		
7	JOBCODE	Char	4		
2	LNAME	Char	15		
8	SALARY	Num	8	COMMA8.	
6	SEX	Char	2		
5	STATE	Char	3		

Output 17.20 *Alphabetic List of Extended Attributes for the Data Set and Variables*

Alphabetic List of Data Set Extended Attributes		
Extended Attribute	**Numeric Value**	**Character Value**
level	1	
region	.	NorthEast

Alphabetic List of Extended Attributes on Variables			
Extended Attribute	**Attribute Variable**	**Numeric Value**	**Character Value**
classification	jobcode	.	local
length	idnum	4	

Example 6: Concatenating Two SAS Data Sets

Features: PROC DATASETS statement options
- LIBRARY=
- NOLIST
- APPEND statement

PRINT procedure

OPTIONS statement

Data set: EXP Library

Details

This example demonstrates the following tasks:

- suppresses the printing of a library
- appends two data sets
- prints the data sets before appending and prints the new data set after appending

To create the Exp.Results and Exp.Sur data sets and print them out before using this example to concatenate them, see "EXP Library" on page 2789.

Program

```
options pagesize=40 linesize=64 nodate pageno=1;
```

```
LIBNAME exp 'SAS-library';

proc datasets library=exp nolist;

   append base=exp.results data=exp.sur force;
run;

proc print data=exp.results noobs;
   title 'The RESULTS Data Set';
run;
```

Program Description

This example appends one data set to the end of another data set.

This example appends one data set to the end of another data set.

The data set Exp.Sur contains the variable Wt6Mos, but the Exp.Results data set does not.

Set the system options. The NODATE option suppresses the display of the date and time in the output. The PAGENO= option specifies the starting page number. The LINESIZE= option specifies the output line length, and the PAGESIZE= option specifies the number of lines on an output page.

```
options pagesize=40 linesize=64 nodate pageno=1;
```

The LIBNAME statement assigns the library.

```
LIBNAME exp 'SAS-library';
```

Suppress the printing of the Exp library. LIBRARY= specifies Exp as the procedure input library. NOLIST suppresses the directory listing for the Exp library.

```
proc datasets library=exp nolist;
```

Append the data set Exp.Sur to the Exp.Results data set. The APPEND statement appends the data set Exp.Sur to the data set Exp.Results. FORCE causes the APPEND statement to carry out the Append operation even though Exp.Sur has a variable that Exp.Results does not. APPEND does not add the Wt6Mos variable to Exp.Results.

```
   append base=exp.results data=exp.sur force;
run;
```

Print the data set.

```
proc print data=exp.results noobs;
   title 'The RESULTS Data Set';
run;
```

Output: Concatenating Two Data Sets

Output 17.21 *The Results Data Set*

The RESULTS Data Set

ID	TREAT	INITWT	WT3MOS	AGE
1	Other	166.28	146.98	35
2	Other	214.42	210.22	54
3	Other	172.46	159.42	33
5	Other	175.41	160.66	37
6	Other	173.13	169.40	20
7	Other	181.25	170.94	30
10	Other	239.83	214.48	48
11	Other	175.32	162.66	51
12	Other	227.01	211.06	29
13	Other	274.82	251.82	31

Output 17.22 *The Sur Data Set*

The EXP.SUR Data Set

ID	treat	initwt	wt3mos	wt6mos	age
14	surgery	203.60	169.78	143.88	38
17	surgery	171.52	150.33	123.18	42
18	surgery	207.46	155.22	.	41

Output 17.23 *Concatenating the Results and the Sur Data Sets*

The RESULTS Data Set

ID	TREAT	INITWT	WT3MOS	AGE
1	Other	166.28	146.98	35
2	Other	214.42	210.22	54
3	Other	172.46	159.42	33
5	Other	175.41	160.66	37
6	Other	173.13	169.40	20
7	Other	181.25	170.94	30
10	Other	239.83	214.48	48
11	Other	175.32	162.66	51
12	Other	227.01	211.06	29
13	Other	274.82	251.82	31
14	surgery	203.60	169.78	38
17	surgery	171.52	150.33	42
18	surgery	207.46	155.22	41

Example 7: Aging SAS Data Sets

Features:

PROC DATASETS statement options
- LIBRARY=
- NOLIST

AGE statement

OPTIONS statement

Details

This example demonstrates how the AGE statement ages SAS files.

Program

```
options pagesize=40 linesize=80 nodate pageno=1 source;
```

```
LIBNAME daily 'SAS-library';

proc datasets library=daily nolist;

   age today day1-day7;
run;
```

Program Description

Set the system options. The SOURCE system option writes the programming statements to the SAS log. PAGESIZE= option specifies the number of lines that compose a page of the SAS log and SAS output. LINESIZE= option specifies the line size for the SAS log and for SAS procedure output. NODATE option specifies that the date and the time are not printed. PAGENO= option specifies a beginning page number for the next page of output.

```
options pagesize=40 linesize=80 nodate pageno=1 source;

LIBNAME daily 'SAS-library';
```

Specify Daily as the procedure input library and suppress the directory listing.

```
proc datasets library=daily nolist;
```

Delete and age. Delete the last SAS file in the list, Day7, and then age (or rename) Day6 to Day7, Day5 to Day6, and so on, until it ages Today to Day1.

```
   age today day1-day7;
run;
```

Log Examples

Example Code 17.5 *SAS Log*

```
6  options pagesize=40 linesize=80
nodate pageno=1 source;
7
8     proc datasets library=daily nolist;
9
10        age today day1-day7;
11     run;
NOTE: Deleting DAILY.DAY7 (memtype=DATA).
NOTE: Ageing the name DAILY.DAY6 to DAILY.DAY7 (memtype=DATA).
NOTE: Ageing the name DAILY.DAY5 to DAILY.DAY6 (memtype=DATA).
NOTE: Ageing the name DAILY.DAY4 to DAILY.DAY5 (memtype=DATA).
NOTE: Ageing the name DAILY.DAY3 to DAILY.DAY4 (memtype=DATA).
NOTE: Ageing the name DAILY.DAY2 to DAILY.DAY3 (memtype=DATA).
NOTE: Ageing the name DAILY.DAY1 to DAILY.DAY2 (memtype=DATA).
NOTE: Ageing the name DAILY.TODAY to DAILY.DAY1 (memtype=DATA).
```

Example 8: Initiating an Audit File

Features:

PROC DATASETS statement options
- LIB=
- AUDIT statement
- INITIATE statement
- LOG statement
- RESUME statement
- SUSPEND statement
- TERMINATE statement
- USER_VAR statement

SQL procedure

Details

This example demonstrates the following tasks:

- initiates an audit file
- updates the data set
- suspends audit file
- terminates audit file

Program

```
libname mylib "SAS-library";

data mylib.inventory;
input vendor $10. +1 item $4. +1 description $11. +1 units 4.;
datalines;
SmithFarms F001 Apples      10
Tropicana  B002 OrangeJuice 45
UpperCrust C215 WheatBread  25
;
run;

proc datasets lib=mylib;
   audit inventory;
   initiate;
   user_var reason $ 30;
quit;


proc sql;
```

```
   Insert into mylib.inventory values ('Bordens','B132', 'Milk', 100,
                                       'increase on hand');
   Update mylib.inventory    set units=10, reason='recounted inventory'
                             where item='B002';
quit;


proc datasets lib=mylib;
audit inventory;
log admin_image=no;
suspend;
quit;


proc sql;
select * from mylib.inventory(type=audit);
quit;


proc datasets lib=mylib;
audit inventory;
resume;
quit;


proc datasets lib=mylib;
audit inventory;
terminate;
quit;
```

Program Description

Initiates an audit file using USER_VAR.

```
libname mylib "SAS-library";

data mylib.inventory;
input vendor $10. +1 item $4. +1 description $11. +1 units 4.;
datalines;
SmithFarms F001 Apples      10
Tropicana  B002 OrangeJuice 45
UpperCrust C215 WheatBread  25
;
run;

proc datasets lib=mylib;
   audit inventory;
   initiate;
   user_var reason $ 30;
quit;
```

Update the data set.

```
proc sql;
   Insert into mylib.inventory values ('Bordens','B132', 'Milk', 100,
                                       'increase on hand');
   Update mylib.inventory    set units=10, reason='recounted inventory'
                             where item='B002';
quit;
```

Discontinue the logging of ADMIN images and suspend audit file.

```
proc datasets lib=mylib;
audit inventory;
log admin_image=no;
suspend;
quit;
```

View the audit file.

```
proc sql;
select * from mylib.inventory(type=audit);
quit;
```

Resume the audit file.

```
proc datasets lib=mylib;
audit inventory;
resume;
quit;
```

Terminate the audit file.

```
proc datasets lib=mylib;
audit inventory;
terminate;
quit;
```

Log Examples

Example Code 17.6 *Initiating an Audit File*

```
1    options nocenter;
2
3    libname mylib "SAS-library";
NOTE: Libref MYLIB was successfully assigned as follows:
      Engine:        V9
      Physical Name: c:\mylib
4
5    data mylib.inventory;
6    input vendor $10. +1 item $4. +1 description $11. +1 units 4.;
7    datalines;

NOTE: The data set MYLIB.INVENTORY has 3 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           3.45 seconds
      cpu time            0.00 seconds


11   ;
12   run;
13
14   proc datasets lib=mylib;
NOTE: Writing HTML Body file: sashtml.htm
15      audit inventory;
16      initiate;
WARNING: The audited data file MYLIB.INVENTORY.DATA is not password protected.
Apply an Alter password to prevent accidental
         deletion or replacement of it and any associated audit files.
17      user_var reason $ 30;
18   quit;

NOTE: The data set MYLIB.INVENTORY.AUDIT has 0 observations and 11 variables.
NOTE: PROCEDURE DATASETS used (Total process time):
      real time           18.17 seconds
      cpu time            0.79 seconds


19
20   proc sql;
21      Insert into mylib.inventory values ('Bordens','B132', 'Milk', 100,
22                                          'increase on hand');
NOTE: 1 row was inserted into MYLIB.INVENTORY.

23      Update mylib.inventory    set units=10, reason='recounted inventory'
24                                where item='B002';
NOTE: 1 row was updated in MYLIB.INVENTORY.

25   quit;
NOTE: PROCEDURE SQL used (Total process time):
      real time           2.57 seconds
      cpu time            0.03 seconds


26
27   proc datasets lib=mylib;
28   audit inventory;
29   log admin_image=no;
30   suspend;
31   quit;

NOTE: PROCEDURE DATASETS used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

```
32
33   proc sql;
34   select * from mylib.inventory(type=audit);
35   quit;
NOTE: PROCEDURE SQL used (Total process time):
      real time           0.54 seconds
      cpu time            0.01 seconds


36
37   proc datasets lib=mylib;
37 !                           /* resume audit file */
38   audit inventory;
39   resume;
40   quit;

NOTE: PROCEDURE DATASETS used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds


41
42   /* additional step(s) which update the inventory dataset could go here*/
43
44   proc datasets lib=mylib;
44 !                          /* terminate audit file */
45   audit inventory;
46   terminate;
NOTE: Deleting MYLIB.INVENTORY (memtype=AUDIT).
47   quit;

NOTE: PROCEDURE DATASETS used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

Output Examples

Output 17.24 *Inventory Contents for MyLib Library*

Directory	
Libref	MYLIB
Engine	V9
Physical Name	c:\mylib
Filename	c:\mylib
Owner Name	BUILTIN\Administrators
File Size	4KB
File Size (bytes)	4096

#	Name	Member Type	File Size	Last Modified
1	CLASS	DATA	128KB	08/16/2016 14:48:34
2	INVENTORY	DATA	128KB	08/16/2016 15:38:44
3	SALARY	DATA	128KB	04/30/2014 13:42:52

Output 17.25 *Audit File Listing for MyLib Library*

Directory	
Libref	MYLIB
Engine	V9
Physical Name	c:\mylib
Filename	c:\mylib
Owner Name	BUILTIN\Administrators
File Size	4KB
File Size (bytes)	4096

#	Name	Member Type	File Size	Last Modified
1	CLASS	DATA	128KB	08/16/2016 14:48:34
2	INVENTORY	DATA	128KB	08/16/2016 15:38:44
	INVENTORY	AUDIT	65KB	08/16/2016 15:38:44
3	SALARY	DATA	128KB	04/30/2014 13:42:52

Output 17.26 *Inventory Data File Contents for MyLib Library*

vendor	item	description	units	reason	_ATDATETIME_	_ATOBSNO_	_ATRETURNCODE_	_ATUSERID_	_ATOPCODE_	_ATMESSAGE_
Bordens	B132	Milk	100	increase on hand	16AUG2016:15:38:44	4	.	suholm	DA	
Tropicana	B002	OrangeJuice	45		16AUG2016:15:38:44	2	.	suholm	DR	
Tropicana	B002	OrangeJuice	10	recounted inventory	16AUG2016:15:38:44	2	.	suholm	DW	

Example 9: Extended Attributes

Features: PROC DATASETS statement options
- LIB=
- NOLIST

CONTENTS statement
MODIFY statement
XATTR ADD DS statement
XATTR ADD VAR statement

Program

```
libname mylib 'C:\mylib';

data mylib.sales;
   purchase="car";
   age=10;
   income=200000;
   kids=3;
   cars=4;
run;

proc datasets lib=mylib nolist;
   modify sales;
      xattr add ds role="train" attrib="table";
      xattr add var purchase (role="target" level="nominal")
                    age (role="reject")
                    income (role="input" level="interval");

   contents data=sales;
   title  'The Contents of the Sales Data Set That Contains Extended
Attributes';

run;
quit;
```

Program Description

Create MyLib.Sales data set.

```
libname mylib 'C:\mylib';

data mylib.sales;
   purchase="car";
   age=10;
   income=200000;
   kids=3;
   cars=4;
run;
```

Adding extended attributes to the data set and to the variables.

```
proc datasets lib=mylib nolist;
   modify sales;
      xattr add ds role="train" attrib="table";
      xattr add var purchase (role="target" level="nominal")
                    age (role="reject")
                    income (role="input" level="interval");

   contents data=sales;
   title  'The Contents of the Sales Data Set That Contains Extended
Attributes';

run;
quit;
```

Log Examples

Example Code 17.7 *Extended Attributes*

```
355   libname mylib 'C:\mylib';
NOTE: Libref MYLIB was successfully assigned as follows:
      Engine:        V9
      Physical Name: C:\mylib
356
357  data mylib.sales;
358     purchase = "car";
359     age = 10;
360     income = 200000;
361     kids = 3;
362     cars = 4;
363  run;

NOTE: The data set MYLIB.SALES has 1 observations and 5 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


364
365  proc datasets lib=mylib nolist ;
366     modify sales;
367        xattr add ds role= "train" attrib="table";
368        xattr add var purchase ( role="target" level="nominal" )
369                      age ( role="reject" )
370                      income ( role="input" level="interval" );
NOTE: MODIFY was successful for MYLIB.SALES.DATA.
371
372     contents data=sales;
373     title  'The Contents of the Sales Data Set That Contains Extended
Attributes';
374
375  run;

376  quit;

NOTE: PROCEDURE DATASETS used (Total process time):
      real time           1.02 seconds
      cpu time            0.10 seconds
```

Output Examples

Output 17.27 *Contents of the Sales Data Set with Extended Attributes*

The Contents of the Sales Data Set That Contains Extended Attributes

The DATASETS Procedure

Data Set Name	MYLIB.SALES	**Observations**	1
Member Type	DATA	**Variables**	5
Engine	V9	**Indexes**	0
Created	08/16/2016 15:46:14	**Observation Length**	40
Last Modified	08/16/2016 15:46:19	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label		**EXTATTR Segment Length**	256
Data Representation	WINDOWS_64		
Encoding	wlatin1 Western (Windows)		

Alphabetic List of Variables and Attributes			
#	Variable	Type	Len
2	age	Num	8
5	cars	Num	8
3	income	Num	8
4	kids	Num	8
1	purchase	Char	3

Alphabetic List of Data Set Extended Attributes		
Extended Attribute	Numeric Value	Character Value
attrib	.	table
role	.	train

Alphabetic List of Extended Attributes on Variables			
Extended Attribute	Attribute Variable	Numeric Value	Character Value
level	income	.	interval
level	purchase	.	nominal
role	age	.	reject
role	income	.	input
role	purchase	.	target

18

DATEKEYS Procedure

Overview: DATEKEYS Procedure

Overview: The DATEKEYS Procedure

The DATEKEYS procedure enables you to process a single date or a set of dates in a time series using a name to reference the dates. For example, the DATEKEYS procedure can be used to identify time periods that are associated with a datekey, read and write datekeys, and provide details about datekey definitions.

The DATEKEYS procedure can be used to identify time periods that are associated with a datekey.

Some common uses of the DATEKEYS procedure are to define datekeys that identify holiday periods, sales events, or changes to operating hours.

Concepts: DATEKEYS Procedure

Concepts: The DATEKEYS Procedure

A SAS datekey describes a date or time interval that is associated with special events such as holidays and sale periods and time computations.

A datekey has a name, a date or set of dates that are associated with the datekey, and a set of qualifiers.

The DATEKEYS procedure provides results in output data sets that can be interpreted in other SAS procedures. It enables you to define datekeys that can be specified as SAS predefined datekeys when used in conjunction with the SAS system option EVENTDS=. The datekeys that you define can be used as date keywords, just as SAS predefined datekeys are used.

The following example creates datekeys, and then writes the datekey definitions to an output data set named MyHolidays. The datekey definitions are automatically available to SAS High-Performance Forecasting procedures by setting the SAS system option EVENTDS=.

```
proc datekeys;
   datekeydef SuperBowl=
                '15JAN1967'd '14JAN1968'd '12JAN1969'd '11JAN1970'd
   '17JAN1971'd '16JAN1972'd '14JAN1973'd '13JAN1974'd '12JAN1975'd
   '18JAN1976'd '09JAN1977'd '15JAN1978'd '21JAN1979'd '20JAN1980'd
   '25JAN1981'd '24JAN1982'd '30JAN1983'd '22JAN1984'd '20JAN1985'd
   '26JAN1986'd '25JAN1987'd '31JAN1988'd '22JAN1989'd '28JAN1990'd
   '27JAN1991'd '26JAN1992'd '31JAN1993'd '30JAN1994'd '29JAN1995'd
   '28JAN1996'd '26JAN1997'd '25JAN1998'd '31JAN1999'd '30JAN2000'd
   '28JAN2001'd '03FEB2002'd '26JAN2003'd '01FEB2004'd '06FEB2005'd
   '05FEB2006'd '04FEB2007'd '03FEB2008'd '01FEB2009'd '07FEB2010'd
   '06FEB2011'd '05FEB2012'd '03FEB2013'd '02FEB2014'd '01FEB2015'd
...'07FEB2016'd '05FEB2017'd '04FEB2018'd '03FEB2019'd '02FEB2020'd
   / PULSE=DAY ;

   datekeydef GoodFriday=Easter / shift=-2 pulse=day;
   datekeykey EasterMonday=Easter / shift=1 pulse=day;
   datekeydata out=MyHolidays condense;
run;

options eventds=(MyHolidays);

proc hpfevents data=sashelp.citiday;
   id date interval=day start='27JAN1991'd end='01APR1991'd;
   eventkey SuperBowl;
   eventkey GoodFriday;
   eventkey EasterMonday;
   eventdata out=MyHolidayEvents condense;
   eventdummy out=MyHolidayDates;
run;
```

The following output shows the results:

Figure 18.1 *Event Definition Data Set Based on User-Defined Datekeys*

The SAS System

Obs	_NAME_	_KEYNAME_
1	SuperBowl	SUPERBOWL
2	GoodFriday	GOODFRIDAY
3	EasterMonday	EASTERMONDAY

The following statements display an output data set that shows variables for the Super Bowl, Good Friday, and Easter Monday events. The first output shows the results when Month=1. The second output shows the results when Month GE 3.

```
proc print data=MyHolidayDates(where=(month(date)=1));
   var date SuperBowl GoodFriday EasterMonday;
run;

proc print data=MyHolidayDates(where=(month(date) GE 3));
   var date SuperBowl GoodFriday EasterMonday;
```

```
run;
```

Figure 18.2 *Output Data Set Based on User-Defined Datekeys: Month=1*

The SAS System

Obs	DATE	SuperBowl	GoodFriday	EasterMonday
1	27JAN1991	1	0	0
2	28JAN1991	0	0	0
3	29JAN1991	0	0	0
4	30JAN1991	0	0	0
5	31JAN1991	0	0	0

Figure 18.3 *Output Data Set Based on User-Defined Datekeys: Month GE 3*

The SAS System

Obs	DATE	SuperBowl	GoodFriday	EasterMonday
34	01MAR1991	0	0	0
35	02MAR1991	0	0	0
36	03MAR1991	0	0	0
37	04MAR1991	0	0	0
38	05MAR1991	0	0	0
39	06MAR1991	0	0	0
40	07MAR1991	0	0	0
41	08MAR1991	0	0	0
42	09MAR1991	0	0	0
43	10MAR1991	0	0	0
44	11MAR1991	0	0	0
45	12MAR1991	0	0	0
46	13MAR1991	0	0	0
47	14MAR1991	0	0	0
48	15MAR1991	0	0	0
49	16MAR1991	0	0	0
50	17MAR1991	0	0	0
51	18MAR1991	0	0	0
52	19MAR1991	0	0	0
53	20MAR1991	0	0	0
54	21MAR1991	0	0	0
55	22MAR1991	0	0	0
56	23MAR1991	0	0	0
57	24MAR1991	0	0	0
58	25MAR1991	0	0	0
59	26MAR1991	0	0	0
60	27MAR1991	0	0	0
61	28MAR1991	0	0	0
62	29MAR1991	0	1	0
63	30MAR1991	0	0	0
64	31MAR1991	0	0	0
65	01APR1991	0	0	1

Syntax: DATEKEYS Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

PROC DATEKEYS<*options*>;

BY *variable(s)*;

DATEKEYCALENDAR OUT=*SAS-data-set* <SUMMARY=*SAS-variable-name*>;

DATEKEYDATA IN=*SAS-data-set* | OUT=*SAS-data-set* <*options*>;

DATEKEYDEF *SAS-variable-name=timing-value* </*qualifier-options*>;

DATEKEYDSOPT LOCALE=<(ONLY)>*'POSIX locale'*;

DATEKEYKEY <*SAS-variable-name=*> *datekey-keyword* </*qualifier-options*>;

DATEKEYPERIODS OUT=*SAS-data-set*;

ID *SAS-variable-name* INTERVAL=*interval* <*options*>;

VAR *variable(s)*;

Statement	Task	Example
PROC DATEKEYS	Creates and manages datekeys that are associated with time computations	Ex. 1, Ex. 2, Ex. 3, Ex. 4
BY	Obtains separate calendar variables for groups of observations that are defined by the BY variables	
DATEKEYCALENDAR	Writes variables that indicate the active time periods for datekeys	Ex. 3, Ex. 4
DATEKEYDATA	Inputs and outputs datekeys	Ex. 1, Ex. 2, Ex. 3, Ex. 4
DATEKEYDEF	Defines a datekey that can be used in other SAS procedures	Ex. 1, Ex. 2, Ex. 3, Ex. 4
DATEKEYDSOPT	Limits input and output processing of data sets to a specified locale	Ex. 4
DATEKEYKEY	Alters a user-defined or predefined SAS datekey, or creates a new datekey from another datekey	Ex. 1, Ex. 2, Ex. 3, Ex. 4
DATEKEYPERIODS	Writes variables that list the active time periods in the input time ID for datekeys	Ex. 1
ID	Names a numeric variable containing SAS date, datetime or time values that identifies	Ex. 1, Ex. 2, Ex. 4

Statement	Task	Example
	observations by time period in input and output data sets	
VAR	Copies input variables to the output calendar variables data set	

PROC DATEKEYS Statement

Creates and manages datekeys that are associated with time computations.

Syntax

PROC DATEKEYS <*options*>;

Optional Argument

option

The following options are available:

DATA=*SAS-data-set*

names the SAS data set that contains the variables that are used in the VAR, ID, and BY statements.

Tip If the DATA= option is not specified, the most recently created SAS data set is used.

LEAD=*number-of-periods*

specifies the number of periods to extend the calendar variables beyond the input time ID. The LEAD= value is relative to the last observation in the input data set. If BY variables are specified, the LEAD= value is relative to the last observation in each BY group.

Default 0

MAXERROR=*number*

specifies the maximum number of warning and error messages that are produced during the execution of the procedure.

Default 25

Tip This option is particularly useful in BY-group processing, where it can be used to suppress the recurring messages.

SORTNAMES

specifies that the datekeys and variables in the output data sets be written in alphabetical order. Variables are sorted within their groups. Variables that

are listed in the VAR statement are sorted with respect to other variables that are listed in the VAR statement. Calendar variables are sorted with respect to other calendar variables.

BY Statement

Obtains separate calendar variables for groups of observations that are defined by the BY variables.

Syntax

BY *variable(s)*;

Required Argument

variable
specifies a variable that is used to obtain separate calendar variables for groups of observations that are defined by the BY variables.

Tip When a BY statement appears, the procedure expects the input data set to be sorted in order of the BY variables. If your input data set is not sorted in ascending order, use one of the following alternatives: Sort the data by using the SORT procedure with a similar BY statement, or create an index for the BY variables by using the DATASETS procedure. For more information, see the DATASETS procedure in *Base SAS Procedures Guide*.

DATEKEYCALENDAR Statement

Writes variables that indicate the active time periods for datekeys. The active periods are indicated with a value of 1, and the inactive periods are indicated with a value of 0.

Syntax

DATEKEYCALENDAR OUT=*SAS-data-set* <SUMMARY=*SAS-variable-name*>;

Summary of Optional Arguments

SUMMARY | SUM=*SAS-variable-name*

Required Argument

OUT=*SAS-data-set*
names the output data set to contain the calendar variables for the specified datekeys based on the ID information as specified in the ID statement.

Tip *SAS-data-set* also includes variables that are specified in the VAR, BY, and ID statements.

Optional Argument

SUMMARY | SUM=*SAS-variable-name*
specifies that the datekey calendar variables be summed and that the result be placed in the specified variable in the DATEKEYCALENDAR OUT= data set.

The SUM= variable can be interpreted as the number of keydates that are active for each time interval. If the SUM= option is not specified, no such variable is included in the OUT= data set.

DATEKEYDATA Statement

Inputs datekeys from a datekeys data set or writes datekeys to a datekeys data set. You can specify multiple DATEKEYDATA statements.

Syntax

DATEKEYDATA IN=*SAS-data-set* | OUT=*SAS-data-set* <*options*>;

Summary of Optional Arguments

option

Required Arguments

IN=*SAS-data-set*
names an input data set that contains datekey definitions.

Note: The IN= or OUT= argument is required.

OUT=*SAS-data-set*
names the output data set to contain the datekey definitions that are specified in the DATEKEYDATA IN= data sets and in the DATEKEYDEF and DATEKEYKEY statements.

Note: The IN= or OUT= argument is required.

Tip If the LIST option is not specified, the OUT= data set can then be used in other SAS procedures and system options to define datekeys.

Optional Argument

option

The following options are available:

CONDENSE

specifies that the DATEKEYDATA OUT= data set be condensed. Any variables that contain only default values are omitted from the data set.

The DATEKEYDATA IN= option reads both condensed data sets and data sets that have not been condensed. For more information, see "Identifying Variables in the DATEKEYDATA OUT= Data Set" on page 757.

LIST

specifies that the DATEKEYDATA OUT= data set contain only a list of the available datekeys. When you specify the LIST option, the output data set does not contain the parameters that are required for datekey definition.

NODEFAULTS

specifies that the DATEKEYDATA OUT= data set not contain any SAS predefined datekeys.

DATEKEYDEF Statement

Defines a datekey that can be interpreted in other SAS procedures. You can specify multiple DATEKEYDEF statements.

Note: These datekeys can be used to create events that can be included in forecasting models.

Syntax

DATEKEYDEF *SAS-variable-name*=*timing-value* </*qualifier-options*>;

Summary of Optional Arguments

qualifier-options

Required Arguments

SAS-variable-name
specifies a name in the DATEKEYDEF statement.

timing-value list
specifies one or more datekeys, dates, datetime values, or observation numbers. You can also specify a *value-list*.

The way you specify *value-list* depends on the type of variable:

integer value-list
For integer variables, *integer value-list* is either an explicit list of one or more integers or a starting value and an ending value with an interval increment, or a combination of both forms:

- *n* <*...n*>

  Here is an example:

```
10,11,12
```

- *n* TO *n* <BY *increment*>

  Here is an example:

```
10 to 12 by 1
```

- *n* <*...n*> TO *n* TO *n* <BY increment> <*n*<*...n*> >

  Here is an example:

```
11 to 5, 5 to 10 by 1;
```

SAS keyword value-list
For character variables, *SAS keyword value-list* is a list of one or more unique character values that are separated by blanks:

"value-1" <"value-2"..."value-n">

Here is an example:

```
"INDEPENDENCE"
or
"INDEPENDENCE" "EASTER" "NEWYEARS"
```

SAS date value-list* and *SAS datetime value-list
For date and time values, *value-list* can have the following forms:

- *"SAS-value"i<..."SAS-value"i>*

  Here are some examples:

```
'01Jan2000'd,'01Feb2000'd, '01Mar2000'd
or
'01Mar1990:15:03:00'dt
or
'01Jan:15:03:00'dt,'1Feb:15:03:00'dt, '01Mar:15:03:00'dt
```

- *"SAS-value"i* TO *"SAS-value"i*< BY *interval>*

Note: *"SAS-value"i* TO *"SAS-value"i* must be integers, dates, datetime, or time values. Do not mix types.

Here are some examples:

```
'01Jan2000'd TO '01Mar2000'd BY month
or
'01Jan1990:15:03:00'dt TO '01Mar1990:15:03:00'd
```

Optional Argument

qualifier-options

The following qualifier options are available:

AFTER=(<DURATION=*value*>)
specifies options that control the datekey definition after the timing value. The DURATION= suboption is used within the parentheses in the AFTER= ( ) option. DURATION specifies the datekey duration after the timing value.

BEFORE=(<DURATION=*value*>)
specifies options that control the datekey definition before the timing value. The DURATION= suboption is used within the parentheses in the BEFORE= ( ) option. DURATION specifies the datekey duration before the timing value.

LABEL='*SAS-label*'
specifies a label that is associated with the datekey. '*SAS-label*' is a text string that is enclosed in quotation marks and can be up to 256 characters.

The default label is '*SAS-variable-name* where *SAS-variable-name* is the name that is specified in the DATEKEYDEF statement. The label is stored in the DATEKEYDATA OUT= data set.

LOCALE='*POSIX locale*'
specifies a locale that is associated with the datekey. The locale should be a POSIX locale value. There is no default for the locale value.

PERIOD=*interval*
specifies the interval for the frequency of the datekey. For example, PERIOD=YEAR produces a datekey that is periodic in a yearly pattern.

If the PERIOD= option is omitted, the datekey is not periodic. The PERIOD= option does not apply to observation numbers, which are not periodic, or to date keywords, which have their own periodicity. For intervals that you can specify, see Chapter 4, "Date Intervals, Formats, and Functions" in *SAS/ETS User's Guide*.

PULSE=*interval*
specifies the interval to be used with the DURATION= option to determine the width of the datekey.

If the datekey is evaluated with respect to a time ID variable, then the default pulse is one observation. When no DURATION= values are specified and the PULSE= option is specified, the DURATION= values are set to zero. For intervals that you can specify, see Chapter 4, "Date Intervals, Formats, and Functions" in *SAS/ETS User's Guide*.

RULE=*value*

specifies the action to take when the defined datekey has multiple timing values that include at least one datekey.

When the datekey timing values consist only of SAS date, SAS datetime values, and observation numbers, the RULE= option does not apply. The RULE= option also does not apply when the timing value list consists of a single datekey. The RULE= option accepts the values AND and OR. The default is RULE=OR.

The following examples demonstrate the RULE= option:

```
datekeykey JANUARY               / pulse=month;
datekeydef RainyDays='11JUL2013'd '13JUL2013'd '21JUL2013'd;
datekeydef HotDays=  '11JUL2013'd '16JUL2013'd '17JUL2013'd
                     '18JUL2013'd '19JUL2013'd;
datekeydef FridaysInJanuary=JANUARY FRIDAY / rule=and;
datekeydef JanuaryPlusFridays=JANUARY FRIDAY / rule=or;
datekeydef HotandRainyDays=RainyDays HotDays / rule=and;
```

The RULE= option does not apply to the first statement because the timing value list consists of a single datekey. The RULE= option does not apply to the second and third statements because the timing value list consists only of SAS date values. The operation between two SAS date, datetime, or observation values is always OR. In the fourth statement, the RULE=AND option identifies only dates where the month is January and the day of the week is Friday. In the fifth statement, the RULE=OR option identifies all dates in January and all dates where the day of the week is Friday. In the sixth statement, the RULE=AND option identifies days that are both rainy and hot. The RULE=AND applies to the two datekeys, RainyDays and HotDays.

Usually, the result of an AND operation between two discrete time periods is an empty value. Therefore, the OR operation is always used between discrete time periods. An example is '13JUL2013'd, '01Mar1990:15:03:00'dt, 3.

The following table explains how the RULE= option is interpreted for each observation:

Table 18.1 *Definition of RULE= Option Values*

RULE= option	Name	Definition
AND	and	identifies time periods that are identified by all datekeys and the group of discrete timing values
OR	or	identifies time periods that are identified by any datekeys or the group of discrete timing values

SHIFT=*number*
specifies the number of pulses to shift the timing value δ. The default is not to shift the timing value (δ= 0). When the SHIFT= option is used, all timing values in the list (including those that are generated by date keywords) are shifted. Therefore, SHIFT= can be used with EASTER to specify ecclesiastical holidays that are based on Easter. For example, the following statement specifies Good Friday, which is defined as two days before Easter (Montes 2001).

```
datekeydef GoodFriday=EASTER / shift=-2 pulse=day;
```

DATEKEYDSOPT Statement

Limits the input and output processing of data sets to a specified locale.

Syntax

DATEKEYDSOPT LOCALE= '*POSIX locale*'<(ONLY)>;

Summary of Optional Arguments

(ONLY)

Required Arguments

LOCALE=
specifies a locale that is used to filter input and output data sets.

'POSIX locale'
specifies a POSIX locale value. There is no default for the locale value.

Optional Argument

(ONLY)
specifies to process only the specified locale, both for input and output data sets. If (ONLY) is not specified, the specified locale and defaults (no specified locale) are processed, both for input and output data sets.

DATEKEYKEY Statement

Alters a user-defined or predefined SAS datekey, or creates a new datekey from another datekey. You can specify multiple DATEKEYKEY statements.

See: "Using the DATEKEYKEY Statement" on page 753

Syntax

DATEKEYKEY <*SAS-variable-name=*> *datekey-keyword* </*qualifier-options*>;

Summary of Optional Arguments

qualifier-option

SAS-variable-name

Required Argument

datekey-keyword
specifies the default SAS variable name for a user-defined or predefined datekey.

Optional Arguments

SAS-variable-name
specifies the name of the new datekey keyword.

> **TIP** If you specify the DATEKEYCALENDAR option, a variable by this name is created and indicates the active and inactive periods of the keyword. If this option is not specified, then *datekey-keyword* is the name of the altered datekey.

qualifier-option
The following options are available:

AFTER=(<DURATION=*value*>)
specifies options that control the datekey definition after the timing value. The DURATION= suboption is used within the parentheses in the AFTER ( ) option.

DURATION specifies the datekey duration after the timing value when used in the AFTER= option.

BEFORE=(<DURATION=*value*>)
specifies options that control the datekey definition before the timing value. The DURATION= suboption is used within the parentheses in the BEFORE ( ) option.

DURATION specifies the datekey duration before the timing value when used in the BEFORE= option.

LABEL='*SAS-label*'
specifies a label that is associated with the datekey. 'SAS-label' is a text string that is enclosed in quotation marks and can be up to 256 characters. The default label is '*SAS-variable-name* , where *SAS-variable-name* is the name that is specified in the DATEKEYKEY statement. If *SAS-variable-name* is not specified in the DATEKEYKEY statement, then the label is the default label for the SAS predefined datekey. The label is stored in the DATEKEYDATA OUT= data set.

LOCALE='*POSIX locale*'
specifies a locale that is associated with the datekey. The locale should be a POSIX locale value. There is no default for the locale value.

PERIOD=*interval*
specifies the interval for the frequency of the datekey. For example, PERIOD=YEAR produces a datekey that is periodic in a yearly pattern. If the PERIOD= option is omitted, the datekey is not periodic. The PERIOD= option does not apply to observation numbers, which are not periodic, or to date keywords, which have their own periodicity. For intervals that can be specified, see Chapter 4, "Date Intervals, Formats, and Functions" in *SAS/ETS User's Guide*.

PULSE=*interval*
specifies the interval to be used with the DURATION= option to determine the width of the datekey. If the datekey is evaluated with respect to a time ID variable, then the default pulse is one observation. When no DURATION= values are specified and the PULSE= option is specified, the DURATION= values are set to zero. For intervals that can be specified, see Chapter 4, "Date Intervals, Formats, and Functions" in *SAS/ETS User's Guide*.

RULE=*value*
specifies the action to take when the defined datekey has multiple timing values that include at least one datekey. When the datekey timing values consist only of SAS date, SAS datetime, and observation numbers, the RULE= option does not apply. The RULE= option also does not apply when the timing value list consists of a single datekey. The RULE= option accepts the values AND and OR. The default is RULE=OR. The following examples demonstrate the RULE= option:

```
datekeykey JANUARY / pulse=month;
datekeydef RainyDays='11JUL2013'd '13JUL2013'd '21JUL2013'd;
datekeydef HotDays=  '11JUL2013'd '16JUL2013'd '17JUL2013'd
                     '18JUL2013'd '19JUL2013'd;
datekeydef FridaysInJanuary=JANUARY FRIDAY / rule=and;
datekeydef JanuaryPlusFridays=JANUARY FRIDAY / rule=or;
datekeydef HotandRainyDays=RainyDays HotDays / rule=and;
```

The RULE= option does not apply to the first statement because the timing value list consists of a single datekey. The RULE= option does not apply to the second and third statements because the timing value list consists only of SAS date values. The operation between two SAS date, datetime, or observation values is always OR. In the fourth statement, the RULE=AND option identifies dates that are both in January and the day of the week is Friday. In the fifth statement, the RULE=OR option identifies all dates in January and all dates where the day of the week is Friday. In the sixth

statement, the RULE=AND option identifies days that are both rainy and hot. The RULE=AND applies to the two datekeys, RainyDays and HotDays.

Usually, the result of an AND operation between two discrete time periods is an empty value. Therefore, the OR operation is always used between discrete time periods. An example is '13JUL2013'D, '01Mar1990:15:03:00'DT, 3.

Table 18.55 on page 739 explains how the RULE= option is interpreted for each observation.

SHIFT=*number*
specifies the number of pulses to shift the timing value δ. The default is not to shift the timing value (δ=0). When the SHIFT= option is used, all timing values in the list (including those generated by date keywords) are shifted.

DATEKEYPERIODS Statement

Writes variables that list the active time periods in the input time ID for datekeys. The active period dates, datetime values, or observation numbers, are listed with the associated datekey.

Syntax

DATEKEYPERIODS OUT=*SAS-data-set*;

Required Argument

OUT=*SAS-data-set*
names the output data set to contain the active dates, datetime values, or observations for the specified datekeys based on the ID information that is specified in the ID statement. The OUT= data set also includes variables that are specified in the BY and ID statements.

ID Statement

Specifies a numeric variable that identifies observations in the input and output data sets.

See: "Details for the ID Statement" on page 756

Syntax

ID *SAS-variable-name* INTERVAL=*interval* <*options*>;

Summary of Optional Arguments

Required Arguments

SAS-variable-name
specifies a numeric variable that identifies observations in the input and output data sets. *SAS-variable-name* can be a SAS date, time, datetime value, or an observation number.

INTERVAL=*interval*
specifies the frequency of the input time ID. For example, if the time ID in the input data set consists of quarterly observations, then use INTERVAL=QTR. For intervals that can be specified, see Chapter 4, "Date Intervals, Formats, and Functions" in *SAS/ETS User's Guide*.

Optional Argument

option
The following options are available:

ALIGN=*option*
controls the alignment of SAS dates that are used to identify output observations. The ALIGN= option accepts the following values: BEGINNING | BEG | B, MIDDLE | MID | M, and ENDING | END | E.

Default BEGINNING

END=*option*
specifies a SAS date, datetime, or time value that represents the end of the data. If the last time ID variable value is less than the END= value, the variables in the VAR statement are extended with missing values. If the last time ID variable value is greater than the END= value, the variables are truncated. For example, END="&sysdate"d uses the automatic macro variable SYSDATE to extend or truncate the variables to the current date. This option and the START= option can be used to ensure that data associated with each BY group contains the same number of observations.

FORMAT=*format*
specifies the SAS format for the time ID values. If the FORMAT= option is not specified, the default format is implied from the INTERVAL= option.

START=*option*
specifies a SAS date, datetime, or time value that represents the beginning of the data. If the first time ID variable value is greater than the START= value, the variables in the VAR statement are prefixed with missing values. If the first time ID variable value is less than the START= value, the variables are truncated. This option and the END= option can be used to ensure that data associated with each BY group contains the same number of observations.

VAR Statement

Copies input variables to the output calendar variables data set. If the VAR statement is omitted, all numeric variables are selected except those that appear in a BY or ID statement.

Syntax

VAR *variable(s)*;

Required Argument

variable
specifies numeric input variables to be copied to the output calendar variables data set.

Usage: DATEKEYS Procedure

Using the DATEKEYS Procedure

Functional Summary of the DATEKEYS Procedure

The following table summarizes the statements and options that control the DATEKEYS procedure.

Description	Statement	Option
Statements		
Specifies BY-group processing	BY	Not applicable
Specifies a calendar variable data set	DATEKEYCALENDAR	Not applicable
Specifies a datekey data set	DATEKEYDATA	Not applicable

Description	Statement	Option
Specifies a datekey definition	DATEKEYDEF	Not applicable
Specifies a datekey definition based on an existing datekey	DATEKEYKEY	Not applicable
Specifies a data set that contains a list of active periods by datekey	DATEKEYPERIODS	Not applicable
Specifies the time ID variable	ID	Not applicable
Specifies the variables to be copied to the calendar variable data set	VAR	Not applicable
Data Set Options		
Specifies the input data set	PROC DATEKEYS	DATA=
Specifies an output data set that contains calendar variables for datekeys	DATEKEYCALENDAR	OUT=
Specifies a datekeys input data set	DATEKEYDATA	IN=
Specifies a datekeys output data set	DATEKEYDATA	OUT=
Specifies that the datekeys output data set is to be condensed	DATEKEYDATA	CONDENSE
Specifies that the datekeys output data set contain only a list of datekeys	DATEKEYDATA	LIST
Specifies that the datekeys output data set contain no SAS predefined datekeys	DATEKEYDATA	NODEFAULTS
Specifies that input and output data sets process the specified locale	DATEKEYDSOPT	LOCALE=
Specifies an output data set that contains active dates for datekeys	DATEKEYPERIODS	OUT=
Specifies a starting time ID value	ID	START=
Specifies an ending time ID value	ID	END=
Specifies the format of the ID variable	ID	FORMAT=

Description	Statement	Option
Calendar Variable Format Options		
Extends the calendar variables past the end of the input time ID	PROC DATEKEYS	LEAD=
Specifies the frequency of the time ID variables	ID	INTERVAL=
Specifies the interval alignment	ID	ALIGN=
Miscellaneous Options		
Specifies that variables in output data sets are to be in sorted order	PROC DATEKEYS	SORTNAMES
Limits error and warning messages	PROC DATEKEYS	MAXERROR=

Datekey Definitions

The purpose of a datekey definition is to define time periods that are associated with the reference datekey. These time periods are then interpreted in other SAS procedures that define time-dependent features such as events. The time period of the datekey definition is compared to the time period of interest. If the time period of interest falls within the range of the datekey definition, then appropriate action is taken. The datekey definitions can be written to an output file by using the OUT= option of the DATEKEYDATA statement.

Once a datekey has been defined, it is referenced using its SAS variable name. When the datekey definition is written to an output file by using the DATEKEYDATA statement, the datekey is identified by its SAS variable name. As with SAS predefined datekeys, when an event is specified using a user-defined datekey name, a dummy variable is created using the datekey definition. The dummy variable name is the same as the datekey SAS reference name.

Each datekey must have a unique SAS variable name. If two datekey definitions have the same name, the following rules apply:

- If two DATEKEYDEF statements exist using the same name, the second statement is used.
- If a datekey is defined in both a DATEKEYDEF statement and in a data set specified using the DATEKEYDATA statement, the definition in the DATEKEYDEF statement is used.
- Any datekey that is defined using a DATEKEYDEF, DATEKKEYKEY, or DATEKEYDATA statement is used, rather than a predefined SAS datekey.

Details of the Timing Value List Specification

Each DATEKEYDEF statement must be defined using one or more timing values. The timing values can be specified using a list. Each item in the list can be a predefined SAS date keyword, an integer, a SAS date, a SAS datetime value, or a *value-list*. For example, the following DATEKEYDEF statement specifies timing values that use each of these methods in the order listed:

```
datekeydef datekey1=USINDEPENDENCE 10 '25Dec2000'd
                    '01Mar1990:15:03:00'dt
                    '01Jan2000'd to '01Mar2000'd by month;
```

The timing values are interpreted as follows: July 4 of any relevant year; the 10th observation in a time series or data set; December 25, 2000; March 1, 1990 at 3:03PM; January 1, 2000; February 1, 2000; and March 1, 2000.

The following two DATEKEYDEF statements specify identical timing values:

```
datekeydef MyFirstDATEKEY='01Jan2000'd to '01Mar2000'd by month;
datekeydef MyNextDATEKEY=('01Jan2000'd, '01Feb2000'd, '01Mar2000'd );
```

The *timing-value list* can be enclosed in parentheses, and commas can separate the items in the list. Numbers must be integers and are always interpreted as observation numbers. The *value-list* can be based on observation numbers, SAS dates, or SAS datetime values. However, the first and second values in the list must be of the same type. SAS always expects the type of the second value to be the same as the type of the first value, and tries to interpret the statement in that way. The following statement yields erratic results:

```
datekeydef baddatekey='01Jan2000'd to '01Mar2000:00:00:00'dt by month;
```

Either the DATEKEYS procedure produces a list much longer than expected or the procedure does not have enough memory to execute.

Note: Do not mix date, datetime, integer, and value types in a *value-list*.

The following table shows the holiday date keywords that can be used in a *timing-value list*, and their definitions:

Table 18.2 *Holiday Date Keywords and Definitions*

Date Keyword	Definition
BOXING	December 26
CANADA	July 1
CANADAOBSERVED	July 1, or July 2, if July 1 is a Sunday
CHRISTMAS	December 25

Date Keyword	Definition
COLUMBUS	second Monday in October
EASTER[1]	Easter Sunday
FATHERS	third Sunday in June
HALLOWEEN	October 31
LABOR	first Monday in September
MLK	third Monday in January
MEMORIAL	last Monday in May
MOTHERS	second Sunday in May
N<*n*>W<*w*><MON>YR	date specified by NWKDOM(*n*, *w*, *m*, *year*), where *m* corresponds to the month that is specified by MON, and *year* is any year relevant to the data. Example: N4W5NOVYR is the same as THANKSGIVING
NEWYEAR	January 1
THANKSGIVING	fourth Thursday in November
THANKSGIVINGCANADA	second Monday in October
USINDEPENDENCE	July 4
USPRESIDENTS	third Monday in February (since 1971)
VALENTINES	February 14
VETERANS	November 11
VETERANSUSG	U.S. government observed date for Monday–Friday schedule
VETERANSUSPS	U.S. government observed date for Monday–Saturday schedule (U.S. Post Office)
VICTORIA	Monday on or preceding May 24

1. The date for Easter is calculated using a method described by Montes (2001).

The following table shows the seasonal date keywords that can be used in a *timing value list*, and their definitions:

Table 18.3 *Seasonal Date Keywords and Definitions*

Date Keyword	Definition
SECOND_1, ...SECOND_60	the specified second.
MINUTE_1, ...MINUTE_60	the beginning of the specified minute.
HOUR_1, ...HOUR_24	the beginning of the specified hour.
SUNDAY, ...SATURDAY	all Sundays, and so on, in the time series.
WEEK_1, ...WEEK_53	the first day of the *n*th week of the year. PULSE=WEEK.*n* shifts this date for *n* NE 1.
TENDAY_1, ...TENDAY_36	the 1st, 11th, or 21st day of the appropriate month.
SEMIMONTH_1, ...SEMIMONTH_24	the 1st or 16th day of the appropriate month.
JANUARY, ...DECEMBER	the 1st day of the specified month.
QTR_1, QTR_2, QTR_3, QTR_4	the first date of the quarter. PULSE=QTR.*n* shifts this date for *n* NE 1.
SEMIYEAR_1, SEMIYEAR_2	the first date of the semiyear. PULSE=SEMIYEAR.*n* shifts this date for *n* NE 1.

Timing values are evaluated with respect to the application and relevant time specified by the user. Select the timing values that are consistent with the usage. In particular, date and datetime timing values are ignored when no date or time information is specified, and only observation numbers are available for analysis.

Details of Modifying Timing Values Using Options

The qualifier options define functional modifications to be applied at each timing value. The options are applied in the following order:

1. If a SHIFT= value is specified, the timing values in the list are shifted using the SHIFT= value, and the PULSE= value, if specified.
2. If a DURATION= value is specified in the BEFORE= or AFTER= options, then a continuous interval is defined around the shifted timing values based on the DURATION= and PULSE= values.

3 If PERIOD= values are specified, then periodic values are generated based on the timing values that result from steps 1 and 2.

Details of Identifying Active Intervals Based on Timing Values and Options

When a datekey is evaluated with respect to a time ID, active intervals are identified with respect to the time ID intervals. Therefore, the active periods are dependent on both the time ID and the datekey definition.

The observation that is specified by the shifted timing value, t_i, is the observation that contains the date that is generated by `INTNX(interval,timing_value,s,'same')`, where SHIFT=*s* and PULSE=*interval*. If no PULSE= value is specified, the default is PULSE=OBS, which is equivalent to PULSE=*interval*, where *interval* is the interval of the time ID.

Table 18.4 *Calculating the Beginning and Ending Observations for Datekeys When Applied to Time Series*

BEFORE=(DURATION=*value*)	**PULSE=*value***	**Definition of t_b**
ALL	Not available	t_b=1, the first observation in the data set, or t_b= the observation specified by START=
m=0	Not specified	$t_b=t_i$, the observation specified by the shifted timing value
m>0	Not specified	$t_b=t_i-m$
m>=0	*interval*	t_b= the observation specified by the date `INTNX(interval, timing-value,-m, 'begin')`
AFTER=(DURATION=*value*	PULSE=*value*	Definition of t_e
ALL	Not available	t_e= the last observation in the data set, or t_e= the observation specified by END=

BEFORE=(DURATION=*value*)	PULSE=*value*	Definition of t_b
n=0	Not specified	$t_e=t_i$, the observation specified by the shifted timing value
n>0	Not specified	$t_e=t_i+n$
n>=0	*interval*	t_e= the observation specified by the date `INTNX(interval, timing-value,n,'end')`

The following table shows active time periods for datekey definitions:

Table 18.5 *Active Time Periods for Datekey Definitions*

BEFORE=(DURATION=*m*)	AFTER=(DURATION=*n*)	Active Observation
m=ALL	*n*=ALL	ξ_{it}, for all *t*
m=finite	*n*=ALL	ξ_{it}, for all $t>=t_b$
m=ALL	*n*=finite	ξ_{it}, for all $t<=t_e$
m=finite	*n*=finite	ξ_{it}, if $t_b<=t<=t_e$

If an observation is not within an active period for a datekey, then it is not altered by the datekey action.

The active period always occurs at the shifted timing value. You specify three observations before the timing value, one observation at the timing value, and four after the timing value. The total would be 3+1+4=8 observations as follows:

```
datekeydef E1='01JAN1950'd / before=(duration=3)
                                  after=(duration=4);
```

In this example, you specify three weeks before the timing value, the week of the timing value, and four weeks after the timing value by using a combination of the BEFORE=, AFTER=, and PULSE= options as follows:

```
datekeydef E1='01JAN1950'd / before=(duration=3)
                                  after=(duration=4)
                                  pulse=week;
```

DURATION=ALL implies that the active period should be extended to the beginning (BEFORE=) or end (AFTER=) of time. If only one DURATION= value is specified, the other value is assumed to be zero. When neither DURATION= value is specified, both DURATION= values are set to zero. DURATION=ALL is represented in the

datekey definition data set as a special missing value displayed as "A". For more information, see "Missing Values" in *SAS Language Reference: Concepts*.

Using the DATEKEYKEY Statement

Creating New Datekeys from Existing Datekey Definitions

A DATEKEYKEY statement can be used with PROC DATEKEYS to create new datekeys from existing datekey definitions and make them available for processing. SAS events that are based on user-defined datekeys are also available directly through PROC HPFDIAGNOSE and PROC HPFENGINE by specifying the EVENTDS= system option.

A user-defined datekey variable has timing values and qualifiers that are defined by the user. A DATEKEYKEY variable that is defined using a predefined SAS datekey has a predefined set of timing values and qualifiers that are associated with the predefined datekey keyword. You can redefine the qualifiers by using the statement options. The options are the same as in the DATEKEYDEF statement. In "Concepts: The DATEKEYS Procedure" on page 728, the default SAS variable name for an event based on a datekey is the datekey keyword. However, you can specify a different SAS name for the datekey. For example, you can rename the CHRISTMAS predefined datekey to XMAS by using the following statement:

```
datekeykey xmas=christmas;
```

If you redefine the qualifiers that are associated with a predefined SAS datekey and do not rename the datekey, then that has the impact of redefining the predefined SAS datekey. This redefinition occurs because any user definition takes precedence over a SAS predefined definition. The following example produces an event named FALLHOLIDAYS with a pulse of 1 day at Halloween and a pulse of 1 month at Thanksgiving:

```
datekeykey thanksgiving / pulse=month;
eventcomb fallholidays=halloween thanksgiving;
```

The following table describes how to construct a predefined SAS datekey keyword. It also gives the default qualifier options for those predefined datekeys.

Table 18.6 *Definitions for DATEKEYKEY Predefined Event Keywords*

Variable Name or Variable Name Format	Description	Qualifier Option
AO<obs>OBS	outlier	BEFORE=(DURATION=0)
AO<date>D		AFTER=(DURATION=0)
AO<datetime>DT		

Variable Name or Variable Name Format	Description	Qualifier Option
LS<obs>OBS LS<date>D LS<datetime>DT	level shift	BEFORE=(DURATION=0) AFTER=(DURATION=ALL)
TLS<obs>OBS<n> TLS<date>D<n> TLS<datetime>DT<n>	temporary level shift	BEFORE=(DURATION=0) AFTER=(DURATION=<n>)
NLS<obs>OBS NLS<date>D NLS<datetime>DT	negative level shift	BEFORE=(DURATION=0) AFTER=(DURATION=ALL)
CBLS<obs>OBS CBLS<date>D CBLS<datetime>DT	U.S. Census Bureau level shift	SHIFT=–1 BEFORE=(DURATION=ALL) AFTER=(DURATION=0)
TC<obs>OBS TC<date>D TC<datetime>DT	temporary change	BEFORE=(DURATION=0) AFTER=(DURATION=ALL)
<date keyword>	date pulse	BEFORE=(DURATION=0) AFTER=(DURATION=0)
LINEAR QUAD CUBIC	polynomial trends	BEFORE=(DURATION=ALL) AFTER=(DURATION=ALL) default timing value is 0 observation
INVERSE LOG	trends	BEFORE=(DURATION=0) AFTER=(DURATION=ALL) default timing value is 0 observation

Variable Name or Variable Name Format	Description	Qualifier Option
<seasonal keywords>	seasonal	PULSE= depends on keyword BEFORE=(DURATION=0) AFTER=(DURATION=0) timing values based on keyword

Modifying or Cloning a User-Defined Datekey

A DATEKEYKEY statement can be used in a similar manner to modify or clone a user-defined datekey. In the following example, the DATEKEYDEF statement is used to define a simple event named SPRING. The DATEKEYKEY statement is used to modify the SPRING event definition. Then the DATEKEYKEY statement is used to create a new event named SPRINGBREAK that is based on the previously defined user event named SPRING. Therefore, the example defines a total of two datekeys, SPRING and SPRINGBREAK. The DATEKEYKEY statement can be used to modify the qualifiers. It cannot be used to modify the timing values.

```
datekeydef spring='20mar2005'd;
datekeykey spring / pulse=day;
datekeykey SPRINGBREAK=spring / pulse=week;
```

If the preceding datekeys are stored in a data set named SPRINGHOLIDAYS, the first DATEKEYKEY statement in the following example clones SPRING as a datekey named FirstDayOfSpring. The second DATEKEYKEY statement changes the case of the SPRINGBREAK datekey name.

```
datekeydata in=springholidays;
datekeykey FirstDayOfSpring=spring;
datekeykey Springbreak=springbreak;
```

Datekey names that refer to a previously defined datekey are not case sensitive. However, datekey names that are used to create a new datekey preserve the casing in the _NAME_ variable of the DATEKEYDATA OUT= data set.

SAS Datekey Keywords

The date keywords that are described in Table 18.56 on page 748 can be used in the DATEKEYDEF statement as predefined SAS datekey keywords. The timing values are as defined in Table 18.56 on page 748. The default qualifiers are as shown in Table 18.60 on page 753. Table 18.57 on page 750 shows the seasonal keywords that can be used as predefined SAS datekey keywords. The default qualifiers for seasonal keywords are shown in Table 18.60 on page 753. Table 18.61 on page 756

describes how date and observation numbers are encoded into AO, LS, TLS, NLS, CBLS, and TC enter predefined datekeys.

SAS predefined date keywords have only active periods.

Table 18.7 *Encoding Data Information into AO, LS, TLS, NLS, CBLS, and TC Type DATEKEYKEY Variable Names*

Variable Name Format	Example	Refers To
AO<int>OBS	AO15OBS	15th observation
AO<date>D	AO01JAN2000D	'01JAN2000'D
AO<date>h<hr>m<min>s<sec>DT	AO01Jan2000h12m34s56DT	'01Jan2000:12:34:56'DT
TLS<int>OBS<n>	TLS15OBS10	15th observation
TLS<date>D<n>	TLS01JAN2000D10	'01JAN2000'D
TLS<date>h<hr>m<min>s<sec>DT<n>	TLS01Jan2000h12m34s56DT10	'01Jan2000:12:34:56'DT

Details for the ID Statement

The ID statement accepts a SAS variable name and an interval. The ID variable's values are assumed to be SAS date, time, datetime values, or observation numbers. In addition, the ID statement specifies the desired frequency for examining active and inactive time periods. The information that is specified affects all variables that are generated by using the DATEKEYCALENDAR and DATEKEYPERIODS statements. If no DATEKEYCALENDAR or DATEKEYPERIODS statements are specified, the ID statement has no impact on processing, because the DATEKEYDEF definitions are independent of the time identification values and frequencies. If the ID statement is specified, the INTERVAL= option must also be specified. If an ID statement is not specified, the observation number (with respect to the BY group) is used as the time ID. In this case, only datekey timing values that are based on observation numbers are applied to the input time ID to create calendar variables. Timing values that are based on SAS date or datetime values are ignored.

Data Set Output

Creating Data Set Output

The DATEKEYS procedure can create the DATEKEYCALENDAR OUT=, DATEKEYDATA OUT=, and DATEKEYPERIODS OUT= data sets. The DATEKEYDATA OUT= data set contains the datekey definitions that can be used for input to another SAS procedure. If the LIST option is specified in the DATEKEYDATA OUT= statement, then the output data set contains a list of available datekeys. The DATEKEYCALENDAR OUT= data set contains calendar indicator variables that show the active periods for the datekeys relative to the input time ID. The DATEKEYPERIODS OUT= data set contains information about datekeys that are active for the input time ID and the associated dates.

Identifying Variables in the DATEKEYCALENDAR OUT= Data Set

The DATEKEYCALENDAR OUT= data set contains the variables that are listed in the BY statement, the ID variable, any variables that are defined by the VAR statement, and any calendar variables that are generated by the procedure. The calendar indicator variables show the active periods for the datekeys relative to the input time ID. You can specify the SUM= option in the DATEKEYCALENDAR statement. In this case, the variable that is specified in the SUM= option is included in the DATEKEYCALENDAR OUT= data set and contains the sum of the calendar indicator variables.

Identifying Variables in the DATEKEYDATA OUT= Data Set

The DATEKEYDATA OUT= data set contains the following variables. The default values for the CONDENSE option are also given. When all the observations in the variable are equal to the default value, the variable can be omitted from the datekey definition data set.

CLASS
: specifies that the class for all datekeys is DATEKEY. The default for _CLASS_ is DATEKEY.

DATEINTRVL
: specifies the interval for the date *value-list*. The default for _DATEINTRVL_ is no interval, designated by ".".

DTINTRVL
specifies the interval for the datetime *value-list*. The default for _DTINTRVL_ is no interval, designated by ".".

_DUR_AFTER_
specifies the number of durations after the timing value. The default for _DUR_AFTER_ is 0.

_DUR_BEFORE_
specifies the number of durations before the timing value. The default for _DUR_BEFORE_ is 0.

ENDDATE
specifies the last date timing value to use in a *value-list*. The default for _ENDDATE_ is no date, designated by a missing value.

ENDDT
specifies the last datetime timing value to use in a *value-list*. The default for _ENDDT_ is no datetime, designated by a missing value.

ENDOBS
specifies the last observation number timing value to use in a *value-list*. The default for _ENDOBS_ is no observation number, designated by a missing value.

KEYNAME
specifies either a predefined datekey keyword or a user-defined datekey keyword. All _KEYNAME_ values are displayed in uppercase. However, if the _KEYNAME_ value refers to a user-defined keyword, then the actual name can be mixed case. The default for _KEYNAME_ is no keyname, designated by ".".

LABEL
specifies a label or description for the datekey. If you do not specify a label, then the default label value is displayed as ".". For more information, see the LABEL system option in *SAS System Options: Reference*.

LOCALE
specifies the locale for the datekey. _LOCALE_ values are the valid POSIX locale values. For more information, see the LOCALE system option in *SAS National Language Support (NLS): Reference Guide*. There is no default.

NAME
specifies a datekey reference name. _NAME_ is displayed with the case preserved. Because _NAME_ is a SAS variable name, the datekey can be referenced using any case. The _NAME_ variable is required. There is no default.

OBSINTRVL
specifies the interval length of the observation number *value-list*. The default for _OBSINTRVL_ is no interval, designated by ".".

PERIOD
specifies the frequency interval at which the datekey should be repeated. If this value is missing, then the datekey is not periodic. The default for _PERIOD_ is no interval, designated by ".".

PULSE
specifies an interval that defines the units for the DURATION values. The default for _PULSE_ is no interval (one observation), designated by ".".

RULE
specifies the rule to use when you combine the timing values of a datekey. The default for _RULE_ for datekeys is OR.

SHIFT
specifies the number of PULSE= intervals to shift the timing value. The shift can be positive (forward in time) or negative (backward in time). If PULSE= is not specified, then the shift occurs in observations. The default for _SHIFT_ is 0.

STARTDATE
specifies either the date timing value or the first date timing value to use in a *value-list*. The default for _STARTDATE_ is no date, designated by a missing value.

STARTDT
specifies either the datetime timing value or the first datetime timing value to use in a *value-list*. The default for _STARTDT_ is no datetime, designated by a missing value.

STARTOBS
specifies either the observation number timing value or the first observation number timing value to use in a *value-list*. The default for _STARTOBS_ is no observation number, designated by a missing value.

Identifying Variables in the DATEKEYPERIODS OUT= Data Set

The DATEKEYPERIODS OUT= data set contains the following variables.

LOCALE
specifies the locale for the datekey. _LOCALE_ values are the valid POSIX locale values. For more information, see the LOCALE system option in *SAS National Language Support (NLS): Reference Guide*. There is no default.

NAME
specifies a datekey reference name. _NAME_ is displayed with the case preserved. Because _NAME_ is a SAS variable name, the datekey can be referenced using any case. The _NAME_ variable is required. There is no default.

STARTDATE
specifies either the date timing value or the first date timing value to use in a *value-list*. The default for _STARTDATE_ is no date, designated by a missing value.

TIME ID
specifies the date.

Listing the Datekeys By Using the LIST Option

You can use the LIST option in the DATEKEYDATA statement to list datekeys. Specifying the LIST option in the DATEKEYDATA OUT= statement alters the output data set. The purpose of the LIST option is to create a data set that lists the available datekeys that are defined by the data set. When the LIST option is specified, the data set contains only the _LOCALE_, _NAME_, and _LABEL_ variables. The data set contains one observation for each datekey.

Creating a Data Set of BY Statement Variables

You can create a data set of BY statements by using the DATEKEYPERIODS statement. The DATEKEYPERIODS OUT= data set contains the following items:

- variables that are listed in the BY statement
- a list of active datekeys that are associated with the input time ID
- the ID variable dates that are associated with the active datekeys
- the starting date, datetime, or observation value that is associated with the active time ID period

In addition to the BY variables and the ID variable, the DATEKEYPERIODS OUT= data set contains the following variables:

NAME
: specifies a datekey reference name. _NAME_ is displayed with the case preserved. The datekey that is displayed is active on the dates that are specified by the ID variable and the _STARTDATE_, _STARTDT_, or _STARTOBS_ values for the observation.

One of the following variables is included, based on the time ID variable:

STARTDATE
: specifies the date that is associated with the beginning of the period that is specified by the INTERVAL= option relative to the value of the time ID variable.

STARTDT
: specifies the datetime that is associated with the beginning of the period that is specified by the INTERVAL= option relative to the value of the time ID variable.

STARTOBS
: specifies the observation number that is associated with the beginning of the period that is specified by the INTERVAL= option relative to the value of the time ID variable.

Written Output

The DATEKEYS procedure has no written output other than warning and error messages as recorded in the log.

Examples: DATEKEYS Procedure

Example 1: Methods for Constructing a Datekeys Definition Data Set

Features:

PROC DATEKEYS statement options
- ID
- DATEKEYDEF
- DATEKEYKEY
- DATEKEYDATA
- DATEKEYPERIODS

Details

This example uses two methods to construct a datekeys definition data set. The first method uses the DATA step to construct a datekey data set for Fridays when an item was on sale. The second method uses the DATEKEYS procedure to construct the datekey definition data set. The TimeSeriesDates data set contains the time ID variable for the time series.

The same dates that are defined in WhiteSaleDates in the DATA step can be defined using the DATEKEYS procedure. The active dates are the same as in the data set that is shown in Output 18.121 on page 763. However, the definitions in the DATEKEYS procedure are continuous.

Program: Using the DATA Step

```
options eventds=(nodefaults);
```

```
data TimeSeriesDates(keep=date);
   set sashelp.citiday;
   format date date.;
run;

data WhiteSaleDates(keep=_name_ _startdate_);
   set TimeSeriesDates;
   _name_='WhiteSale';
   if (month(date)=1) then do;
      if (year(date)=1991 or year(date)=1992) then do;
         if (weekday(date)=6) then do;
            _startdate_=date;
         end;
         else delete;
         end;
      else delete;
      end;
   else delete;
   format _startdate_ date.;
run;

proc print data=WhiteSaleDates;
run;
```

Program Description

Set the EVENTDS= system option. The EVENTDS= system option specifies the data set that defines the event. The NODEFAULTS option specifies not to use default event definitions. The only events that are used are specified by the event-data-set list.

```
options eventds=(nodefaults);
```

Create the TimeSeriesDates data set. The DATA step uses sashelp.citiday to create the data set for this example:

```
data TimeSeriesDates(keep=date);
   set sashelp.citiday;
   format date date.;
run;
```

Construct a datekeys data set, WhiteSalesDates, for use with the EVENTDS= system option. When you construct a datekeys data set using a DATA step, all observations that define a specific datekey must be consecutive. If necessary, use the SORT procedure to sort the data set by the _NAME_ variable. The DATA step describes an item that was on sale during January 1991 and January 1992. The user-defined datekeys identify the Fridays that the item was on sale.

```
data WhiteSaleDates(keep=_name_ _startdate_);
   set TimeSeriesDates;
   _name_='WhiteSale';
   if (month(date)=1) then do;
      if (year(date)=1991 or year(date)=1992) then do;
         if (weekday(date)=6) then do;
            _startdate_=date;
         end;
```

```
         else delete;
         end;
      else delete;
      end;
   else delete;
   format _startdate_ date.;
run;

proc print data=WhiteSaleDates;
run;
```

Output: HTML

Output 18.1 *User-Defined Datekeys Data Set*

The SAS System

Obs	_NAME_	_STARTDATE_
1	WhiteSale	04JAN91
2	WhiteSale	11JAN91
3	WhiteSale	18JAN91
4	WhiteSale	25JAN91
5	WhiteSale	03JAN92
6	WhiteSale	10JAN92
7	WhiteSale	17JAN92
8	WhiteSale	24JAN92
9	WhiteSale	31JAN92

Program: Using the DATEKEYS Procedure

```
proc datekeys data=sashelp.citiday;
   id date interval=day;
   datekeydef Years1991_1992='01JAN1991'd / pulse=year
after=(duration=1);
   datekeykey January / pulse=month;
   datekeydef WhiteSale=JANUARY FRIDAY Years1991_1992 / rule=and;
   datekeydata out=WhiteSaleDefinitions condense;
   datekeyperiods out=WhiteSaleActiveDates;
run;
```

```
proc print data=WhiteSaleActiveDates(where=(_name_='WhiteSale'));
run;

proc print data=WhiteSaleDefinitions;
run;
```

Program Description

Begin the DATEKEYS procedure. The DATA= option contains the variables that are used in the ID statement.

```
proc datekeys data=sashelp.citiday;
```

Specify the time ID variable. The ID statement names a numeric variable that identifies observations in the data set. If you use the ID statement, the INTERVAL= option must be used. In this case, INTERVAL=day.

```
    id date interval=day;
```

Define a datekey. The DATEKEYDEF statement defines a datekey. PULSE= specifies the interval to be used with the DURATION= option to determine the width of the datekey.

```
    datekeydef Years1991_1992='01JAN1991'd / pulse=year
after=(duration=1);
```

Alter or create a new datekey. Because January is used in the timing value list, it represents the first day of January. Using DATEKEYKEY with PULSE=MONTH creates a datekey for the entire month of January.

```
    datekeykey January / pulse=month;
```

Define a datekey. The DATEKEYDEF statement defines a datekey. The RULE=AND option identifies days in January that are Fridays.

```
    datekeydef WhiteSale=JANUARY FRIDAY Years1991_1992 / rule=and;
```

Write the datekey to an output data set. The DATEKEYDATA OUT= data set contains the definitions for the WhiteSale datekey. The CONDENSE option specifies that the output data set be condensed. Any variables that contain only default values are omitted from the data set.

```
    datekeydata out=WhiteSaleDefinitions condense;
```

Write variables that list the active time periods in the input time ID for datekeys. The DATEKEYPERIODS OUT= data set contains the active time periods for the WhiteSale datekey, as shown in Output 18.122 on page 765.

```
    datekeyperiods out=WhiteSaleActiveDates;
```

Execute the example. The RUN statement causes the program to execute.

```
run;
```

Write the active sales dates data set. The results are shown in Output 18.122 on page 765.

```
proc print data=WhiteSaleActiveDates(where=(_name_='WhiteSale'));
run;
```

Write the definitions for the WhiteSale datekey. The results are shown in Output 18.123 on page 765.

```
proc print data=WhiteSaleDefinitions;
run;
```

HTML Output

Output 18.2 *Datekeys Active Periods Data Set Output*

The SAS System

Obs	_LOCALE_	DATE	_NAME_	_STARTDATE_
557	.	04JAN1991	WhiteSale	04JAN1991
558	.	11JAN1991	WhiteSale	11JAN1991
559	.	18JAN1991	WhiteSale	18JAN1991
560	.	25JAN1991	WhiteSale	25JAN1991
561	.	03JAN1992	WhiteSale	03JAN1992
562	.	10JAN1992	WhiteSale	10JAN1992
563	.	17JAN1992	WhiteSale	17JAN1992
564	.	24JAN1992	WhiteSale	24JAN1992
565	.	31JAN1992	WhiteSale	31JAN1992

The following output shows the DATEKEYDATA OUT= data set definitions for the WhiteSale datekey:

Output 18.3 *Datekey Definitions Data Set Output*

The SAS System

Obs	_NAME_	_CLASS_	_KEYNAME_	_STARTDATE_	_PULSE_	_DUR_AFTER_	_RULE_
1	JANUARY	DATEKEY	JANUARY	.	MONTH	0	OR
2	Years1991_1992	DATEKEY	.	01JAN1991	YEAR	1	OR
3	WhiteSale	DATEKEY	JANUARY	.	.	0	AND
4	WhiteSale	DATEKEY	FRIDAY	.	.	0	AND
5	WhiteSale	DATEKEY	YEARS1991_1992	.	.	0	AND

Example 2: Using User-Defined SAS Datekey Keywords Directly in Other SAS Procedures

Features:

PROC DATEKEYS statements
- DATEKEYDEF
- DATEKEYKEY
- DATEKEYDATA

System option
- EVENTDS=

Other Procedures
- HPFDIAGNOSE

Details

If a procedure supports an EVENT statement, then you can use either data set that is shown in "Example 1: Methods for Constructing a Datekeys Definition Data Set" on page 761 without using PROC HPFEVENTS. PROC HPFEVENTS enables you to use a user-defined datekey. However, when the user-defined datekey is specified as an event, the event is created automatically, provided that the user-defined datekey definition data set has been specified using the EVENTDS= system option. This example uses the data set from "Example 1: Methods for Constructing a Datekeys Definition Data Set" on page 761 and the EVENT statement in PROC HPFDIAGNOSE.

The output from PROC HPFDIAGNOSE shows that a model that included the WhiteSale event was selected. The event was a poor fit, but REQUIRED=YES was specified. REQUIRED=YES specifies that the events be included in the model as long as the model does not fail to be diagnosed.

Program

```
proc datekeys;

   datekeydef Years1991_1992='01JAN1991'd / pulse=year
after=(duration=1);

   datekeykey JANUARY / pulse=month;

   datekeydef WhiteSale=JANUARY FRIDAY Years1991_1992 / rule=and;

   datekeydata out=WhiteSaleDefinitions condense;

run;

options eventds=(WhiteSaleDefinitions);
```

```
proc hpfdiagnose data=sashelp.citiday
     print=all;

   id date interval=day;

   forecast snysecm;

   event WhiteSale / required=yes;

   arimax;

run;
```

Program Description

Begin the DATEKEYS procedure.

```
proc datekeys;
```

Define a datekey. The DATEKEYDEF statement defines a datekey. PULSE= specifies the interval to be used with the DURATION= option to determine the width of the datekey.

```
   datekeydef Years1991_1992='01JAN1991'd / pulse=year
after=(duration=1);
```

Alter or create a new datekey. The DATEKEYKEY statement alters a user-defined or predefined SAS datekey, or creates a new datekey from another datekey. PULSE= specifies the interval to be used with the DURATION= option to determine the width of the datekey.

```
   datekeykey JANUARY / pulse=month;
```

Define a datekey. The DATEKEYDEF statement defines a datekey. The RULE=AND option identifies days in January 1991 and 1992 that are Fridays.

```
   datekeydef WhiteSale=JANUARY FRIDAY Years1991_1992 / rule=and;
```

Write the datekey to an output data set. The CONDENSE option specifies that the output data set be condensed. Any variables that contain only default values are omitted from the data set.

```
   datekeydata out=WhiteSaleDefinitions condense;
```

Execute the DATEKEYS procedure.

```
run;
```

Set the EVENTDS= system option. The EVENTDS= system option specifies the data set that defines the event.

```
options eventds=(WhiteSaleDefinitions);
```

Begin the HPFDIAGNOSE procedure. The HPFDIAGNOSE procedure automatically diagnoses the statistical characteristics of time series and identifies appropriate models.

```
proc hpfdiagnose data=sashelp.citiday
     print=all;
```

Specify the ID statement. The ID statement names a numeric variable that identifies observations in the input and output data sets. The ID variable's values are SAS date values. In addition, the ID statement specifies the desired frequency that is associated with the time series. The INTERVAL= option specifies the frequency of the input time ID.

```
id date interval=day;
```

List the variables in the data set that you want to diagnose. The FORECAST statement lists the variables to be diagnosed in the data set that is specified by the DATA= option. The variables are dependent variables or response variables that you want to forecast in the HPFENGINE procedure.

```
forecast snysecm;
```

Name the event. The EVENT statement name identifies the events. The REQUIRED option specifies that the events be included in the model as long as the model does not fail to be diagnosed.

```
event WhiteSale / required=yes;
```

Find an appropriate ARIMAX specification. An ARIMAX model specifies trend factors, seasonal factors, and regression variables, including events. The HPFDIAGNOSE procedure performs the intermittency test first. If the series is not intermittent, an ARIMAX model is fitted to the data.

```
arimax;
```

Execute the HPFDIAGNOSE procedure.

```
run;
```

HTML Output

The following output shows the results:

Output 18.4 *Using the EVENT Statement in PROC HPFDIAGNOSE*

The SAS System

The HPFDIAGNOSE Procedure

Variable Information	
Name	SNYSECM
Label	STOCK MKT INDEX:NYSE COMPOSITE, (WSJ)
First	01JAN1988
Last	05FEB1992
Number of Observations Read	1497

Seasonal Dickey-Fuller Unit Root Test(Seasonality=7)				
Type	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean				
Single Mean				

Dickey-Fuller Unit Root Test Summary				
Variable	Seasonality	Zero Mean	Mean	Trend
SNYSECM	1	NO	NO	NO

Seasonal Dickey-Fuller Unit Root Test Summary				
Variable	Seasonality	Zero Mean	Mean	Trend
SNYSECM	7	NO	NO	

ARIMA Model Specification												
Variable	Functional Transform	Constant	p	d	q	P	D	Q	Seasonality	Model Criterion	Statistic	Status
SNYSECM	NONE	YES	0	0	4	0	0	2	7	RMSE	2.7772	OK

ARIMA Event Selection				
Event Name	Selected	d	D	Status
WHITESALE	REQUIRED	0	0	Not Improved

ARIMA Outlier Selection					
Variable	Type	Obs	Time	Chi-Square	Approx Pr > ChiSq
SNYSECM	LS	677	07NOV1989	334.86	<.0001
	LS	1138	11FEB1991	183.43	<.0001

ARIMA Model Specification After Adjusting for Events and Outliers														
Variable	Functional Transform	Constant	p	d	q	P	D	Q	Seasonality	Outlier	Event	Model Criterion	Statistic	Status
SNYSECM	NONE	YES	0	0	4	0	0	2	7	2	1	RMSE	2.2440	OK

Example 3: Obtaining a Calendar Variable By Using the DATEKEYS Procedure

Features:

PROC DATEKEYS statements
- DATEKEYDEF
- DATEKEYKEY
- DATEKEYDATA
- ID
- DATEKEYCALENDAR

System option
- EVENTDS=

Details

Consider the datekey definitions that are shown in "Concepts: The DATEKEYS Procedure" on page 728. The DATEKEYS procedure can be used to create a calendar variable that indicates the active periods of the datekey definitions that are defined in the data set MyHolidays.

Program

```
options eventds=(nodefaults);

data Year2010;
   do date='01JAN2010'd to '31DEC2010'd;
      output;
   end;
   format date date.;
run;

proc datekeys;

   datekeydef SuperBowl=
                '15JAN1967'd '14JAN1968'd '12JAN1969'd '11JAN1970'd
    '17JAN1971'd '16JAN1972'd '14JAN1973'd '13JAN1974'd '12JAN1975'd
    '18JAN1976'd '09JAN1977'd '15JAN1978'd '21JAN1979'd '20JAN1980'd
    '25JAN1981'd '24JAN1982'd '30JAN1983'd '22JAN1984'd '20JAN1985'd
    '26JAN1986'd '25JAN1987'd '31JAN1988'd '22JAN1989'd '28JAN1990'd
    '27JAN1991'd '26JAN1992'd '31JAN1993'd '30JAN1994'd '29JAN1995'd
    '28JAN1996'd '26JAN1997'd '25JAN1998'd '31JAN1999'd '30JAN2000'd
    '28JAN2001'd '03FEB2002'd '26JAN2003'd '01FEB2004'd '06FEB2005'd
    '05FEB2006'd '04FEB2007'd '03FEB2008'd '01FEB2009'd '07FEB2010'd
    '06FEB2011'd '05FEB2012'd '03FEB2013'd '02FEB2014'd
                         / pulse=day;
```

```
   datekeydef GoodFriday=Easter / shift=-2 pulse=day;
   datekeykey EasterMonday=Easter / shift=1 pulse=day;
   datekeydata out=MyHolidays condense;
run;
options eventds=(MyHolidays);
proc datekeys data=Year2010;
   id date interval=day;
   datekeycalendar out=MyHolidaysIn2010;
run;
proc print data=MyHolidaysIn2010(where=(month(date)=2));
run;
proc print data=MyHolidaysIn2010(where=(month(date)=4));
run;
```

Program Description

Set the EVENTDS= system option. The EVENTDS= system option specifies the data set that defines the event. The NODEFAULTS option specifies not to use default event definitions. The only events that are used are specified by the event-data-set list.

```
options eventds=(nodefaults);
```

Create a SAS data set. Create the Year2010 data set, which contains a series of dates.

```
data Year2010;
   do date='01JAN2010'd to '31DEC2010'd;
      output;
   end;
   format date date.;
run;
```

Begin the DATEKEYS procedure.

```
proc datekeys;
```

Define a datekey. The DATEKEYDEF statement defines a datekey. PULSE= specifies the interval to be used with the DURATION= option to determine the width of the datekey.

```
   datekeydef SuperBowl=
                '15JAN1967'd '14JAN1968'd '12JAN1969'd '11JAN1970'd
    '17JAN1971'd '16JAN1972'd '14JAN1973'd '13JAN1974'd '12JAN1975'd
    '18JAN1976'd '09JAN1977'd '15JAN1978'd '21JAN1979'd '20JAN1980'd
    '25JAN1981'd '24JAN1982'd '30JAN1983'd '22JAN1984'd '20JAN1985'd
    '26JAN1986'd '25JAN1987'd '31JAN1988'd '22JAN1989'd '28JAN1990'd
    '27JAN1991'd '26JAN1992'd '31JAN1993'd '30JAN1994'd '29JAN1995'd
    '28JAN1996'd '26JAN1997'd '25JAN1998'd '31JAN1999'd '30JAN2000'd
    '28JAN2001'd '03FEB2002'd '26JAN2003'd '01FEB2004'd '06FEB2005'd
    '05FEB2006'd '04FEB2007'd '03FEB2008'd '01FEB2009'd '07FEB2010'd
```

```
'06FEB2011'd '05FEB2012'd '03FEB2013'd '02FEB2014'd
                    / pulse=day;
```

Define a datekey. The DATEKEYDEF statement defines a datekey named GoodFriday and makes it equal to the datekey timing value named Easter. When you specify the PULSE= option, DURATION= values are set to zero. SHIFT= specifies the number of pulses to shift the timing value. When the SHIFT= option is used, all timing values are shifted.

```
datekeydef GoodFriday=Easter / shift=-2 pulse=day;
```

Alter or create a new datekey. The value of the DATEKEYKEY statement with the datekey name EasterMonday is equal to the datekey named Easter. When Easter is treated as a datekey timing value, only the timing value definition is used, and qualifiers (such as SHIFT or PULSE) are not part of the definition. When Easter is treated as a datekey, the qualifiers that you select (such as SHIFT and PULSE) are part of the new definition. When you specify the PULSE= option, DURATION= values are set to zero. SHIFT= specifies the number of pulses to shift the timing value. When the SHIFT= option is used, all timing values are shifted.

```
datekeykey EasterMonday=Easter / shift=1 pulse=day;
```

Write the datekey to an output data set. The DATEKEYDATA statement writes datekeys to an output data set named MyHolidays. The CONDENSE option specifies that the output data set be condensed. Any variables that contain only default values are omitted from the data set.

```
datekeydata out=MyHolidays condense;
```

Execute the DATEKEYS procedure.

```
run;
```

Set the EVENTSDS= system option. The EVENTSDS system option specifies the data set that defines the event.

```
options eventds=(MyHolidays);
```

Begin the DATEKEYS procedure. The DATA= option names the data set that contains the variables that are used in the ID statement.

```
proc datekeys data=Year2010;
```

Specify the time ID variable. The ID statement names a numeric variable that identifies observations in the data set. If you use the ID statement, then the INTERVAL= option must be used. In this case, INTERVAL= day.

```
id date interval=day;
```

Create a data set that contains variables that indicate the active time periods for datekeys. The DATEKEYCALENDAR OUT= statement specifies the data set that is created, and contains calendar variables that are based on the information that is specified in the ID statement. The DATEKEYCALENDAR OUT= data set contains calendar variables that identify the holidays that are defined in the MyHolidays data set. Values for the month in which of February 2010 are shown Output 18.125 on page 774.Values for the month in which of April 2010 are shown Output 18.126 on page 775. Only the active and inactive periods that correspond to the input time ID are contained in the DATEKEYCALENDAR OUT= data set MyHolidaysIn2010. Because the input time ID has a daily frequency and spans the year 2010, the results are calendar variables for the year 2010.

```
   datekeycalendar out=MyHolidaysIn2010;
run;
```

Write the output for the MyHolidaysIn2010 data set for February. The results are shown in Output 18.125 on page 774.

```
proc print data=MyHolidaysIn2010(where=(month(date)=2));
```

Execute the DATEKEYS procedure.

```
run;
```

Write the output for the MyHolidaysIn2010 data set for April. The results are shown in Output 18.126 on page 775.

```
proc print data=MyHolidaysIn2010(where=(month(date)=4));
run;
```

HTML Output

Output 18.5 *Holiday Calendar from the Daily 2010 Time ID for February*

The SAS System

Obs	date	SuperBowl	GoodFriday	EasterMonday
32	01FEB2010	0	0	0
33	02FEB2010	0	0	0
34	03FEB2010	0	0	0
35	04FEB2010	0	0	0
36	05FEB2010	0	0	0
37	06FEB2010	0	0	0
38	07FEB2010	1	0	0
39	08FEB2010	0	0	0
40	09FEB2010	0	0	0
41	10FEB2010	0	0	0
42	11FEB2010	0	0	0
43	12FEB2010	0	0	0
44	13FEB2010	0	0	0
45	14FEB2010	0	0	0
46	15FEB2010	0	0	0
47	16FEB2010	0	0	0
48	17FEB2010	0	0	0
49	18FEB2010	0	0	0
50	19FEB2010	0	0	0
51	20FEB2010	0	0	0
52	21FEB2010	0	0	0
53	22FEB2010	0	0	0
54	23FEB2010	0	0	0
55	24FEB2010	0	0	0
56	25FEB2010	0	0	0
57	26FEB2010	0	0	0
58	27FEB2010	0	0	0
59	28FEB2010	0	0	0

Output 18.6 *Holiday Calendar from the Daily 2010 Time ID for April*

The SAS System

Obs	date	SuperBowl	GoodFriday	EasterMonday
91	01APR2010	0	0	0
92	02APR2010	0	1	0
93	03APR2010	0	0	0
94	04APR2010	0	0	0
95	05APR2010	0	0	1
96	06APR2010	0	0	0
97	07APR2010	0	0	0
98	08APR2010	0	0	0
99	09APR2010	0	0	0
100	10APR2010	0	0	0
101	11APR2010	0	0	0
102	12APR2010	0	0	0
103	13APR2010	0	0	0
104	14APR2010	0	0	0
105	15APR2010	0	0	0
106	16APR2010	0	0	0
107	17APR2010	0	0	0
108	18APR2010	0	0	0
109	19APR2010	0	0	0
110	20APR2010	0	0	0
111	21APR2010	0	0	0
112	22APR2010	0	0	0
113	23APR2010	0	0	0
114	24APR2010	0	0	0
115	25APR2010	0	0	0
116	26APR2010	0	0	0
117	27APR2010	0	0	0
118	28APR2010	0	0	0
119	29APR2010	0	0	0
120	30APR2010	0	0	0

Example 4: Filtering Data Sets By Using the DATEKEYDSOPT Statement

Features:

PROC DATEKEYS statements
- DATEKEYKEY
- DATEKEYDEF
- DATEKEYDATA
- ID
- DATEKEYDSOPT
- DATEKEYCALENDAR

System option
- EVENTDS=

Details

The DATEKEYS procedure can be used to filter input data sets and create data sets that contain only datekey data that is associated with a specified locale. The DATEKEYDSOPT statement applies to the data sets that are specified in the DATEKEYDATA, DATEKEYPERIODS, and DATEKEYCALENDAR statements.

This example creates the datekey definitions for the following English Canadian holidays: Canada, CanadaObserved, and Boxing. It also creates an English U.S. datekey definition for USINDEPENDENCE. The definition for NewYearsEve does not have a specified locale.

Program

```
options eventds=(nodefaults);

data December2010;
   do date='01DEC2010'd to '31DEC2010'd;
      output;
   end;
   format date date.;
run;

proc datekeys;

   datekeykey Canada / locale=en_CA;
   datekeykey CanadaObserved / locale=en_CA;
   datekeykey Boxing / locale='en_CA';
   datekeykey USINDEPENDENCE / locale=en_US;

   datekeydef NewYearsEve=NEWYEAR / shift=-1 pulse=day;
```

```
   datekeydata out=MyHolidays condense;
run;
options eventds=(MyHolidays);
proc datekeys data=December2010;
   id date interval=day;
  datekeydsopt locale=en_CA;
   datekeycalendar out=AllCAHolidaysInDecember2010;
run;
proc datekeys data=December2010;
   id date interval=day;
   datekeydsopt locale=(ONLY)en_CA;
   datekeycalendar out=OnlyCAHolidaysInDecember2010;
run;
proc print data=MyHolidays;
run;
proc print data=AllCAHolidaysInDecember2010;
run;
proc print data=OnlyCAHolidaysInDecember2010;
run;
```

Program Description

Set the EVENTDS= system option. The EVENTDS= system option specifies the data set that defines the event. The NODEFAULTS option specifies not to use default event definitions. The only events that are used are specified by the event-data-set list.

```
options eventds=(nodefaults);
```

Create a SAS data set. Create the December2010 data set, which contains a series of dates:

```
data December2010;
   do date='01DEC2010'd to '31DEC2010'd;
      output;
   end;
   format date date.;
run;
```

Begin the DATEKEYS procedure.

```
proc datekeys;
```

Create a new datekey. The DATEKEYKEY statement creates a new datekey. The LOCALE= option specifies a locale that is associated with the datekey. The locale should be a POSIX locale value.

```
   datekeykey Canada / locale=en_CA;
```

```
datekeykey CanadaObserved / locale=en_CA;
datekeykey Boxing / locale='en_CA';
datekeykey USINDEPENDENCE / locale=en_US;
```

Define a datekey. The DATEKEYDEF statement identifies a datekey. The SHIFT= option specifies the number of pulses to shift the timing value 6. When this option is used, all timing values in the list (including those that are generated by date keywords) are shifted. The PULSE= option specifies the interval to be used.

```
datekeydef NewYearsEve=NEWYEAR / shift=-1 pulse=day;
```

Write the datekey to an output data set. The DATEKEYDATA statement creates an output data set. The CONDENSE option specifies that the output data set be condensed. Any variables that contain only default values are omitted from the data set.

```
datekeydata out=MyHolidays condense;
```

Execute the DATEKEYS procedure.

```
run;
```

Set the EVENTDS= system option. The EVENTDS= system option specifies the data set that defines the event.

```
options eventds=(MyHolidays);
```

Begin the DATEKEYS procedure. The DATEKEYS procedure creates datekeys that are associated with time computations. The DATA= option contains the variables that are used in the ID statement.

```
proc datekeys data=December2010;
```

Specify the ID statement. The ID statement names a numeric variable that identifies observations in the input and output data sets. The ID variable's values are SAS date values. In addition, the ID statement specifies the desired frequency that is associated with the time series.

```
id date interval=day;
```

Create a data set for a specific locale. The DATEKEYDSOPT statement limits the processing of data sets to a specified locale. When you use this statement, only the datekey definitions with a locale value of en_CA, and datekey definitions with no specified locale, are used to create the AllCAHolidaysInDecember2010 data set.

```
datekeydsopt locale=en_CA;
```

Create a data set that contains variables that indicate the active time periods for datekeys. The DATEKEYCALENDAR statement writes variables that indicate the active time periods for datekeys. The OUT= option is the data set that is created, and contains calendar variables based on the information that is specified in the ID statement.

```
datekeycalendar out=AllCAHolidaysInDecember2010;
```

Execute the DATEKEYS procedure.

```
run;
```

Begin the DATEKEYS procedure. The DATA= option contains the variables that are used in the ID statement.

```
proc datekeys data=December2010;
```

Specify the ID statement. The ID statement names a numeric variable that identifies observations in the input and output data sets. The ID variable's values are SAS date values. In addition, the ID statement specifies the desired frequency that is associated with the time series.

```
id date interval=day;
```

Create a data set for a specific locale. The DATEKEYDSOPT statement creates a data set that contains only datekey data that is associated with a specified locale. If you specify LOCALE=(ONLY)en_CA, then only the specified locale is processed for both input and output data sets. The locale should be a POSIX locale value.

```
datekeydsopt locale=(ONLY)en_CA;
```

Create a data set that contains variables that indicate the active time periods for datekeys. The DATEKEYCALENDAR statement writes variables that indicate the active time periods for datekeys. The OUT= option specifies the data set that is created, and contains calendar variables based on the information that is specified in the ID statement.

```
datekeycalendar out=OnlyCAHolidaysInDecember2010;
```

Execute the DATEKEYS procedure.

```
run;
```

Write the MyHolidays data set. For results, see Output 18.127 on page 780.

```
proc print data=MyHolidays;
run;
```

Write the AllCAHolidaysInDecember2010 data set. For results, see Output 18.128 on page 781.

```
proc print data=AllCAHolidaysInDecember2010;
run;
```

Write the OnlyCAHolidaysInDecember2010 data set. For results, see Output 18.129 on page 782.

```
proc print data=OnlyCAHolidaysInDecember2010;
run;
```

HTML Output

Output 18.7 *All Holiday Definitions That Are Specified in MyHolidays*

The SAS System

Obs	_LOCALE_	_NAME_	_CLASS_	_KEYNAME_	_PULSE_	_SHIFT_
1	EN_CA	Canada	DATEKEY	CANADA	DAY	0
2	EN_CA	CanadaObserved	DATEKEY	CANADAOBSERVED	DAY	0
3	en_CA	Boxing	DATEKEY	BOXING	DAY	0
4	EN_US	USINDEPENDENCE	DATEKEY	USINDEPENDENCE	DAY	0
5	.	NewYearsEve	DATEKEY	NEWYEAR	DAY	-1

Output 18.8 *Holiday Calendar for All Canadian Holidays in December 2010*

The SAS System

Obs	date	Canada	CanadaObserved	Boxing	NewYearsEve
1	01DEC2010	0	0	0	0
2	02DEC2010	0	0	0	0
3	03DEC2010	0	0	0	0
4	04DEC2010	0	0	0	0
5	05DEC2010	0	0	0	0
6	06DEC2010	0	0	0	0
7	07DEC2010	0	0	0	0
8	08DEC2010	0	0	0	0
9	09DEC2010	0	0	0	0
10	10DEC2010	0	0	0	0
11	11DEC2010	0	0	0	0
12	12DEC2010	0	0	0	0
13	13DEC2010	0	0	0	0
14	14DEC2010	0	0	0	0
15	15DEC2010	0	0	0	0
16	16DEC2010	0	0	0	0
17	17DEC2010	0	0	0	0
18	18DEC2010	0	0	0	0
19	19DEC2010	0	0	0	0
20	20DEC2010	0	0	0	0
21	21DEC2010	0	0	0	0
22	22DEC2010	0	0	0	0
23	23DEC2010	0	0	0	0
24	24DEC2010	0	0	0	0
25	25DEC2010	0	0	0	0
26	26DEC2010	0	0	1	0
27	27DEC2010	0	0	0	0
28	28DEC2010	0	0	0	0
29	29DEC2010	0	0	0	0
30	30DEC2010	0	0	0	0
31	31DEC2010	0	0	0	1

Output 18.9 *Holiday Calendar for Only Canadian Holidays in December 2010*

The SAS System

Obs	date	Canada	CanadaObserved	Boxing
1	01DEC2010	0	0	0
2	02DEC2010	0	0	0
3	03DEC2010	0	0	0
4	04DEC2010	0	0	0
5	05DEC2010	0	0	0
6	06DEC2010	0	0	0
7	07DEC2010	0	0	0
8	08DEC2010	0	0	0
9	09DEC2010	0	0	0
10	10DEC2010	0	0	0
11	11DEC2010	0	0	0
12	12DEC2010	0	0	0
13	13DEC2010	0	0	0
14	14DEC2010	0	0	0
15	15DEC2010	0	0	0
16	16DEC2010	0	0	0
17	17DEC2010	0	0	0
18	18DEC2010	0	0	0
19	19DEC2010	0	0	0
20	20DEC2010	0	0	0
21	21DEC2010	0	0	0
22	22DEC2010	0	0	0
23	23DEC2010	0	0	0
24	24DEC2010	0	0	0
25	25DEC2010	0	0	0
26	26DEC2010	0	0	1
27	27DEC2010	0	0	0
28	28DEC2010	0	0	0
29	29DEC2010	0	0	0
30	30DEC2010	0	0	0
31	31DEC2010	0	0	0

References

Montes, M. J. “Calculation of the Ecclesiastical Calendar.” 2001. Available at http://www.smart.net/~mmontes/ec-cal.html.

Montes, M. J. “Algorithm for Calculating the Date of Easter in the Gregorian Calendar.” 2001. Available at http://www.smart.net/~mmontes/nature1876.html.

19

DELETE Procedure

Overview: DELETE Procedure

What Does the DELETE Procedure Do?

The DELETE procedure deletes members in a SAS library. Use PROC DELETE to do the following:

- delete either permanent or temporary SAS files

- delete loaded CAS tables from a caslib. It does not delete the original files from the data source specified by the caslib.
- delete a list of data sets with the same name and a numeric suffix, such as

```
proc delete data=x1-x3;
run;
```

- delete a member type.
- delete generation data sets using the GENNUM= option.
- delete AES-encrypted data sets when using GENNUM=ALL and ENCRYPTKEY= options.

Concepts: DELETE Procedure

Concepts: DELETE Procedure

One of the benefits of using PROC DELETE instead of the DELETE statement in the DATASETS procedure is that it does not use the in-memory directory to delete SAS data sets. As a result, the DELETE procedure is faster.

Syntax: DELETE Procedure

Tip: You can perform similar functions with the DELETE statement in the DATASETS procedure.

PROC DELETE DATA=*SAS-file(s)* <*options*>;

Statement	Task	Example
PROC DELETE	Delete SAS files from SAS libraries	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5

PROC DELETE Statement

Deletes SAS files from SAS libraries.

Syntax

PROC DELETE <LIBRARY=*libref*> DATA=*SAS-file(s)*
(<GENNUM=ALL | HIST | REVERT | *integer*>
<MEMTYPE=*member-type*>
<ENCRYPTKEY=*key-value*>
<ALTER=*alter-password*>);

Summary of Optional Arguments

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files.

ENCRYPTKEY=*key-value*
The ENCRYPTKEY= option unlocks the data sets that are protected by an AES-encrypted key value.

GENNUM=ALL | HIST | REVERT | *integer*
restricts processing for generation data sets.

LIBRARY=*libref*
specifies the SAS library that contains members to be deleted.

MEMTYPE=(*member-type(s)*)
restricts deletion to a certain type of SAS file.

Required Argument

DATA= *SAS-file(s)*
specifies one or more SAS files that you want to delete.

Note: You can also use a numbered range list. For more information, see "Data Set Name Lists" in *SAS Programmer's Guide: Essentials*. You cannot use a colon list.

TIP If you want to delete all files in a library, use the PROC DATASETS KILL option. Use `PROC DATASETS LIB=library name KILL` to delete all files including catalogs. For more information, see "KILL" on page 582.

Optional Arguments

ALTER=*alter-password*
provides the Alter password for any alter-protected SAS files.

See "Using Passwords with the DATASETS Procedure" on page 665

ENCRYPTKEY=*key-value*
The ENCRYPTKEY= option unlocks the data sets that are protected by an AES-encrypted key value. The ENCRYPTKEY= option is needed only when a data set must be opened.

See "Example 7: Using the ENCRYPTKEY= Option" on page 793

GENNUM=ALL | HIST | REVERT | *integer*
restricts processing for generation data sets. You use the option in parentheses after the name of each SAS file. The following is a list of valid values:

ALL	refers to the base version and all historical versions in a generation group.
HIST	refers to all historical versions, but excludes the base version in a generation group.
REVERT | 0	deletes the base version and changes the most current historical version, if it exists, to the base version.
integer	is a number that references a specific version from a generation group. Specifying a positive number is an absolute reference to a specific generation number that is appended to a data set's name (that is, `gennum=2` specifies MYDATA#002).

See "Understanding Generation Data Sets" in *SAS Language Reference: Concepts*

"Restricting Processing for Generation Data Sets" on page 667

Examples "Example 1: Deleting Several SAS Data Sets" on page 790

"Example 2: Deleting the Base Version and All Historical Versions" on page 791

"Example 3: Deleting the Base Version and Renaming the Youngest Historical Version to the Base Version" on page 791

"Example 4: Deleting a Version with an Absolute Number" on page 792

"Example 5: Deleting All Historical Versions and Leaving the Base Version" on page 792

LIBRARY=*libref*
specifies the SAS library that contains members to be deleted.

Alias LIB=

MEMTYPE=(*member-type(s)*)
restricts deleting one or more member types. For example, if you have a data set and a catalog named MyFile in the MyLib library and you want to delete only the catalog, then use the MEMTYPE= option.

```
proc delete lib=MyLib data=MyFile (memtype=catalog);
run;
```

ACCESS
access descriptor files (created by SAS/ACCESS software)

CATALOG
SAS catalogs

DATA
SAS data files

FDB
financial database

MDDB
multidimensional database

PROGRAM
stored compiled SAS programs

VIEW
SAS views

Aliases MTYPE=

MT=

Default DATA

Example "Example 6: Using the MEMTYPE= Option" on page 793

Details

Working with Generation Groups

When you are working with generation groups, you can use PROC DELETE to delete the following versions:

- delete the base version and all historical versions. See "Example 2: Deleting the Base Version and All Historical Versions" on page 791.
- delete the base version and rename the youngest historical version to the base version. See "Example 3: Deleting the Base Version and Renaming the Youngest Historical Version to the Base Version" on page 791.
- delete an absolute version. See "Example 4: Deleting a Version with an Absolute Number" on page 792.
- delete all historical versions and leave the base version. See "Example 5: Deleting All Historical Versions and Leaving the Base Version" on page 792.

Deleting Specific Member Types

With the MEMTYPE= option, you can specify the member type that you want to delete. The default for the MEMTYPE= option is DATA. For more information, see "MEMTYPE=(*member-type(s)*)" on page 789.

Working with Integrity Constraints

You cannot use the DELETE procedure to delete a data file that has a foreign key integrity constraint or a primary key with foreign key references. For data files that have foreign keys, you must remove the foreign keys before you delete the data file. For data files that have primary keys with foreign key references, you must remove the foreign keys that reference the primary key before you delete the data file.

Examples: DELETE Procedure

Example 1: Deleting Several SAS Data Sets

Features: PROC DELETE statement options
DATA=
GENNUM=

Details

This example demonstrates the following tasks:

- deletes data sets from a library
- deletes all historical versions of each data set

Program

Delete SAS data sets named A, B, and C from a SAS library named MyLib. The GENNUM= option deletes all the historical versions for each of the data sets.

```
proc delete data=MyLib.A MyLib.B MyLib.C (gennum=all);
run;
```

Example 2: Deleting the Base Version and All Historical Versions

Features: PROC DELETE statement options
DATA=
GENNUM=

Details

This example demonstrates the following tasks:

- deletes a data set from a library
- deletes all historical versions of the data set

Program

Deletes the data set named MyLib.A and all the historical versions.

```
proc delete data=MyLib.A (gennum=all);
run;
```

Example 3: Deleting the Base Version and Renaming the Youngest Historical Version to the Base Version

Features: PROC DELETE statement options
DATA=
GENNUM=

Details

This example demonstrates the following tasks:

- deletes a data set from a library

- renames the youngest historical version

The following statement deletes the data set named MyLib.A and renames the youngest historical version.

Program

Deletes the data set named MyLib.A and renames the youngest historical version.

```
proc delete data=MyLib.A(gennum=revert1);
run;
```

Example 4: Deleting a Version with an Absolute Number

Features: PROC DELETE statement options
DATA=
GENNUM=

Details

This example deletes the first historical version of the data set.

Program

GENNUM= option deletes the first historical version of the data set names MyLib.A. You use GENNUM=*integer* to select the historical version that you want to delete.

```
proc delete data=MyLib.A(gennum=1);
run;
```

Example 5: Deleting All Historical Versions and Leaving the Base Version

Features: PROC DELETE statement options
DATA=
GENNUM=

Details

This example deletes all historical versions except the base version of a data set.

Program

Use the GENNUM=HIST option to delete all historical versions and retain the base version of the data set MyLib.A.

```
proc delete data=MyLib.A(gennum=hist);
run;
```

Example 6: Using the MEMTYPE= Option

Features: PROC DELETE statement options
DATA=
MEMTYPE=

Details

This example deletes the CATALOG file in a specific SAS library.

Program

The MEMTYPE= option names the type of file to delete in a SAS library. If you have other member types named MyFile in the MyLib library, they will not be deleted.

```
proc delete lib=MyLib data=MyFile (memtype=catalog);
run;
```

Example 7: Using the ENCRYPTKEY= Option

Features: PROC DELETE statement options
DATA=

ENCRYPTKEY=
GENNUM=

Details

This example demonstrates the following tasks:

- unlocks an AES encrypted data set
- deletes all historical versions and the base AES data set named MyLib.A.

Program

Deletes the base AES data set named MyLib.A and all historical versions. The ENCRYPTKEY= option must be used if the data set is AES encrypted.

```
proc delete data=MyLib.A (gennum=ALL encryptkey=key-value);
run;
```

Example 8: Using the ALTER= Option

Features:

PROC DELETE statement options
ALTER=
DATA=

Details

This example deletes a password protected data set.

Program

Deletes a password protected data set named MyLib.A. If the data set is password protected, you must supply the password.

```
proc delete data=MyLib.A (alter=alter-password);
run;
```

Example 9: Using the DATA= List Feature

Features: PROC DELETE statement options
DATA=

Program

Deletes multiple data sets named X1, X2, X3, X4, and X5. To use the list feature, the data sets must have the same name and end with a numeric suffix. If a LIBRARY= option is not specified, the data sets are deleted from the Work library.

```
proc delete data=X1-X5;
run;
```

Example 10: Using the LIBRARY= Option

Features: PROC DELETE statement options
DATA=
LIB=

Details

The following statement deletes a data set from a specific SAS library.

Program

Deletes the A data set that is in the specified SAS library named MyLib. The alias for the LIBRARY= option is LIB=.

```
proc delete lib=MyLib data=A;
run;
```

Example 11: Using the LIBRARY= Option and List Feature

Features: PROC DELETE statement options
DATA=
LIB=

Details

This example deletes data sets X1, X2, X3, X4, and X5 in the specified SAS library named MyLib. The alias for the LIBRARY= option is LIB=.

Note: The data sets must end with a numeric suffix.

Program

Deletes data sets X1, X2, X3, X4, and X5 from the specified SAS library named MyLib. When using the list feature, all the data sets must have the same name and end with a numeric suffix. The alias for the LIBRARY= option is LIB=.

```
proc delete lib=MyLib data=X1-X5;
run;
```

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DISPLAY Procedure

Overview: DISPLAY Procedure

What Does the DISPLAY Procedure Do?

The DISPLAY procedure executes SAS/AF applications. These applications consist of a variety of entries that are stored in a SAS catalog and that have been built with the BUILD procedure in SAS/AF software. For complete documentation on building SAS/AF applications, see *Guide to SAS/AF Applications Development*.

Syntax: DISPLAY Procedure

PROC DISPLAY CATALOG=*libref.catalog.entry.type* <BATCH>;

PROC DISPLAY Statement

Executes a SAS/AF application.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Example: "Example: Executing a SAS/AF Application" on page 799

Syntax

PROC DISPLAY CATALOG=*libref.catalog.entry.type* <BATCH>;

Required Argument

CATALOG=*libref.catalog.entry.type*
specifies a four-level name for the catalog entry.

libref
specifies the SAS library where the catalog is stored.

catalog
specifies the name of the catalog.

entry
specifies the name of the entry.

type
specifies the entry's type, which is one of the following. For details, see the description of catalog entry types in the BUILD procedure in online Help.

- CBT
- FRAME
- HELP
- MENU
- PROGRAM
- SCL

Optional Argument

BATCH
runs PROGRAM and SCL entries in batch mode. If a PROGRAM entry contains a display, then it will not run, and you will receive the following error message:

```
ERROR: Cannot allocate window.
```

Restriction PROC DISPLAY cannot pass arguments to a PROGRAM, a FRAME, or an SCL entry.

Usage: DISPLAY Procedure

Using the DISPLAY Procedure

You can use the DISPLAY procedure to execute an application that runs in NODMS batch mode. Be aware that any SAS programming statements that you submit with the DISPLAY procedure through the SUBMIT block in SCL are not submitted for processing until PROC DISPLAY has executed.

If you use the SAS windowing environment, you can use the AF command to execute an application. SUBMIT blocks execute immediately when you use the AF command. You can use the AFA command to execute multiple applications concurrently.

Example: Executing a SAS/AF Application

Features: PROC DISPLAY statement
CATALOG= argument

Details

Suppose that your company has developed a SAS/AF application that compiles statistics from an invoice database. Further, suppose that this application is stored in the SASUSER library, as a FRAME entry in a catalog named INVOICES.WIDGETS. You can execute this application using the following SAS code.

```
proc display catalog=sasuser.invoices.widgets.frame;
run;
```

21

DS2 Procedure

Overview: DS2 Procedure

What Does the DS2 Procedure Do?

The DS2 procedure enables you to submit DS2 language statements from a Base SAS session. The DS2 procedure is supported in both SAS 9.4 and SAS Viya.

DS2 is a SAS programming language that is appropriate for advanced data manipulation. DS2 is included with Base SAS software and SAS Viya software and shares core features with the SAS DATA step. DS2 exceeds the DATA step by adding variable scoping, user-defined methods, ANSI SQL data types, and user-defined packages. The DS2 SET statement accepts embedded FedSQL syntax, and the runtime-generated queries can exchange data interactively between DS2 and any supported database. This allows SQL preprocessing of input tables, which effectively combines the power of the two languages. For more information about the DS2 language, see *SAS DS2 Language Reference* and *SAS DS2 Programmer's Guide*.

Using the DS2 procedure, you can submit DS2 language statements to SAS and third-party data sources that are accessed with SAS and SAS/ACCESS library engines. If you have SAS Cloud Analytic Services (CAS) configured, you can also submit DS2 language statements to the CAS server.

To execute DS2 jobs in a SAS library, specify the PROC DS2 statement followed by DS2 language statements. Qualify table names in your DS2 language statements with a libref. If you do not specify a libref, the request is executed in the SAS Work library.

To execute DS2 jobs on the CAS server, specify the SESSREF= (or SESSUUID=) option and a CAS session name in the procedure statement. Then, either create tables in the CAS session, load tables from external data sources into the CAS session, or qualify table names in your DS2 language statements with caslibs. A caslib enables you to dynamically load external data into your CAS session for processing.

Note: Do not use a CAS engine libref with PROC DS2. When SESSREF= (or SESSUUID=) are specified, PROC DS2 makes a direct connection to the CAS server. The procedure does not need the CAS engine. The procedure silently passes requests to the DS2.runDS2 action and the action executes your DS2 program on the CAS server.

Concepts: DS2 Procedure

Benefits of the DS2 Language

DS2 programs are written for applications that

- require the precision that results from using the additional data types that are available with the language
- benefit from using the new expressions or write methods or packages available in the DS2 syntax
- need to execute the SAS FedSQL language from within the DS2 program
- execute outside of a SAS session (for example, on SAS Federation Server or the CAS server)
- take advantage of threaded processing in products such as SAS Enterprise Miner and the CAS server.

Data Source Support

When submitting DS2 statements to a SAS library, the DS2 procedure can read and write from the following data sources. Unless noted otherwise, availability starts with SAS 9.4 and SAS Viya 3.3. See SAS/ACCESS documentation for supported operating environments.

Table 21.1 *Data Sources for Which DS2 Supports SAS Library Access*

Data Source	SAS V9	SAS Viya 3.5	Release Notes
Amazon Redshift	*	*	Added in SAS 9.4M5
Aster	*	*	Added in SAS 9.4M1
DB2	*	*	DB2
Greenplum	*	*	

Data Source	SAS V9	SAS Viya 3.5	Release Notes
Google BigQuery	*	*	Added in August 2019, on SAS 9.4M6 and SAS Viya 3.4
Hadoop (Hive)	*	*	Added in SAS 9.4M2
HAWQ	*	*	Added in SAS 9.4M3
Impala	*	*	Added in SAS 9.4M3
databases that are compliant with JDBC	*	*	Added in February 2019, on SAS Viya 3.4 and SAS 9.4M6
Microsoft SQL Server	*	*	Added in SAS 9.4M5
MongoDB	*	*	Read-only support available on SAS 9.4M6, starting in April 2019. Write support available starting in November 2019. Read-and-write support available in SAS Viya 3.5.
MySQL	*	*	
Netezza	*	*	
ODBC-compliant databases	*	*	
Oracle	*	*	
PostgreSQL	*	*	Added in SAS 9.4M2
Salesforce	*	*	Read-only support available on SAS 9.4M6, starting in April 2019. Write support available starting in November 2019.

Data Source	SAS V9	SAS Viya 3.5	Release Notes
			Read-and-write support available in SAS Viya 3.5.
SAP	*	*	Read-only
SAP HANA	*	*	Added in SAS 9.4M1
SAP IQ	*	*	
SAS data sets	*	*	Added in SAS Viya 3.1
SAS Scalable Performance Data (SPD) Engine data sets	*	*	
SAS Scalable Performance Data (SPD) Server tables	*	*	Added in SAS 9.4M4 SPD Server SAS Viya access is client only
Snowflake	*	*	Added in August 2019, on SAS 9.4M6 and SAS Viya 3.4
Spark	*		Spark execution of PROC DS2 with the SAS Code Accelerator for Hadoop can be enabled by setting the HADOOPPLATFORM =SPARK system option starting in SAS 9.4M6. SAS/ACCESS to Spark is available on Linux only in SAS 9.4M7.
Teradata	*	*	Teradata
Vertica	*	*	Added in SAS 9.4M5
Yellowbrick	*		SAS/ACCESS to Yellowbrick is limited

Data Source	SAS V9	SAS Viya 3.5	Release Notes
			availability for SAS 9.4 only, starting in SAS 9.4M7.

When submitting DS2 statements to the CAS server, the procedure reads data from files and in-memory tables and creates CAS session tables. A caslib uses a SAS Data Connector (or SAS Data Connector Accelerator) to access data from a corresponding data source for processing in CAS. For information about available SAS Data Connectors, see *SAS Cloud Analytic Services: User's Guide*. DS2 output tables in CAS are in-memory tables. You must use other actions to persist data to caslib data sources.

For information about how to connect to a data source with PROC DS2, see "Data Source Connection" on page 814.

Syntax: DS2 Procedure

PROC DS2 <*connection-option*><*processing-options*>;

...DS2 language statements

RUN;

RUN CANCEL;

QUIT;

Statement	Task	Example
PROC DS2	Specify that the subsequent input is DS2 language statements.	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5
RUN CANCEL	Cancel the previous DS2 language statements.	Ex. 3

PROC DS2 Statement

Specifies that the subsequent input is DS2 language statements.

Requirement: Follow the PROC DS2 statement with DS2 language statements. See *SAS DS2 Language Reference* for information about DS2 language statements.

Interactions: The DS2 procedure requires the RUN statement to submit DS2 statements. That is, SAS reads the program statements that are associated with one task until it reaches a RUN statement.

By default, the procedure processes non-existent numeric values as SAS missing values. To request that non-existent values are processed as ANSI SQL null values, specify ANSIMODE.

When creating tables with PROC DS2, note that by default, you cannot overwrite an existing table. To specify that an output table should be deleted before a replacement output table is created, use the OVERWRITE=YES table option. For information about the OVERWRITE= table option, see *SAS DS2 Language Reference*.

Note: As of September 2023, Microsoft Azure Active Directory (Azure AD) was renamed to Microsoft Entra ID.

Examples:

"Example 1: Introducing DS2 Code" on page 826

"Example 2: Creating a SAS Data Set" on page 828

"Example 3: Terminating the Current Step in Line Prompt Mode" on page 830

"Example 4: Routing Data to Tables Based on Values" on page 831

"Example 5: Run a DS2 Program in CAS" on page 833

Syntax

PROC DS2 <*connection-option* ><*processing-options*>;

Summary of Optional Arguments

Connection

LIBS=*libref* | (*libref1libref2 ...librefn*)
: restricts the default data source connection to the specified libref(s). All other librefs are ignored.

SESSREF=*session-name*
: specifies to run the DS2 statements in a CAS session. The CAS session is identified by its session name.

SESSUUID="*session-uuid*"
: specifies to run the DS2 statements in a CAS session. The CAS session is identified by its universally unique identifier (UUID).

General Processing

ANSIMODE
: specifies that nonexistent values in CHAR and DOUBLE columns are processed as ANSI SQL null values.

BYPARTITION=YES | NO
: determines whether the input data for the DS2 program is automatically re-partitioned when executed inside the database with in-database processing.

DS2ACCEL=NO | YES
: determines whether DS2 code is enabled for parallel processing in supported environments using the SAS In-Database Code Accelerator.

ERRORSTOP | NOERRORSTOP
: specifies whether the procedure stops executing if it encounters an error.

LABEL | NOLABEL
: specifies whether to use the column label or the column name as the column heading.

MEMSIZE=n | nM | nG
: specifies a limit for the amount of memory that is used for an underlying query (such as a SELECT statement), so that allocated memory is available to support other PROC DS2 operations.

NUMBER
: specifies to include a column named Row, which is the row (observation) number of the data as the rows are retrieved.

SCOND=WARNING | NONE | NOTE | ERROR
: specifies the level of messages that PROC DS2 displays in the SAS log for the DS2 variable declaration strict mode, which requires that every variable must be declared in the DS2 program.

STIMER
: specifies to write a subset of system performance statistics, such as time-elapsed statistics, to the SAS log.

XCODE=ERROR | WARNING | IGNORE
: controls the behavior of the SAS session when an NLS transcoding failure occurs.

Optional Arguments

ANSIMODE
specifies that nonexistent values in CHAR and DOUBLE columns are processed as ANSI SQL null values. By default, PROC DS2 processes nonexistent values in CHAR and DOUBLE columns as missing values. This is how SAS processes nonexistent values. The ANSIMODE option specifies to process nonexistent values in CHAR and DOUBLE columns as ANSI SQL null values. It is important to understand the differences, or data can be lost. For information about processing differences, see “How DS2 Processing Nulls and SAS Missing Values” in *SAS DS2 Programmer’s Guide*. All other data types use ANSI NULL semantics all of the time.

Default SAS mode

BYPARTITION=YES | NO
determines whether the input data for the DS2 program is automatically re-partitioned when executed inside the database with in-database processing.

YES
specifies that the input data is automatically re-partitioned by the first BY variable. All of the BY groups are in the same data partition and processed by the same thread. Each thread does the BY processing for the entire group of data.

NO
specifies that the input data is not re-partitioned even if there is a BY statement in the DS2 program. Each group of data resides on different data partitions and is processed by different DS2 threads. Each thread gets partial

data from a group, and each group is processed by multiple threads. The DS2 program must request the final aggregation of data.

Default YES

Restrictions BYPARTITION= is supported only for SAS libraries.

BYPARTITION= is not supported in SAS Viya.

BYPARTITION=NO is not supported in SAS In-Database Code Accelerator for Hadoop.

DS2ACCEL=NO | YES

determines whether DS2 code is enabled for parallel processing in supported environments using the SAS In-Database Code Accelerator. The SAS In-Database Code Accelerator enables you to publish a DS2 thread program to the database and execute the thread program in parallel inside the database. If you are using Hadoop or Teradata, then the DS2 data program is also published and executed inside the database.

NO

disables DS2 code from executing in supported parallel environments. The DS2 code is executed in the Base SAS session.

YES

enables DS2 code to execute in supported parallel environments.

Alias INDB=

Default The default value is determined by the DS2ACCEL= system option. The default value for the system option is NO. The SAS In-Database Code Accelerator is not automatically executed in supported parallel environments. For information about the DS2ACCEL= system option, see *SAS DS2 Language Reference*.

Restrictions DS2ACCEL= is supported for SAS libraries only.

DS2ACCEL= is not supported in SAS Viya.

DS2ACCEL= is not supported for all data sources.

Interaction The DS2ACCEL= procedure option takes precedence over the DS2ACCEL= system option.

Notes The INDB= option was added in SAS 9.4M1 and was renamed to DS2ACCEL= in SAS 9.4M2.

The DS2ACCEL= system option can be restricted by a site administrator. If the system option is restricted, then it cannot be overridden by the DS2ACCEL= procedure option.

See “Threaded Processing” and “SAS In-Database Code Accelerator” in *SAS DS2 Programmer’s Guide*

“Using the SAS In-Database Code Accelerator” in *SAS In-Database Products: User’s Guide*

ERRORSTOP | NOERRORSTOP

specifies whether the procedure stops executing if it encounters an error. In a batch or noninteractive session, ERRORSTOP instructs the procedure to stop executing the statements but to continue checking the syntax after it has encountered an error. NOERRORSTOP instructs the procedure to execute the statements and to continue checking the syntax after an error occurs.

Default NOERRORSTOP in an interactive SAS session; ERRORSTOP in a batch or noninteractive session

Tips ERRORSTOP has an effect only when SAS is running in a batch or noninteractive execution mode.

NOERRORSTOP is useful if you want a batch job to continue executing procedure statements after an error is encountered.

LABEL | NOLABEL

specifies whether to use the column label or the column name as the column heading.

Default LABEL

Interactions If a column does not have a label, the procedure uses the column's name as the column heading.

A column alias overwrites the label or column name as the column heading.

LIBS=*libref* | (*libref1libref2 ...librefn*)

restricts the default data source connection to the specified libref(s). All other librefs are ignored. When you specify a list of librefs, the order of the list defines the library order.

Alias LIBNAMES=

Restriction LIBS= is supported only for SAS libraries.

Interactions If both LIBS= and SESSREF= (or SESSUID=) are specified in the procedure statement, SESSREF= is applied and the other option is ignored.

If LIBS= is specified multiple times, the last one on the procedure statement is applied.

Note LIBS= is available starting in SAS 9.4M3

Tips LIBS= is useful when multiple LIBNAME statements are defined in a SAS session, to limit the scope of the DS2 program to only the LIBNAME statement(s) to which the program applies. It can also avoid duplicate catalog errors when connecting to data sources that support native catalogs, such as Netezza.

If you are curious about how LIBS= affects library assignments, set the MSGLEVEL=i system option before running a PROC DS2 request with LIBS=. The option produces Include and Ignore

messages for each of the LIBNAME statements that are processed in the procedure request.

See "Data Source Connection" on page 814

"About the LIBS= Procedure Option" on page 815

Example The following PROC DS2 procedure statement specifies to create a data source connection that uses only librefs MyLib3 and MyLib4.

```
proc ds2 libs=(mylib3 mylib4);
```

MEMSIZE=n | nM | nG

specifies a limit for the amount of memory that is used for an underlying query (such as a SELECT statement), so that allocated memory is available to support other PROC DS2 operations. Specify the memory limit in multiples of 1 (bytes); 1,048,576 (megabytes); or 1,073,741,824 (gigabytes). For example, the value 23M specifies 24,117,248 bytes of memory. The value 16G specifies 17,179,869,184 bytes of memory.

Default The procedure optimizes the setting based on the amount of memory on the host.

Note On the CAS server, MEMSIZE= specifies the memory for a single worker.

Tip Generally, specifying a memory limit is not necessary unless DS2 reports a memory problem error.

NUMBER

specifies to include a column named Row, which is the row (observation) number of the data as the rows are retrieved.

Default No row numbers.

SCOND=WARNING | NONE | NOTE | ERROR

specifies the level of messages that PROC DS2 displays in the SAS log for the DS2 variable declaration strict mode, which requires that every variable must be declared in the DS2 program. For more information about the DS2 variable declaration strict mode, see the *SAS DS2 Language Reference*.

WARNING

writes warning messages to the SAS log.

NONE

no messages are written to the SAS log.

NOTE

writes notes to the SAS log.

ERROR

writes error messages to the SAS log.

Default The default is determined by the DS2SCOND= system option. The default for DS2SCOND= is WARNING. For information about the DS2SCOND= system option, see *SAS DS2 Language Reference*.

Interaction Specifying the SCOND= option in the PROC DS2 statement takes precedence over the DS2SCOND= system option.

SESSREF=*session-name*
specifies to run the DS2 statements in a CAS session. The CAS session is identified by its session name.

Requirements A CAS server must be configured for your system.

The CAS session must have been previously established by using the CAS statement. If the specified CAS session does not exist, the procedure terminates.

Interactions Use SESSREF= (or SESSUUID=) to connect to the CAS session. If both options are specified, the last option in the procedure statement is applied.

If both SESSREF= and LIBS= are specified in the procedure statement, SESSREF= is applied and the other option is ignored.

Note This option is supported in SAS Viya 3.1 and later and in SAS 9.4M5 and later.

See “Connecting to the CAS Server” on page 816

“Using PROC DS2 in SAS Cloud Analytic Services” on page 817

“Example 5: Run a DS2 Program in CAS” on page 833

SESSUUID="*session-uuid*"
specifies to run the DS2 statements in a CAS session. The CAS session is identified by its universally unique identifier (UUID).

Requirements A CAS server must be configured for your system.

The CAS session must have been previously established by using the CAS statement. The CAS statement generates a UUID value. If the specified CAS session does not exist, the procedure terminates.

Interactions Use SESSUUID= (or SESSREF=) to connect to the CAS session. If both options are specified, the last option in the procedure statement is applied.

If both SESSUUID= and LIBS= are specified in the procedure statement, SESSUUID= is applied and the other option is ignored.

Note This option is supported in SAS Viya 3.1 and later and in SAS 9.4M5 and later.

See “Connecting to the CAS Server” on page 816

“Using PROC DS2 in SAS Cloud Analytic Services” on page 817

Example Here is a PROC DS2 procedure statement that specifies SESSUUID=:

```
proc ds2 sessuuid="76904741-fb09-554d-a8de-6cbce2a0e0e5";
```

The UUID value can be enclosed in single or double quotation marks.

STIMER
specifies to write a subset of system performance statistics, such as time-elapsed statistics, to the SAS log. When STIMER is in effect, the procedure writes to the SAS log a list of computer resources used for each step and the entire SAS session.

Default No performance statistics are written to the SAS log.

Interaction If the SAS system option FULLSTIMER is in effect, the complete list of computer resources is written to the SAS log.

XCODE=ERROR | WARNING | IGNORE
controls the behavior of the SAS session when an NLS transcoding failure occurs. Transcoding failures can occur during row input or output operations, or during string assignment. Transcoding is the process of converting character data from one encoding to another encoding.

ERROR
specifies that a run-time error occurs, which causes row processing to halt. An error message is written to the SAS log. This is the default behavior.

WARNING
specifies that the incompatible character is set to a substitution character. A warning message is written to the SAS log.

IGNORE
specifies that the incompatible character is set to a substitution character. No messages are written to the SAS log.

Default ERROR

Note This option was added in SAS 9.4M2.

RUN CANCEL Statement

Cancels the previous DS2 language statements.

Tip: The RUN CANCEL statement is useful if you enter a typographical error.

Example: "Example 3: Terminating the Current Step in Line Prompt Mode" on page 830

Syntax

RUN CANCEL;

Usage: DS2 Procedure

Data Source Connection

PROC DS2 can execute programs in SAS libraries (librefs) and on the CAS server. By default, PROC DS2 connects to a data source by using available librefs. You can override this default behavior by specifying CAS connection options. The DS2 procedure is not affected by the CASNAME= system option.

Understanding the Default Data Source Connection

PROC DS2 connects to a data source by using the attributes of currently assigned librefs. These librefs are defined by LIBNAME statements. Attributes include the physical location of the data, and for some data sources, access information such as network information used to access the data server, and user identification and password.

1 You first submit the LIBNAME statement for a SAS engine. For information to define a LIBNAME statement, see:

SAS data sets
SAS Global Statements: Reference

Relational DBMS data sources
SAS/ACCESS for Relational Databases: Reference

MongoDB and Salesforce
SAS/ACCESS for Nonrelational Databases: Reference

SPD Engine data sets
SAS Scalable Performance Data Engine: Reference

SPD Server tables
SAS Scalable Performance Data Server: User's Guide

2 In your DS2 program, use a two-part name in the form *libref.table-name* to refer to tables. The libref tells the program where to create or locate a table.

3 Then, submit the DS2 procedure.

This example illustrates how PROC DS2 accesses a data source by using the attributes of a previously assigned libref. The LIBNAME statement assigns the libref MyFiles, specifies the BASE engine, and then specifies the physical location

for the SAS data set. The DS2 program then creates the SAS data set MyFiles.Table1 at the location specified in the LIBNAME statement.

```
libname myfiles base 'C:\myfiles';

proc ds2;
   data myfiles.table1;
      dcl double j j2;
      method run();
         do j = 1 to 1000;
            j2 = 2*j;
            output;
         end;
      end;
   enddata;
run;
quit;
```

The DS2 procedure builds a data source connection string that includes all active librefs and sends it to the DS2 program. You reference a particular library by specifying its libref in a two-part table name in the form *libref.table-name*. If you do not specify a libref, the table is created in the SAS Work library.

PROC DS2 uses libref attributes for connection information only (such as physical location). PROC DS2 generally does not use libref attributes that define behavior. For example, if a previously submitted LIBNAME statement for the BASE engine specifies that SAS data sets are to be compressed, the compression attribute is not used by the procedure. There are exceptions. For example, the MAX_BINARY_LEN= and MAX_CHAR_LEN= for Google BigQuery are included in the internal connection string.

You can determine which LIBNAME options are used by the procedure by setting the MSGLEVEL=i system option before submitting a LIBNAME statement. For many data sources, you can specify a DS2 table option to override a LIBNAME option. For example, the COMPRESS= table option can be used to request compression of SAS data sets. The SCANSTRINGCOLUMNS= table option can be used to override the MAX_CHAR_LEN= LIBNAME option. Not all LIBNAME statement options have a corresponding table option.

Note: PROC DS2 connects immediately, so an error is generated if the LIBNAME statement includes the DEFER=YES option.

z/OS Specifics: The physical location for the libref must be an HFS path specification.

About the LIBS= Procedure Option

When multiple librefs are active in the SAS session, you might want to include the LIBS= option in the PROC DS2 statement. LIBS= restricts the data source connection to the specified libref or librefs and the default library. Work is the default library unless a User library is assigned.

You must continue to qualify table names with a libref, even when LIBS= specifies only one library; otherwise, the default library is used.

The following example illustrates the use of the LIBS= option. In the example, two librefs are assigned in the SAS session: AllFiles and MyFiles. The LIBS= option specifies to use libref MyFiles only.

```
libname allfiles 'C:\sharedfiles';
libname myfiles base 'C:\myfiles;

proc ds2 libs=myfiles;
   data myfiles.table1;
      dcl double j j2;
      method run();
         do j = 1 to 1000;
            j2 = 2*j;
            output;
         end;
      end;
   enddata;
run;
quit;
```

For more information, see "LIBS=*libref* | (*libref1 libref2 ...librefn*)" on page 810.

Connecting to the CAS Server

You connect to a CAS session on the CAS server by specifying the SESSREF= (or SESSUUID=) procedure option with a CAS session name. When SESSREF= (or SESSUUID=) is specified, both the default connection mechanism and the LIBS=option are ignored. Instead, the procedure connects to the specified CAS session.

Note: You must have a CAS server configured. You must first submit the CAS statement to establish the CAS session. To interact with data in a CAS session, you need a caslib. You must first define a caslib or use a pre-defined caslib. You define a caslib and list the caslibs that are available to your CAS session by using the CASLIB statement. For syntax information, see *SAS Cloud Analytic Services: User's Guide*. A caslib uses a SAS Data Connector (or SAS Data Connector Accelerator) to access data. For information about SAS Data Connectors, see *SAS Cloud Analytic Services: User's Guide*.

Use a two-part name in the form *caslib.table-name* to identify tables in your DS2 statements. The following example illustrates a PROC DS2 request to the CAS server.

```
options cashost="cloud.example.com" casport=5570;
cas mysess;

caslib castera desc='Teradata Caslib'
   datasource=(srctype='teradata'
      username='myname'
```

```
      password='mypw'
      server='testserver',
      db='testdb');

proc ds2 sessref=mysess;
   data newtable;
     method run();
       set {select * from castera.employees};
     end;
enddata;
run;
quit;
```

This example establishes a CAS session named MySess on a CAS server on CAS host cloud.example.com. It then uses the CASLIB statement to assign caslib CASTERA. The PROC DS2 statement specifies the SESSREF= procedure option and the CAS session name MySess. The FedSQL SELECT statement in the DS2 SET statement identifies table Employees using the CASTERA caslib.

SAS Viya data connectors support explicit and automatic (shown here) loading of data into CAS. For an example that explicitly loads data, see "Example 5: Run a DS2 Program in CAS" on page 833.

The tables that you create with PROC DS2 are in-memory CAS tables. That is, the tables are available for the duration of the CAS session and are accessible only to the current session. PROC DS2 does not provide a way to persist a table to a data source or to share the table with other CAS sessions. To persist or share a CAS table, use the CASUTIL procedure.

Note: Although CAS tables are in-memory tables, you must specify the OVERWRITE= table option to overwrite an initial output table with a replacement output table.

For more information, see:

- *SAS Cloud Analytic Services: Fundamentals*
- CAS statement, CASLIB statement, and CASUTIL procedure in *SAS Cloud Analytic Services: User's Guide*

Using PROC DS2 in SAS Cloud Analytic Services

SAS Cloud Analytic Services is an alternative environment for processing DS2 requests. When you specify the SESSREF= (or SESSUUID=) option, PROC DS2 prepares and executes your DS2 programs on a CAS server. When you run PROC DS2 with SESSREF= or SESSUUID=, you are actually using the runDS2 action. Unless you are using Lua, Python, or R, it is recommended that you use PROC DS2 to submit your DS2 programs to the CAS server instead of the runDS2 action. There are advantages of using PROC DS2. For more information, see the runDS2 action in the *SAS Viya: System Programming Guide*.

The CAS server is a symmetric multiprocessing (SMP) server. A DS2 program executing on the CAS server can perform manipulations on multiple data observations concurrently, thereby reducing the time required to process large data sets. Based on the structure of the DS2 program, the DS2 compiler determines which operations can be performed on multiple observations concurrently. It also determines which operations must be applied to each observation sequentially.

A DS2 program is classified as either a serial program, a parallel program, or a parallel-serial program. In order to benefit from the CAS server, the DS2 program must be structured as either a DS2 parallel program or a DS2 parallel-serial program.

- A DS2 parallel program contains no operations with data dependencies across observations. Therefore, multiple data observations can be processed in parallel. Each CAS worker can process a subset of the input data and generate a subset of the result set.
- A DS2 parallel-serial program contains some operations with data dependencies across observations and some operations without data dependencies. The processing of the operations is divided into two stages: a parallel stage and a serial stage. During the parallel stage, each CAS worker processes a subset of the input data set and generates a subset of an intermediate data set. During the serial stage, one CAS worker processes the complete intermediate data set and generates the complete result set.

Most of the functionality of the DS2 language is supported for use on the CAS server. However, there are some exceptions. For information about the DS2 functionality that is supported in CAS, see *SAS DS2 Programmer's Guide*.

For an example of how a DS2 parallel program is submitted to the CAS server, see "Example 5: Run a DS2 Program in CAS" on page 833.

DS2 output tables in CAS are in-memory tables. The tables are created in the user's CAS session. You must use other CAS actions to promote the output tables for global use in CAS or to store data to caslib data sources.

RUN-Group Processing

PROC DS2 supports RUN-group processing. RUN-group processing enables you to submit RUN groups without ending the procedure.

To use RUN-group processing, you start the procedure and then submit multiple RUN-groups. A RUN-group is a group of statements that contains at least one action statement and ends with a RUN statement. As long as you do not terminate the procedure, it remains active and you do not need to resubmit the PROC statement.

Note: When using PROC DS2, DS2 programs are delimited by RUN statements. If additional DS2 code is found after a RUN statement, then this code composes a new, distinct DS2 program from the DS2 program before the previous RUN statement.

To end RUN-group processing, submit a RUN CANCEL statement. Statements that have not been submitted are terminated. To stop the procedure, submit a QUIT statement. Statements that have not been submitted are terminated as well.

Applying DS2 Table Options

When you access a data source with PROC DS2, you can apply DS2 table options in the subsequent DS2 statements. A table option specifies actions that enable you to perform operations on a table such as assigning buffer page size or specifying passwords. A DS2 table option performs much of the same functionality as a Base SAS data set option.

DS2 table options are used to apply options when you access a data source within PROC DS2. For example, the following code applies a table option to the SAS data set to specify the size of a permanent buffer page for the new table:

```
libname myfiles base 'C:\myfiles';

proc ds2;
   data myfiles.table1 (bufsize=16k);
      dcl double j j2;
      method run();
         do j = 1 to 1000;
            j2 = 2*j;
            output;
         end;
      end;
enddata;
run;
quit;
```

For a list of available table options, see *SAS DS2 Language Reference*.

Using Macro Variables in a Literal String

Note: The information in this section applies to PROC DS2 use in a libref.

Macro variables enable you to dynamically modify text in a program through symbolic substitution. When you reference a macro variable in a program, the macro processor replaces the reference with the value of the specified macro variable.

With PROC DS2, you can use a macro variable on a subsequent DS2 statement. However, if a macro variable occurs within a literal string, you cannot enclose the string in double quotation marks. The macro processor requires double quotation marks to resolve the macro variable reference. DS2 statements consider a string enclosed in double quotation marks to be a delimited (case sensitive) identifier such as a table or column name.

To reference a macro variable in a literal string, use the SAS macro function %TSLIT. %TSLIT overrides the need for double quotation marks around the literal string and puts single quotation marks around the input value. For example, the following statement includes the %TSLIT function to specify the &SYSHOSTNAME macro variable, which returns the host name of the computer on which it is executed:

```
if hostname = %tslit(&syshostname) then ...
```

The %TSLIT macro function is stored in the default autocall macro library. For more information, see “Referencing a Macro Variable in a Delimited Identifier” in the *SAS DS2 Programmer’s Guide*.

DS2 Automatic Variables

The DS2 language sets up automatic variables with certain values after it executes each statement. These automatic variables are useful for subsetting a problem across DS2 threads. They are also useful for providing context when debugging with PUT statements.

Table 21.2 *DS2 Automatic Variables*

Variable	Description
HOSTNAME	Returns the name of the worker node or host on which the DS2 program is running.
NTHREADS	Returns the total number of DS2 threads running in the program. In a parallel environment, _NTHREADS_ is the total number of DS2 threads across all nodes on which the DS2 program is running.
THREADID	Returns the _THREADID_. A serial program (which does not contain a thread component) is assigned _THREADID_ = 0. In a parallel program, the executing data program is assigned _THREADID_ = 0 and each executing thread program is assigned a unique _THREADID_ from 1 to the number of threads.

Here is an example of how the automatic variables might be used:

```
proc ds2;
thread thd / overwrite = yes;
  dcl double x;
  method init();
    put 'THREAD: thread' _threadid_ 'on' _hostname_;
  end;
endthread;

data _null_;
  dcl thread thd t;
  method init();
```

```
      put 'DATA: thread' _threadid_ 'on' _hostname_;
    end;
    method run();
      set from t threads=8;
    end;
  enddata;
  run;
  quit;
```

Passwords

SAS software enables you to restrict access to SAS data sets and SPD Engine data sets by assigning SAS passwords to the files. You can specify three levels of protection: read, write, and alter.

With PROC DS2, you assign or specify a password for a data source using the DS2 table options ALTER=, PW=, READ=, and WRITE=. For example, the following code applies the DS2 table option PW= in order to assign READ, WRITE, and ALTER passwords to a SAS data set:

```
libname myfiles base 'C:\myfiles';

proc ds2;
   data myfiles.table1 (pw=luke);
      dcl double j j2;
      method run();
         do j = 1 to 1000;
            j2 = 2*j;
            output;
         end;
      end;
enddata;
run;
quit;
```

A SAS password does not control access to a SAS file beyond SAS. You should use the operating system-supplied utilities and file system security controls to control access to SAS files outside SAS. For more information about SAS passwords, see "Assigning Passwords" in *SAS Programmer's Guide: Essentials*..

CAS tables do not support SAS passwords. Therefore, you cannot assign a password for a CAS table. When accessing password-protected data from CAS, passwords are specified in the CAS language element used to access the data. For example, passwords are supported in the CASUTIL procedure, which loads data into CAS, as well as in the CASLIB statement and in the Table.addCaslib action. For more information, see the SAS Viya SAS Data Connector documentation in *SAS Cloud Analytic Services: User's Guide*.

Encryption

SAS software enables you to encrypt the contents of a SAS data set, SPD Engine data set, and SPD Server table. SAS supports SAS proprietary encryption and AES encryption.

SAS proprietary encryption is performed by specifying the ENCRYPT= table option with the PW= or READ= table option. A data set or table encrypted with SAS proprietary encryption must be decrypted by specifying the PW= or READ= table option with the appropriate password.

AES encryption is performed by specifying the ENCRYPT= table option with the ENCRYPTKEY= table option. A data set or table encrypted with AES encryption is later decrypted by specifying the ENCRYPTKEY= table option with the appropriate key value.

Beginning with SAS 9.4M5, SAS supports two levels of AES encryption: AES and AES2. The new AES2 option provides AES encryption to meet newer and more secure encryption standards. You must specify the ENCRYPTKEY= table option when using AES or AES2 encryption. AES2 encryption is initially supported for SAS data sets only. For more information, see "ENCRYPT=" in *SAS DS2 Language Reference*.

DS2 currently does not support the encryption attribute for CAS tables. When accessing SAS and AES encrypted data sets from CAS, passwords and encryption keys are specified in the CAS language element that is used to access the data. For example, passwords and encryption keys are supported in the CASUTIL procedure, which loads data into CAS, as well as in the CASLIB statement and in the Table.addCaslib action. For more information, see the SAS Viya SAS Data Connector documentation in *SAS Cloud Analytic Services: User's Guide*.

DS2 Data Type Support for SAS Data Sets

In PROC DS2, when you submit DS2 statements, all DS2 language data types are supported. For information about the DS2 data types, see *SAS DS2 Language Reference*. However, when reading and creating data, the DS2 data types are translated to and from the data types of the target data source. When submitting statements to read or to create a Base SAS data set, DS2 data types are translated to and from the SAS numeric and SAS character data types. The following table lists the DS2 data types and how they are translated to and from SAS data types:

Table 21.3 *DS2 Data Type Translation for SAS Data Sets*

DS2 Data Type	Legacy SAS Data Type	Description
BIGINT	SAS numeric	Because a SAS numeric is a DOUBLE, there is potential for loss of precision. DOUBLE is an approximate numeric data type rather than an exact numeric data type
BINARY(*n*)	SAS character	Applies the SAS format $n.
CHAR(*n*)	SAS character	Applies the SAS format $n.
DATE	SAS numeric	Applies the SAS format DATE9. Valid SAS date values are in the range from 1582-01-01 to 9999-12-31. Dates outside the SAS date range are not supported and are treated as invalid dates.
DECIMAL| NUMERIC(*p*,*s*)	SAS numeric	
DOUBLE	SAS numeric	
FLOAT	SAS numeric	
INTEGER	SAS numeric	
NCHAR(*n*)	SAS character	Applies the SAS format $n.
NVARCHAR(*n*)	SAS character	Applies the SAS format $n.
REAL	SAS numeric	
SMALLINT	SAS numeric	
TIME(*p*)	SAS numeric	Applies the SAS format TIME8.
TIMESTAMP(*p*)	SAS numeric	Applies the SAS format DATETIME19.2.
TINYINT	SAS numeric	
VARBINARY(*n*)	SAS character	Applies the SAS format $n.
VARCHAR(*n*)	SAS character	Applies the SAS format $n.

DS2 Data Type Support for CAS Tables

Beginning with SAS Viya 3.5, DS2 can create, read, and write VARBINARY columns in CAS, in addition to BIGINT, CHAR(n), DOUBLE, INTEGER, and VARCHAR columns. When writing data to the CAS server, some DS2 data types are translated to and from these data types, but not all of them. The following table lists the DS2 data types and how they are translated to and from CAS data types.

Table 21.4 *DS2 Data Type Translation for CAS Tables*

DS2 Data Type	CAS Data Type	Description
BIGINT[1]	INT64	Large signed, exact whole number.
BINARY(*n*)	Not supported[3]	
CHAR(*n*)	CHAR	Applies the SAS format $*n*. Stores a fixed-length character string, where *n* is the maximum number of characters to store. The maximum number of characters is required to store each value regardless of the actual size of the value. If char(10) is specified and the character string is only five characters long, the value is right-padded with spaces.
DATE	DOUBLE	Applies the SAS format DATE9. Valid SAS date values are in the range from 1582-01-01 to 9999-12-31. Dates outside of the SAS date range are not supported and are treated as invalid dates.
DECIMAL| NUMERIC(*p*,*s*)	Not supported	
DOUBLE	DOUBLE	Stores a signed, approximate, double-precision, floating-point number. Allows numbers of large magnitude and permits computations that require many digits of precision to the right of the decimal point. For SAS Cloud Analytic Services, this is a 64-bit double precision, floating-point number.
FLOAT	DOUBLE	

DS2 Data Type	CAS Data Type	Description
INTEGER[1]	INT32	Regular signed, exact whole number.
NCHAR(*n*)	CHAR	Applies the SAS format $*n*.
NVARCHAR(*n*)	VARCHAR	
REAL	DOUBLE	
SMALLINT	INT32	Small signed, exact whole number.
TIME(*p*)	DOUBLE	Applies the SAS format TIME8.
TIMESTAMP(*p*)	DOUBLE	Applies the SAS format DATETIME25.6.
TINYINT	INT32	Very small signed, exact whole number.
VARBINARY(*n*)[2]	VARBINARY	Varying-length binary opaque data. This data type is used to store image data, audio, documents, and other unstructured data.
VARCHAR(*n*)	VARCHAR	Stores a varying-length character string.

1 Support for the integer data types starts with SAS Viya 3.3.

2 Beginning with SAS Viya 3.5, a DS2 program that runs in CAS can read and create a column with a VARBINARY data type in a CAS table. It can also write to an existing VARBINARY column in a CAS table. In earlier SAS Viya releases, DS2 does not return an error when reading VARBINARY columns. However, the data is incorrectly treated as character data.

3 Beginning with SAS Viya 3.5, a DS2 program that runs in CAS can create a column with a BINARY data type. However, it cannot read a BINARY data column from a CAS table or write to an existing BINARY column in a CAS table. DS2 returns an error if an attempt is made to do so. Use the DROP data set option to exclude BINARY columns when reading or writing to a CAS table that contains a BINARY column. In earlier SAS Viya releases, no error was reported when reading BINARY columns. However, the data was not read correctly.

CAS tables use the UTF-8 character set by default.

Date, time, and timestamp values in CAS tables are supported as DOUBLEs, with a SAS format applied. When SAS Viya Data Connectors read DATE, TIME, and TIMESTAMP columns from an ANSI-compliant data source, they convert the columns to data type DOUBLE. DS2 applies a DATE. SAS format to date values, a TIME. SAS format to time values, and a DATETIME. SAS format to datetime values.

Examples: DS2 Procedure

Example 1: Introducing DS2 Code

Features:
- PROC DS2 statement
- LIBS= procedure option
- QUIT statement
- DS2 language statements

Details

This example uses a simple DS2 program that displays **`Hello World!`** in the SAS log. The example shows basic differences between DS2 and the SAS DATA step. The code looks similar to the SAS DATA step, but there are syntax elements that are different, such as default system methods (INIT, RUN, and TERM). Also, DS2 supports the most common SQL data types such as DECIMAL, INTEGER, and VARCHAR to make operations more native for DBMS data.

Program

```
proc ds2 libs=work;

data _null_;
   method init();
      dcl varchar(16) str;
      str = 'Hello World!';
      put str;
   end;
enddata;

run;

quit;
```

Program Description

Execute the PROC DS2 statement. The LIBS= connection option specifies to execute the request in the SAS Work library. The PROC DS2 statement sets up the environment to submit DS2 language statements.

```
proc ds2 libs=work;
```

Enter the DS2 language statements. _NULL_ on the DS2 DATA statement indicates that there is no automatic output generated. The DS2 PUT statement writes to the SAS log.

```
data _null_;
   method init();
      dcl varchar(16) str;
      str = 'Hello World!';
      put str;
   end;
enddata;
```

Submit the DS2 statements. The RUN statement submits the DS2 statements. The RUN statement is required. SAS reads the program statements that are associated with one task until it reaches a RUN statement.

```
run;
```

Stop the procedure. The QUIT statement stops the procedure.

```
quit;
```

Example Code 21.1 *SAS Log Showing Hello World!*

```
48   proc ds2 libs=work;
49   data _null_;
50      method init();
51         dcl varchar(16) str;
52         str = 'Hello World!';
53         put str;
54      end;
55   enddata;
56   run;
Hello World!
NOTE: Execution succeeded. No rows affected.
57   quit;

NOTE: PROCEDURE DS2 used (Total process time):
      real time           16.38 seconds
      cpu time            0.15 seconds
```

Example 2: Creating a SAS Data Set

Features:
PROC DS2 statement
LIBS= procedure option
QUIT statement
LIBNAME statement
DS2 language statements
PROC PRINT

Details

This example creates a SAS data set in a Base SAS session by submitting the DS2 procedure, and then submitting DS2 language statements. The output shows the first ten rows of the data set.

Program

```
libname myfiles base 'C:\myfiles';
proc ds2 libs=myfiles;

   data myfiles.basetable;
      declare double j j2;
      method run();
         do j = 1 to 1000;
            j2 = 2*j;
            output;
         end;
      end;
   enddata;

run;

quit;

proc print data=myfiles.basetable (obs=10);
run;
```

Program Description

Assign a library reference to the SAS data set to be created. The LIBNAME statement assigns the libref MyFiles, specifies the BASE engine, and specifies the physical location for the SAS data set.

```
libname myfiles base 'C:\myfiles';
```

Execute the PROC DS2 statement. The PROC DS2 statement connects to the data source by using the libref MyFiles and sets up the environment to submit DS2 language statements.

```
proc ds2 libs=myfiles;
```

Enter the DS2 language statements. The DS2 DATA statement creates an output table named Myfiles.BaseTable. The two-level name in the DATA statement specifies the catalog identifier MyFiles. The DECLARE statement assigns the data type DOUBLE to the variables J and J2. The METHOD statement identifies the RUN system method that is used to create output. The OUTPUT statement writes a row to table MyFiles.BaseTable after each execution of the DO loop.

```
data myfiles.basetable;
   declare double j j2;
   method run();
      do j = 1 to 1000;
         j2 = 2*j;
         output;
      end;
   end;
enddata;
```

Submit the DS2 language statements. The RUN statement submits the DS2 statements. The RUN statement is required. SAS reads the program statements that are associated with one task until it reaches a RUN statement.

```
run;
```

Stop the procedure. The QUIT statement stops the procedure.

```
quit;
```

Print the SAS data set. The PRINT procedure prints the observations in the SAS data set. The OBS= data set option limits the output to 10 observations.

```
proc print data=myfiles.basetable (obs=10);
run;
```

Output: Creating a SAS Data Set

Output 21.1 *PROC PRINT Output of MyFiles.BaseTable*

The SAS System

Obs	j	j2
1	1	2
2	2	4
3	3	6
4	4	8
5	5	10
6	6	12
7	7	14
8	8	16
9	9	18
10	10	20

Example 3: Terminating the Current Step in Line Prompt Mode

Features:

PROC DS2 statement
RUN CANCEL statement
QUIT statement
DS2 language statements

Details

The following example shows the usefulness of the RUN CANCEL statement in a line prompt mode session. The sixth statement in the code contains an invalid value for the column (Z instead of Y). RUN CANCEL ends the PROC DS2 step and prevents it from executing.

Program

```
proc ds2;
data xy_data;
   declare double x y;
   method init();
      do x = 1 to 5;
         z = 2*x;
      end;
   end;
enddata;
run cancel;
quit;
```

Example Code 21.2 *SAS Log Showing the Canceled PROC DS2 Step*

```
17   proc ds2 libs=work;
NOTE: Writing HTML Body file: sashtml1.htm
18   data xy_data;
19      dcl double x y;
20      method init();
21         do x = 1 to 5;
22            z = 2*x;
23         end;
24      end;
25   enddata;
26   run cancel;
NOTE: DS2 query cancelled per user request.
27   quit;

NOTE: PROCEDURE DS2 used (Total process time):
      real time           14.33 seconds
      cpu time            0.71 seconds
```

Example 4: Routing Data to Tables Based on Values

Features: PROC DS2 statement
QUIT statement
DS2 language statements

Details

This example illustrates how to create tables based on a condition. Programs 1 and 2 create two tables, Dept1_Items and Dept2_Items, that hold costs for items used by two departments. The third program creates two tables, Highcosts and Lowcosts, based on the costs of the items in the two items tables. Programs 4 and 5 output the contents of the costs tables.

Program

```
proc ds2;
/* Program 1 */
data dept1_items (overwrite=yes);
   dcl varchar(20) item;
   dcl double cost;
   method init();
      item = 'staples';   cost =  1.59; output;
      item = 'pens';      cost =  3.26; output;
      item = 'envelopes'; cost = 11.42; output;
   end;
enddata;
run;
/* Program 2 */
data dept2_items (overwrite=yes);
   dcl varchar(20) item;
   dcl double cost;
   method init();
      item = 'erasers'; cost =  5.43; output;
      item = 'paper';   cost = 26.92; output;
      item = 'toner';   cost = 62.29; output;
   end;
enddata;
run;
/* Program 3 */
data lowCosts (overwrite=yes) highCosts (overwrite=yes);
   method run();
      set dept1_items dept2_items;
      if cost <= 10.00 then
         output lowCosts;
      else
         output highCosts;
      end;
enddata;
run;
/* Program 4 */
data;
   method run();
      set lowCosts;
   end;
```

```
enddata;
run;
/* Program 5 */
data;
   method run();
       set highCosts;
   end;
enddata;
run;
quit;
```

Output: Creating Tables Based on a Condition

Output 21.2 *Output of the Costs Tables*

The SAS System

item	cost
staples	1.59
pens	3.26
erasers	5.43

The SAS System

item	cost
envelopes	11.42
paper	26.92
toner	62.29

Example 5: Run a DS2 Program in CAS

Features:

CAS system options
CAS statement
CASLIB statement
CASUTIL procedure
PROC DS2 statement
SESSREF= procedure option
DS2 language statements

Details

Here is an example of a DS2 parallel program that is run in CAS. A DS2 parallel program is a DS2 program that contains a thread program and a data program and does not contain any data manipulation statements. That is, the data program does not contain any statements besides SET FROM and OUTPUT. Operations in the thread program are applied to multiple data observations in parallel. Each CAS worker processes a subset of the data set and generates a subset of the result set.

Program

```
options cashost="cloud.example.com" casport=5570;

cas mysess;

caslib casdata datasource=(srctype=path)
  path="testdata/cas";

proc casutil;
  load casdata="cars_single.sashdat" incaslib="casdata"
casout="cars_single";
run;

proc ds2 sessref=mysess;

 thread cars_thd / overwrite=yes;
   method run();
     set cars_single;
     if (msrp > 100000) then do;
       put make= model= msrp=;
       output;
     end;
   end;
 endthread;

 data cars_luxury /overwrite=yes;
   dcl thread cars_thd t;
   method run();
     set from t threads=4;
   end;
 enddata;


run;

quit;
```

Program Description

Connect to the CAS server. The CASHOST= and CASPORT= options specify to connect to the CAS server at cloud.example.com using port 5570. This step is not required if your network has a pre-configured CAS server connection.

```
options cashost="cloud.example.com" casport=5570;
```

Establish a CAS session. The CAS statement specifies to start a CAS session named MySess.

```
cas mysess;
```

Define a caslib to access your input data. A file named Cars_Single.sashdat is located in the Testdata/Cas subdirectory of the computer on which the CAS server is running. The CASLIB statement assigns caslib CasData to the directory location. To access a directory on a different computer, specify an absolute pathname.

```
caslib casdata datasource=(srctype=path)
  path="testdata/cas";
```

Load the table into CAS for processing. The CASUTIL procedure is used to load table Cars_Single.sashdat into the CAS session. The CASOUT= parameter assigns the loaded table the name Cars_Single.

```
proc casutil;
  load casdata="cars_single.sashdat" incaslib="casdata"
casout="cars_single";
run;
```

Issue the PROC DS2 statement and specify the SESSREF= procedure option. SESSREF= instructs the procedure to process the request using CAS session MySess.

```
proc ds2 sessref=mysess;
```

Enter the DS2 language statements. The DS2 THREAD statement creates a thread program named Cars_Thd that specifies criteria for selecting data from loaded table Cars_Single. The DS2 DATA statement creates an output table, Cars_Luxury, and specifies to set the results of the thread program as the content of the new table. The data program specifies to use four threads to execute the thread program.

```
thread cars_thd / overwrite=yes;
  method run();
    set cars_single;
    if (msrp > 100000) then do;
      put make= model= msrp=;
      output;
    end;
  end;
endthread;

data cars_luxury /overwrite=yes;
  dcl thread cars_thd t;
  method run();
    set from t threads=4;
  end;
enddata;
```

Submit the DS2 language statements. The RUN statement submits the DS2 statements. The RUN statement is required. SAS reads the program statements that are associated with one task until it reaches a RUN statement.

```
run;
```

Stop the procedure. The QUIT statement stops the procedure.

```
quit;
```

22

DSTODS2 Procedure

Overview: DSTODS2 Procedure

What Does the DSTODS2 Procedure Do?

The DSTODS2 procedure enables you to translate a subset of your SAS DATA step code into DS2 code. Then you can revise your program to take advantage of DS2 features and submit your program using PROC DS2.

Note: PROC DSTODS2 is not supported in the z/OS operating environment.

For more information, see Chapter 21, “DS2 Procedure,” on page 801.

Concepts: DSTODS2 Procedure

Input and Output Files

PROC DSTODS2 works with text files for input and output, and these files are presented either as directly named files or as SAS filerefs.

PROC DSTODS2 requires an input file containing the source to be translated. The input file is specified via the IN= argument. PROC DSTODS2 also requires an output filename where the translated source is to be written. This file is specified via the OUT= argument.

Note: The resulting output file might not be syntactically complete. You might have to clean up the output file to create a DS2 program that can be compiled and executed.

Note: PROC DSTODS2 adds this code lines to your output file. You should not remove it from your .ds2 file during cleanup:

```
_return: ;
```

Supported and Unsupported Syntax

Overview

PROC DSTODS2 cannot translate all possible DATA step syntax. Its main purpose is to support typical SAS Enterprise Miner scoring syntax, which is a subset of the full DATA step syntax.

Supported Syntax

The DATA step syntax that PROC DSTODS2 supports includes the following items.

- The following statements are supported:

  ARRAY statements and array initializers. Implicit arrays give a warning.

  Assignment statements that use arrays and scalars.

  Attribute statements, although they have no semantic meaning in PROC DSTODS2. Only the syntax is supported–that is, you do not get a syntax error for them.

  BY

  Comment

  CONTINUE

  DATA statement and associated data sets

  DO (all forms except DO OVER)

  DROP

  END

  FORMAT (only when a LENGTH statement is also included in the program)

  GOTO

  IF and IF-THEN/ELSE

  KEEP

  LABEL

  LEAVE

  LENGTH

  MERGE

  Null

  OUTPUT

  Basic PUT statement functionality: printing variables, arrays, _ALL_, and formatted values. Other PUT arguments are commented out inline.

  RENAME

  RETAIN

  RETURN

  RUN (syntactically supported but has no semantic meaning)

  SELECT

  SET

  STOP

  Sum

- Partial support for the hash object.
- DROP, IN, KEEP, and RENAME data set options
- All DATA step expressions
- All functions and formats are translated as-is. However, only functions and formats that are supported by DS2 are valid. For more information, see "DS2 Functions" in *SAS DS2 Language Reference*.
- Constant lists (as used in IN clauses)
- Variable lists except for type modifiers in lists, for example, **`x-numeric-a`**

Note: Because of the depth of the DATA step language, this list is not exhaustive.

Unsupported Syntax

The DATA step syntax that PROC DSTODS2 does not support includes the following items:

- The following statements are not supported:

  ABORT
  ATTRIB
  CALL
  CARDS
  CARDS4
  DATALINES
  DATALINES4
  DELETE
  DESCRIBE
  DISPLAY
  DO OVER
  ERROR
  EXECUTE
  FILE
  FORMAT (undeclared variables)
  INFILE
  INFORMAT
  INPUT (all forms)
  LINK
  LIST
  LOSTCARD
  MODIFY
  PUT statement with formatting of any kind
  PUTLOG
  REMOVE
  REPLACE
  UPDATE
  WHERE
  WINDOW

- Data set options other than DROP, IN, KEEP, and RENAME
- DATA step executable options like DEBUG and PASSTHRU
- The following I/O options are not supported:

  CONTROL
  CUROBS
  END
  INDSNAME
  KEY
  NOBS
  OPEN
  POINT
  KEYRESET

- Implicit arrays
- INPUT and PUT modifiers
- All objects other than the Hash object
- Argument tags in any method
- View and stored program syntax
- Constant ranges, such as 1:100, in constant lists
- Format justifiers (L, R, C)

- CALL statements except DMNORM and STREAMINIT
- Bitstring expressions
- Other procedures

Note: Because of the depth of the DATA step language, this list is not exhaustive.

Considerations and Limitations with PROC DSTODS2

- Only one DATA step program can be converted at a time.
- The resulting DS2 program contains two lines of code that should be removed before saving your final DS2 program:

```
ds2_options sas tkgmac;
_return: ;
```

- Existing comments are removed.
- Code lines that cannot be translated are placed in comments.

  These comments are placed in-line in the original position as much as possible to enable you to easily compare the original code with the translated code. But there are situations where comments and other code might be moved to other positions. For example, the code might be moved to the top of a block (the outermost scope).
- The resulting DS2 program might not be syntactically complete. The resulting program can result in one of the following outcomes:
  - compile and execute without error. This is unlikely if any of the new DATA step syntax is used.
  - compile but fail to execute. This is particularly true of any programs that contain commented-out sections.
  - not compile. This could happen because there was a warning, or something that translates syntactically but has no corresponding support in DS2. This could be the case for certain functions and formats. It could happen for some of the variable list features also.
  - produce a fatal syntax error. This could happen for some previously undiscovered feature or for some aspect of the previously mentioned variable list syntax.
- The resulting DS2 program does not invoke the SAS In-Database Code Accelerator. You must take the part of the code that can be run in parallel and create a thread program to accompany the data program.
- If any code line is longer than 32767 characters, it is truncated.
- DATA step fixed-length characters are measured in bytes. DS2 fixed-length characters are measured in characters. If your data has multibyte encoding, you

might have to adjust your LENGTH statement before running PROC DSTODS2 to account for the length of the variable in characters to avoid truncation. There is no issue with single-byte encodings.

- If you run PROC DSTODS2 on a DATA step program with the SESSREF= option to run on the CAS server, you must move the SESSREF= option from the DATA statement to the PROC DS2 statement before running on the CAS server.

Syntax: DSTODS2 Procedure

Restrictions: This procedure is not supported on the CAS server.

PROC DSTODS2 is not supported in the z/OS operating environment.

PROC DSTODS2 IN=*datastep-program-filename* OUT=*ds2-program-filename* <OUTDIR="*output-directory-name*">

RUN;

<QUIT;>

Statement	Task	Example
PROC DSTODS2	Translates DATA step code into DS2 code.	Ex. 1, Ex. 2, Ex. 3

PROC DSTODS2 Statement

Translates DATA step code into DS2 code.

Syntax

PROC DSTODS2 IN=*datastep-program-filename* OUT=*ds2-program-filename* <OUTDIR="*output-directory-name*">

Required Arguments

IN=*datastep-program-filename*
specifies the name of the DATA step file or a SAS fileref.

Interaction If you use a fileref for the *datastep-program-filename*, PROC DSTODS2 does not look at any fileref options (for example, encoding).

Tip You can specify a full pathname.

OUT=*ds2-program-filename*
specifies the name of the DS2 file that is created.

Restriction You must specify only a single, output filename. It cannot include a pathname.

Note You should remove the following two lines from your output .ds2 program:

```
ds2_options sas tkgmac;
_return: ;
```

Tip If you cannot or do not specify the OUTDIR= directory, the output file is automatically written to the current working directory. You can use this code to find your current working directory:

```
data _null_;
file 'name.txt';
put x;
run;
```

OUTDIR="*output-directory-name*"
specifies the output directory name for the file.

Restriction This argument is available only in SAS Viya 3.4.

Requirement For UNIX directories, you must include the final directory separator(/), for example, `outdir="/mydir/files/"`

Examples: DSTODS2 Procedure

Example 1: Data Input

Features: PROC DSTODS2 statement

Details

This example uses PROC DSTODS2 to translate the following DATA step program, dsEx1.sas, that has a SET statement and a BY statement.

```
data _null_;
   length x y z w 8;
   set x;
   by x--z w;
   put x=;
run;
```

Execute the PROC DSTODS2 statement. Without a currently assigned libref, the PROC DSTODS2 statement simply sets up the environment to submit DS2 language statements.

```
proc dstods2 in="dsEx1.sas" out="ds2Ex1.ds2";
```

Submit the DSTODS2 statements. The RUN statement submits the DSTODS2 statements. The RUN statement is required. SAS reads the program statements that are associated with one task until it reaches a RUN statement.

```
run;
```

Example Code 22.1 SAS Log Showing Results

```
4    proc dstods2 in="dsEx1.sas" out="ds2Ex1.ds2";
5    run;

NOTE: PROCEDURE DSTODS2 used (Total process time):
      real time           0.20 seconds
      cpu time            0.07 seconds
```

Output: ds2Ex1.ds2 Program

PROC DSTODS2 translates dsEx1.sas into DS2 code and stores the result in dsEx1.ds2. As you can see, the LENGTH statement has been translated to DECLARE statements, the METHOD statement has been added, and the variable list, **X--Z**, has been commented out.

```
data _NULL_;
dcl double X;
dcl double Y;
dcl double Z;
dcl double W;
method run();
set X;
by  /* X--Z */ W;
put X=;
;
_return: ;
end;
enddata;
```

Example 2: PUT Statement with Line Specifiers

Features: PROC DSTODS2 statement

Details

This example uses PROC DSTODS2 to translate the following DATA step program, dsEx2.sas, that has a DO statement and several PUT statements.

```
data _null_;
   file temp linesize=32600;
   do i = 1 to 5330;
      put i 6. @;
   end;
   put @31990 'N1=72' @;
   put @32580 'N2=32413' @;
   put @32001 'N4=32 N3=783424123' @;
   put @32477 'N5=1977' @;
   put @32222 'N6=1981' ;
run;
```

Execute the PROC DSTODS2 statement. Without a currently assigned libref, the PROC DSTODS2 statement simply sets up the environment to submit DS2 language statements.

```
   proc dstods2 in="dsEx2.sas" out="ds2Ex2.ds2";
```

Submit the DSTODS2 statements. The RUN statement submits the DSTODS2 statements. The RUN statement is required. SAS reads the program statements that are associated with one task until it reaches a RUN statement.

```
   run;
```

Example Code 22.2 *SAS Log Showing Results*

```
4    proc dstods2 in="dsEx2.sas" out="ds2Ex2.ds2";
5    run;

NOTE: PROCEDURE DSTODS2 used (Total process time):
      real time           0.18 seconds
      cpu time            0.06 seconds
```

Output: ds2Ex2.ds2 Program

PROC DSTODS2 translates dsEx2.sas into DS2 code and stores the result in dsEx2.ds2. As you can see, the METHOD statement has been added and the FILE statement has been commented out. The PUT statement is translated but the @ line-hold specifier and constants have been commented out.

```
data _NULL_;
method run();
/* FILE TEMP LINESIZE = 32600 */;
do I = 1.0 to 5330.0;
put I 6. /* Put statement contains unsupported feature(s) @  */ ;
end;
put  /* Put statement contains unsupported feature(s) @  31990  'N1=72'
 @  */ ;
put  /* Put statement contains unsupported feature(s) @  32580  'N2=32413'
 @  */ ;
put  /* Put statement contains unsupported feature(s) @  32001  'N4=32
N3=783424123'
 @  */ ;
put  /* Put statement contains unsupported feature(s) @  32477  'N5=1977'
 @  */ ;
put  /* Put statement contains unsupported feature(s) @  32222  'N6=1981'
 */ ;
;
_return: ;
end;
 enddata;
```

Example 3: Arrays

Features: PROC DSTODS2 statement

Details

This example uses PROC DSTODS2 to translate the following DATA step program, dsEx2.sas, that has an ARRAY statement.

```
data _null_;
   array a(*) a1-a5;
   retain a1-a5 (1*(10 10 10 10 10));
   put _all_;
run;
```

Execute the PROC DSTODS2 statement. Without a currently assigned libref, the PROC DSTODS2 statement simply sets up the environment to submit DS2 language statements.

```
   proc dstods2 in="dsEx3.sas" out="ds2Ex3.ds2";
```

Submit the DSTODS2 statements. The RUN statement submits the DSTODS2 statements. The RUN statement is required. SAS reads the program statements that are associated with one task until it reaches a RUN statement.

```
run;
```

Example Code 22.3 *SAS Log Showing Results*

```
6    proc dstods2 in="dsex3.sas" out="ds2ex3.ds2";
7    run;

NOTE: PROCEDURE DSTODS2 used (Total process time):
      real time           1.83 seconds
      cpu time            1.14 seconds
```

Output: ds2Ex3.ds2 Program

PROC DSTODS2 translates dsEx3.sas into DS2 code and stores the result in dsEx3.ds2. As you can see, the METHOD statement has been added and the ARRAY statement has been translated into a VARARRAY statement.

```
data _NULL_;
retain A1-A5 (1 * (10, 10, 10, 10, 10)) ;
vararray double A[*] A1-A5;
 method run();
put _ALL_;
;
_return: ;
end;
 enddata;
```

23

EXPORT Procedure

Overview: EXPORT Procedure

What Does the EXPORT Procedure Do?

The EXPORT procedure reads data from a SAS data set and writes it to an external data source. In Base SAS 9.4, external data sources include delimited files and JMP files.

In delimited files, a delimiter can be a blank, comma, or tab that separates columns of data values. If you have a license for SAS/ACCESS Interface to PC Files, you can also export to additional file formats, such as to a Microsoft Access database,

Microsoft Excel workbook, DBF file, and Lotus spreadsheets. For more information, see *SAS/ACCESS Interface to PC Files: Reference*.

Starting in SAS 9.4, you can export a SAS data set to a JMP 7 or later file, and JMP variables can be up to 255 characters long. Extended attributes are now used automatically, and the META= statement is no longer supported for JMP files. For more information, see "JMP Files" in *SAS/ACCESS Interface to PC Files: Reference*.

The EXPORT procedure uses one of these methods to export data:

- generated DATA step code
- generated SAS/ACCESS code

You control the results with options and statements that are specific to the output data source. The EXPORT procedure generates the specified output file and writes information about the export to the SAS log. The log displays the DATA step or the SAS/ACCESS code that the EXPORT procedure generates. If a translation engine is used, then no code is submitted.

The **Export Wizard** or the **External File Interface** (EFI) can be used to guide you through the steps to export a SAS data set. The Export Wizard can generate EXPORT procedure statements, which you can save to a file for subsequent use. For more information, see "External File Interface (EFI)" in *SAS/ACCESS Interface to PC Files: Reference*.

The Export Wizard uses EFI methods to read and write data in delimited files, and this can affect the behavior when you use the EXPORT procedure or Export Wizard. For example, when exporting SAS data to a delimited file, the EXPORT procedure discards items that exceed the output line-length. For more information, see the DROPOVER option in the FILE Statement in *SAS DATA Step Statements: Reference*.

To open the Export Wizard, from the SAS windowing environment, select **File** ⇨ **Export Data**. For more information about the Export Wizard, see the Base SAS online Help and documentation. For more detail and an example, see "Using SAS Import and Export Wizards" in *SAS/ACCESS Interface to PC Files: Reference*.

Format Catalog Encodings in SAS Viya

SAS Viya supports only the UTF-8 encoding.

For more information about the encodings of format catalogs, see *Migrating Data to UTF-8 for SAS Viya* and *SAS/ACCESS Interface to PC Files: Reference*.

Support for the VARCHAR Data Type

PROC EXPORT supports the VARCHAR data type in CAS. VARCHAR stores a character variable that can have a varying length. The length that you specify for the variable represents the maximum number of characters that you want to store.

The VARCHAR data type is similar to the CHAR data type. CHAR variables have a length that is measured in terms of bytes. VARCHAR variables have a length that is measured in terms of characters rather than bytes. For information about using VARCHAR, see *SAS Cloud Analytic Services: DATA Step Programming*.

In the following example, the CAS engine is used with the LENGTH statement to create a VARCHAR variable and a CHAR variable. The VARCHAR variable, X, has a length of 30 and the CHAR variable, Y, also has a length of 30.

```
libname mycas cas;
data mycas.string;
   length x varchar(30);
   length y $30;
   x = 'abc'; y = 'def';
run;
proc contents data=mycas.string; run;
```

Here is the output that the code produces.

The CONTENTS Procedure

Data Set Name	MYCAS.STRING	Observations	1
Member Type	DATA	Variables	2
Engine	CAS	Indexes	0
Created	09/11/2016 13:48:30	Observation Length	48
Last Modified	09/11/2016 13:48:30	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information	
Data Limit	100MB

Alphabetic List of Variables and Attributes

#	Variable	Type	Len
1	x	Varchar	30
2	y	Char	30

Syntax: EXPORT Procedure

Restrictions: The EXPORT procedure is available for the following operating environments:

- Windows
- UNIX or Linux

A pathname for a file can have a maximum length of 201 characters.

Tip: Beginning with SAS 9.4M5, PROC EXPORT supports the VARCHAR data type for CAS tables. For more information, see "Support for the VARCHAR Data Type" on page 850.

PROC EXPORT DATA=<*libref*.>*SAS data set* <(*SAS data set options*)>

OUTFILE="*filename*" | OUTTABLE="*tablename*"

<DBMS=*identifier*> <REPLACE> <LABEL>;

statements for exporting to delimited files

DELIMITER=*char* | '*nn*'x;

PUTNAMES=YES | NO;

statements for exporting to JMP files

DBENCODING=*12-char SAS encoding-value*;

FMTLIB=<*libref*.>*format-catalog*;

META=*libref.member-data-set*;

Statement	Task	Example
PROC EXPORT	Export SAS data sets to an external data file	Ex. 1, Ex. 2
DBENCODING	Indicate the encoding used to save data in JMP files	
DELIMITER	Specify the delimiter to separate columns of data in the delimited output file	Ex. 1
FMTLIB	Write SAS format values defined in the format catalog to the JMP file for the value labels	
META	Write SAS metadata information to the JMP file	
PUTNAMES	Write the SAS variable names as column headings to the first row of the exported data file.	Ex. 3

PROC EXPORT Statement

Exports SAS data sets to an external data file.

Tips: Beginning with SAS Viya 3.5, PROC EXPORT supports all access types that are available in the FILENAME statement.

Beginning with SAS 9.4M5, PROC EXPORT supports the VARCHAR data type for CAS tables. For more information, see "Support for the VARCHAR Data Type" on page 850.

See: "FILENAME Statement" in *SAS Global Statements: Reference*

Syntax

PROC EXPORT DATA=<*libref*.>*SAS data set* <(*SAS data set options*)>

OUTFILE="*filename*" | OUTTABLE="*tablename*"
<DBMS=*identifier*> <REPLACE> <LABEL>;

Summary of Optional Arguments

(*SAS data set options*)
specifies SAS data set options.

DBMS=*identifier*
specifies the type of data to export.

LABEL
specifies a variable label name.

REPLACE
overwrites an existing file.

Required Arguments

DATA=<*libref*.>*SAS data set*
identifies the input SAS data set with either a one- or two-level SAS name (library and member name). If you specify a one-level name, by default, the EXPORT procedure uses either the USER library (if assigned) or the WORK library.

The EXPORT procedure can export a SAS data set only if the data target supports the format of a SAS data set. The amount of data must also be within the limitations of the data target. For example, some data files have a maximum number of rows or columns. Some data files cannot support SAS user-defined formats and informats. If the SAS data set that you want to export exceeds the limits of the target file, the EXPORT procedure might not be able to export it correctly. In many cases, the procedure attempts to convert the data to the best of its ability. However, conversion is not possible for some types.

Beginning with SAS 9.4M1 a SAS data set name can contain a single quotation mark when the VALIDMEMNAME=EXTEND system option is also specified. Using VALIDMEMNAME= expands the rules for the names of certain SAS members, such as a SAS data set name. For more information, see “Rules for SAS Data Set Names, View Names, and Item Store Names” in *SAS Language Reference: Concepts*.

Default If you do not specify a SAS data set to export, the EXPORT procedure uses the most recently created SAS data set. SAS keeps track of the data sets with the system variable _LAST_. To be certain that the EXPORT procedure uses the correct data set, you should identify the SAS data set.

Examples “Example 1: Exporting to a Delimited External Data Source” on page 858

“Example 2: Exporting a Subset of Observations to a CSV File” on page 862

OUTFILE="*filename*" | "*fileref*"
specifies the complete path and filename or a fileref for the output PC file, spreadsheet, or delimited external file. A fileref is a SAS name that is associated with the physical location of a file. To assign a fileref, use the FILENAME statement.

If you specify a fileref, or if the complete path and filename do not include special characters (such as the backslash in a path), lowercase characters, or spaces, you can omit the quotation marks.

Alias FILE

Restrictions The EXPORT procedure does not support device types or access methods for the FILENAME statement except for DISK. For example, the EXPORT procedure does not support the TEMP device type, which creates a temporary external file.

PROC EXPORT does not support the DROP|KEEP data set options with Name Range Lists for DBMS=CSV | TAB | DLM.

See *SAS/ACCESS Interface to PC Files: Reference* for more information about PC file formats.

Examples "Example 1: Exporting to a Delimited External Data Source" on page 858

"Example 2: Exporting a Subset of Observations to a CSV File" on page 862

OUTTABLE="*tablename*"
specifies the table name of the output DBMS table. If the name does not include special characters (such as question marks), lowercase characters, or spaces, you can omit the quotation marks. Note that the DBMS table name might be case sensitive.

Requirements You must have a license for SAS/ACCESS Interface to PC Files to export to a DBMS table.

When you export a DBMS table, you must specify the DBMS option.

Optional Arguments

DBMS=*identifier*
specifies the type of data to export. To export to a DBMS table, you must specify the DBMS option by using a valid database identifier. For DBMS=DLM, the default delimiter character is a space. However, you can use DELIMITER='*char*'.

The following values are valid for the DBMS identifier.

Table 23.1 DBMS Identifiers Supported in Base SAS

Identifier	Output Data Source	Extension
CSV	Delimited file (comma-separated values)	.csv
DLM	Delimited file (default delimiter is a blank)	
JMP	JMP files, Version 7 or later format	.jmp
TAB	Delimited file (tab-delimited values)	.txt

Restriction The availability of an output external data source depends on these conditions:

- the operating environment and, in some cases, the platform as specified in the previous table.
- whether your site has a license for SAS/ACCESS Interface to PC Files. If you do not have a license, only delimited and JMP files are available.

See *SAS/ACCESS Interface to PC Files: Reference* for a list of additional DBMS identifiers when using SAS/ACCESS Interface to PC Files.

Example "Example 1: Exporting to a Delimited External Data Source" on page 858

LABEL
specifies a variable label name. SAS writes these to the exported table as column names. If the label names do not already exist, SAS writes them to the exported table.

REPLACE
overwrites an existing file. If you do not specify REPLACE, the EXPORT procedure does not overwrite an existing file.

Example "Example 2: Exporting a Subset of Observations to a CSV File" on page 862

(*SAS data set options*)
specifies SAS data set options. For example, if the data set that you are exporting has an assigned password, you can use the ALTER=, PW=, READ=, or WRITE= data set options. To export a subset of data that meets a specified condition, you can use the WHERE option. For information about SAS data set options, see *SAS Data Set Options: Reference*.

Example "Example 2: Exporting a Subset of Observations to a CSV File" on page 862

DBENCODING Statement

Indicates the encoding used to save data in JMP files.

Interaction: The DBENCODING statement is valid only when DBMS=JMP.

Syntax

DBENCODING=*12-char SAS encoding-value*;

Required Argument

12-char SAS encoding-value
indicates the encoding used to save data in JMP files. Encoding maps each character in a character set to a unique numeric representation, which results in a table of code points. A single character can have different numeric representations in different encodings. This value can be up to 12 characters long.

DELIMITER Statement

Specifies the delimiter to separate columns of data in the output file.

Default: Blank space

Interaction: If you specify DBMS=DLM, you must also specify the DELIMITER statement.

Tip: You can enclose *nn* in single or double quotation marks.

Example: "Example 1: Exporting to a Delimited External Data Source" on page 858

Syntax

DELIMITER=*char | 'nn'*x;

Required Argument

***char | 'nn'*x**
specifies the delimiter to use to separate values in the output file. You can specify the delimiter as a single BYTE character or as a hexadecimal value. For example, if you want columns of data to be separated by an ampersand, specify DELIMITER='&'. A single character which requires two bytes to be represented in a DBCS environment is not valid.

FMTLIB Statement

Write SAS format values defined in the format catalog to the JMP file for the value labels.

Interaction: The FMTLIB statement is valid only when DBMS=JMP.

Syntax

FMTLIB=*<libref> format-catalog*;

Required Argument

<libref.>format-catalog
specifies the format catalog to be written to the JMP file.

META Statement

Writes SAS metadata information to the JMP file. (Deprecated)

Interaction: The META statement is valid only when DBMS=JMP.

Syntax

META=*libref.member-data-set*;

Required Argument

libref.member-data-set
specifies the SAS data set that contains the metadata information to be written to the JMP file.

The META statement is no longer supported and is ignored. Instead, extended attributes are automatically used. When exporting a SAS data set to JMP, PROC EXPORT looks for extended attributes on the SAS data set. If the attributes exist, the procedure uses the attributes to build the new JMP file.

The META statement can remain in your programs, yet it generates a NOTE in the log saying that META has been replaced by extended attributes and is ignored.

PUTNAMES Statement

Writes SAS variable names as column headings to the first row of the exported data file.

Default: YES

Restriction: Valid only for the EXPORT procedure.

Note: If you specify the LABEL= option, the SAS variable labels (not the variable names) are written as column headings.

Example: "Example 3: Exporting to a Tab Delimited File with the PUTNAMES= Statement" on page 865

Syntax

PUTNAMES=YES | NO;

Required Arguments

YES
specifies that the EXPORT procedure is to do the following tasks:

- Write the SAS variable names as column names (or headings) to the first row of the exported data file.
- Write the first row of the SAS data set to the second row of the exported data file.

NO
specifies that the EXPORT procedure is to write the first row of SAS data set values to the first row of the exported data file.

Examples: EXPORT Procedure

Example 1: Exporting to a Delimited External Data Source

Features: PROC EXPORT statement options
DATA=

DBMS=
OUTFILE=
REPLACE

DELIMITER= statement

Details

This example exports the SASHelp.Class data set to a delimited external file. The following example is the SASHelp.Class data set before it is exported:

Output 23.1 *PROC PRINT of SASHelp.Class*

The SAS System

Obs	Name	Sex	Age	Height	Weight
1	Alfred	M	14	69.0	112.5
2	Alice	F	13	56.5	84.0
3	Barbara	F	13	65.3	98.0
4	Carol	F	14	62.8	102.5
5	Henry	M	14	63.5	102.5
6	James	M	12	57.3	83.0
7	Jane	F	12	59.8	84.5
8	Janet	F	15	62.5	112.5
9	Jeffrey	M	13	62.5	84.0
10	John	M	12	59.0	99.5
11	Joyce	F	11	51.3	50.5
12	Judy	F	14	64.3	90.0
13	Louise	F	12	56.3	77.0
14	Mary	F	15	66.5	112.0
15	Philip	M	16	72.0	150.0
16	Robert	M	12	64.8	128.0
17	Ronald	M	15	67.0	133.0
18	Thomas	M	11	57.5	85.0
19	William	M	15	66.5	112.0

Program

```
proc export data=sashelp.class
   outfile="c:\myfiles\class"
   dbms=dlm replace;

   delimiter='&';
 run;
```

Program Description

Specify the input data set. Note that the filename does not contain an extension. DBMS=DLM specifies that the output file is a delimited file.

```
proc export data=sashelp.class
   outfile="c:\myfiles\class"
   dbms=dlm replace;
```

The DELIMITER option specifies that an & (ampersand) will delimit data fields in the output file.

```
   delimiter='&';
 run;
```

Log

This partial SAS log displays this information about the successful export, including the generated SAS DATA step.

Example Code 23.1 *SAS Log of Creating a Delimited File*

```
1    proc export data=sashelp.class outfile="c:\myfiles\class" dbms=dlm replace;
1  !                                                              delimiter='&' ; run;

2     /*************************************************************************
3     *   PRODUCT:   SAS
4     *   VERSION:   9.3
5     *   CREATOR:   External File Interface
6     *   DATE:      31JAN11
7     *   DESC:      Generated SAS Datastep Code
8     *   TEMPLATE SOURCE:  (None Specified.)
9     *************************************************************************/
10       data _null_;
11       %let _EFIERR_ = 0; /* set the ERROR detection macro variable */
12       %let _EFIREC_ = 0;     /* clear export record count macro variable */
13       file 'c:\myfiles\class' delimiter='&' DSD DROPOVER lrecl=32767;
14       if _n_ = 1 then        /* write column names or labels */
15        do;
16          put
17             "Name"
18          '&'
19             "Sex"
20          '&'
21             "Age"
22          '&'
23             "Height"
24          '&'
25             "Weight"
26          ;
27        end;
28      set  SASHELP.CLASS   end=EFIEOD;
29          format Name $8. ;
30          format Sex $1. ;
31          format Age best12. ;
32          format Height best12. ;
33          format Weight best12. ;
34        do;
35          EFIOUT + 1;
36          put Name $ @;
37          put Sex $ @;
38          put Age @;
39          put Height @;
40          put Weight ;
41          ;
42        end;
43       if _ERROR_ then call symputx('_EFIERR_',1);  /* set ERROR detection macro variable */
44       if EFIEOD then call symputx('_EFIREC_',EFIOUT);
45       run;

NOTE: The file 'c:\myfiles\class' is:
      Filename=c:\myfiles\class,
      RECFM=V,LRECL=32767,File Size (bytes)=0,
      Last Modified=31Jan2011:09:37:14,
      Create Time=31Jan2011:09:37:14
```

Output

The EXPORT procedure produces this external file:

Output 23.2 *External File*

```
Name&Sex&Age&Height&Weight
Alfred&M&14&69&112.5
Alice&F&13&56.5&84
Barbara&F&13&65.3&98
Carol&F&14&62.8&102.5
Henry&M&14&63.5&102.5
James&M&12&57.3&83
Jane&F&12&59.8&84.5
Janet&F&15&62.5&112.5
Jeffrey&M&13&62.5&84
John&M&12&59&99.5
Joyce&F&11&51.3&50.5
Judy&F&14&64.3&90
Louise&F&12&56.3&77
Mary&F&15&66.5&112
Philip&M&16&72&150
Robert&M&12&64.8&128
Ronald&M&15&67&133
Thomas&M&11&57.5&85
William&M&15&66.5&112
```

Example 2: Exporting a Subset of Observations to a CSV File

Features: PROC EXPORT statement options
- DATA=
- DBMS=
- OUTFILE=
- REPLACE

Details

This example exports the SAS data set SASHelp.Class to a delimited file.

Program

Specify the data set to be exported. The WHERE option requests a subset of the observations. The OUTFILE= option specifies the output file. The DBMS= option specifies that the output file is a CSV file, and overwrites the target CSV, if it exists.

```
proc export data=sashelp.class (where=(sex='F'))
     outfile="c:\myfiles\Femalelist.csv"
```

```
     dbms=csv
     replace;
run;
```

Log

This partial SAS log displays this information about the successful export, including the generated SAS DATA step.

Example Code 23.2 *Exporting to a CSV File*

```
579  proc export data=sashelp.class (where=(sex='F'))
580       outfile="c:\myfiles\Femalelist.csv"
581       dbms=csv
582       replace;
583  run;

584   /*********************************************************************
585   *   PRODUCT:   SAS
586   *   VERSION:   9.4
587   *   CREATOR:   External File Interface
588   *   DATE:      18APR14
589   *   DESC:      Generated SAS Datastep Code
590   *   TEMPLATE SOURCE:  (None Specified.)
591   *********************************************************************/
592      data _null_;
593      %let _EFIERR_ = 0; /* set the ERROR detection macro variable */
594      %let _EFIREC_ = 0;     /* clear export record count macro variable */
595      file 'c:\myfiles\Femalelist.csv' delimiter=',' DSD DROPOVER lrecl=32767
595! ;
596      if _n_ = 1 then        /* write column names or labels */
597       do;
598         put
599            "Name"
600         ','
601            "Sex"
602         ','
603            "Age"
604         ','
605            "Height"
606         ','
607            "Weight"
608         ;
609       end;
610     set  SASHELP.CLASS(where=(sex='F'))   end=EFIEOD;
611         format Name $8. ;
612         format Sex $1. ;
613         format Age best12. ;
614         format Height best12. ;
615         format Weight best12. ;
616       do;
617         EFIOUT + 1;
618         put Name $ @;
619         put Sex $ @;
620         put Age @;
621         put Height @;
622         put Weight ;
623         ;
624       end;
625      if _ERROR_ then call symputx('_EFIERR_',1);  /* set ERROR detection
625! macro variable */
626      if EFIEOD then call symputx('_EFIREC_',EFIOUT);
627      run;

NOTE: The file 'c:\myfiles\Femalelist.csv' is:
      Filename=c:\myfiles\Femalelist.csv,
      RECFM=V,LRECL=32767,File Size (bytes)=0,
      Last Modified=18Apr2014:11:32:07,
      Create Time=18Apr2014:11:32:07
```

Output

The EXPORT procedure produces this external CSV file:

Output 23.3 *CSV File*

Name	Sex	Age	Height	Weight
Alice	F	13	56.5	84
Barbara	F	13	65.3	98
Carol	F	14	62.8	102.5
Jane	F	12	59.8	84.5
Janet	F	15	62.5	112.5
Joyce	F	11	51.3	50.5
Judy	F	14	64.3	90
Louise	F	12	56.3	77
Mary	F	15	66.5	112

Example 3: Exporting to a Tab Delimited File with the PUTNAMES= Statement

Features: PROC EXPORT statement options
- DATA=
- DBMS=
- OUTFILE=
- PUTNAMES=
- REPLACE

Details

This example shows exporting a SAS data set, WORK.INVOICE, to a tab-delimited file. The first program uses PROC EXPORT with the PUTNAMES= statement and the second program does not. They show how the use of this statement affects column headings in a tab-delimited file.

The following display shows the SAS data set, WORK.INVOICE, before it is exported to a tab-delimited file:

Output 23.4 *PROC PRINT of WORK.INVOICE*

Obs	Invoice_ID	Billed_To	Amount_Billed_in_Local_Currency	Country	Amount_Billed_in_US_Dollars	Billed_By	Billed_On	Paid_On
1	11270	39045213	8738600640.00	Brazil	3675848666.21	239185	05OCT2004	18OCT2004
2	11271	18543489	11063836.00	USA	11063836.00	457232	05OCT2004	.
3	11273	19783482	252148.50	USA	252148.50	239185	06OCT2004	11NOV2004
4	11276	14324742	1934460.00	USA	1934460.00	135673	06OCT2004	20OCT2004
5	11278	14898029	1400825.00	USA	1400825.00	239185	06OCT2004	19OCT2004
6	11280	39045213	8738600640.00	Brazil	3675848666.21	423286	07OCT2004	20OCT2004
7	11282	19783482	252148.50	USA	252148.50	457232	07OCT2004	25OCT2004
8	11285	38763919	2234301.30	Argentina	772847.05	239185	10OCT2004	30NOV2004
9	11286	43459747	14936604.08	Australia	11366352.06	423286	10OCT2004	.
10	11287	15432147	252148.50	USA	252148.50	457232	11OCT2004	04NOV2004
11	12051	39045213	8738600640.00	Brazil	3675848666.21	457232	02NOV2004	.
12	12102	18543489	11063836.00	USA	11063836.00	239185	17NOV2004	.
13	12263	19783482	252148.50	USA	252148.50	423286	05DEC2004	.
14	12468	14898029	1400825.00	USA	1400825.00	135673	24DEC2004	02JAN2005
15	12471	39045213	8738600640.00	Brazil	3675848666.21	457232	27DEC2004	.
16	12476	38763919	2234301.30	Argentina	772847.05	135673	24DEC2004	.
17	12478	15432147	252148.50	USA	252148.50	423286	24DEC2004	02JAN2005

Program

```
PROC PRINT DATA=WORK.INVOICE;
RUN;

PROC EXPORT DATA=WORK.INVOICE
   OUTFILE="c:\temp\invoice_names.txt"
       DBMS=TAB REPLACE;
   PUTNAMES=YES;
RUN;
PROC PRINT;
RUN;

PROC EXPORT DATA=WORK.INVOICE
   OUTFILE="c:\temp\invoice_data_1st.txt"
      DBMS=TAB REPLACE;
   PUTNAMES=NO;
RUN;

PROC PRINT;
RUN;
```

Program Description

Use the PUTNAMES=YES statement in the EXPORT procedure. After WORK.INVOICE is printed, using the PUTNAMES=YES statement writes the SAS variables names as column names to the first row of the exported delimited file,

Invoice_names.txt. The first row of data is then written to the second row of the delimited file.

```
PROC PRINT DATA=WORK.INVOICE;
RUN;

PROC EXPORT DATA=WORK.INVOICE
   OUTFILE="c:\temp\invoice_names.txt"
       DBMS=TAB REPLACE;
   PUTNAMES=YES;
RUN;
PROC PRINT;
RUN;
```

Impact of the PUTNAMES=NO statement. When you set this statement to NO, PROC EXPORT writes the first row of data to the first row of the exported delimited file. Therefore, the SAS variable names are skipped, and the columns are left unlabeled.

```
PROC EXPORT DATA=WORK.INVOICE
   OUTFILE="c:\temp\invoice_data_1st.txt"
      DBMS=TAB REPLACE;
   PUTNAMES=NO;
RUN;

PROC PRINT;
RUN;
```

SAS Log

This SAS log displays information about the successful export, including the generated SAS DATA step. The log is divided into sections only for documentation appearances.

```
490  PROC EXPORT DATA= WORK.INVOICE
491              OUTFILE= "c:\temp\invoice_names.txt"
492              DBMS=TAB REPLACE;
493       PUTNAMES=YES;
494  RUN;

495   /*************************************************************************
496   *   PRODUCT:   SAS
497   *   VERSION:   9.4
498   *   CREATOR:   External File Interface
499   *   DATE:      24MAY14
500   *   DESC:      Generated SAS Datastep Code
501   *   TEMPLATE SOURCE:  (None Specified.)
502   *************************************************************************/
503      data _null_;
504      %let _EFIERR_ = 0; /* set the ERROR detection macro variable */
505      %let _EFIREC_ = 0;     /* clear export record count macro variable */
506      file 'c:\temp\invoice_names.txt' delimiter='09'x DSD DROPOVER lrecl=32767;
507      if _n_ = 1 then        /* write column names or labels */
508       do;
509         put
510            "INVNUM"
511         '09'x
512            "BILLEDTO"
513         '09'x
514            "AMTBILL"
515         '09'x
516            "COUNTRY"
517         '09'x
518            "AMTINUS"
519         '09'x
520            "BILLEDBY"
521         '09'x
522            "BILLEDON"
523         '09'x
524            "PAIDON"
525         ;
526       end;
527     set  WORK.INVOICE   end=EFIEOD;
528         format INVNUM best12. ;
529         format BILLEDTO $8. ;
530         format AMTBILL dollar18.2 ;
531         format COUNTRY $20. ;
532         format AMTINUS dollar18.2 ;
533         format BILLEDBY best12. ;
534         format BILLEDON date9. ;
535         format PAIDON date9. ;
536       do;
537         EFIOUT + 1;
538         put INVNUM @;
539         put BILLEDTO $ @;
540         put AMTBILL @;
541         put COUNTRY $ @;
542         put AMTINUS @;
543         put BILLEDBY @;
544         put BILLEDON @;
545         put PAIDON ;
546         ;
547       end;
548      if _ERROR_ then call symputx('_EFIERR_',1);  /* set ERROR detection macro
variable */
549      if EFIEOD then call symputx('_EFIREC_',EFIOUT);
550      run;
```

```
NOTE: The file 'c:\temp\invoice_names.txt' is:
      Filename=c:\temp\invoice_names.txt,
      RECFM=V,LRECL=32767,File Size (bytes)=0,
      Last Modified=24May2014:15:46:36,
      Create Time=24May2014:15:46:36

NOTE: 18 records were written to the file 'c:\temp\invoice_names.txt'.
      The minimum record length was 60.
      The maximum record length was 84.
NOTE: There were 17 observations read from the data set WORK.INVOICE.
NOTE: DATA statement used (Total process time):
      real time           0.04 seconds
      cpu time            0.03 seconds

17 records created in c:\temp\invoice_names.txt from WORK.INVOICE.

NOTE: "c:\temp\invoice_names.txt" file was successfully created.
NOTE: PROCEDURE EXPORT used (Total process time):
      real time           0.20 seconds
      cpu time            0.17 seconds

551  PROC PRINT; RUN;

NOTE: No observations in data set SASUSER.SASMBC.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds

552
553
554  PROC EXPORT DATA= WORK.INVOICE
555              OUTFILE= "c:\temp\invoice_data_1st.txt"
556              DBMS=TAB REPLACE;
557       PUTNAMES=NO;
558  RUN;
```

```
559   /************************************************************************
560   *   PRODUCT:   SAS
561   *   VERSION:   9.4
562   *   CREATOR:   External File Interface
563   *   DATE:      24MAY14
564   *   DESC:      Generated SAS Datastep Code
565   *   TEMPLATE SOURCE:  (None Specified.)
566   ************************************************************************/
567      data _null_;
568      %let _EFIERR_ = 0; /* set the ERROR detection macro variable */
569      %let _EFIREC_ = 0;     /* clear export record count macro variable */
570      file 'c:\temp\invoice_data_1st.txt' delimiter='09'x DSD DROPOVER
lrecl=32767;
571     set  WORK.INVOICE   end=EFIEOD;
572         format INVNUM best12. ;
573         format BILLEDTO $8. ;
574         format AMTBILL dollar18.2 ;
575         format COUNTRY $20. ;
576         format AMTINUS dollar18.2 ;
577         format BILLEDBY best12. ;
578         format BILLEDON date9. ;
579         format PAIDON date9. ;
580       do;
581         EFIOUT + 1;
582         put INVNUM @;
583         put BILLEDTO $ @;
584         put AMTBILL @;
585         put COUNTRY $ @;
586         put AMTINUS @;
587         put BILLEDBY @;
588         put BILLEDON @;
589         put PAIDON ;
590         ;
591       end;
592      if _ERROR_ then call symputx('_EFIERR_',1);  /* set ERROR detection macro
variable */
593      if EFIEOD then call symputx('_EFIREC_',EFIOUT);
594      run;

NOTE: The file 'c:\temp\invoice_data_1st.txt' is:
      Filename=c:\temp\invoice_data_1st.txt,
      RECFM=V,LRECL=32767,File Size (bytes)=0,
      Last Modified=24May2014:15:46:36,
      Create Time=24May2014:15:46:36

NOTE: 17 records were written to the file 'c:\temp\invoice_data_1st.txt'.
      The minimum record length was 60.
      The maximum record length was 84.
NOTE: There were 17 observations read from the data set WORK.INVOICE.
NOTE: DATA statement used (Total process time):
      real time           0.03 seconds
      cpu time            0.03 seconds

17 records created in c:\temp\invoice_data_1st.txt from WORK.INVOICE.

NOTE: "c:\temp\invoice_data_1st.txt" file was successfully created.
NOTE: PROCEDURE EXPORT used (Total process time):
      real time           0.07 seconds
      cpu time            0.07 seconds

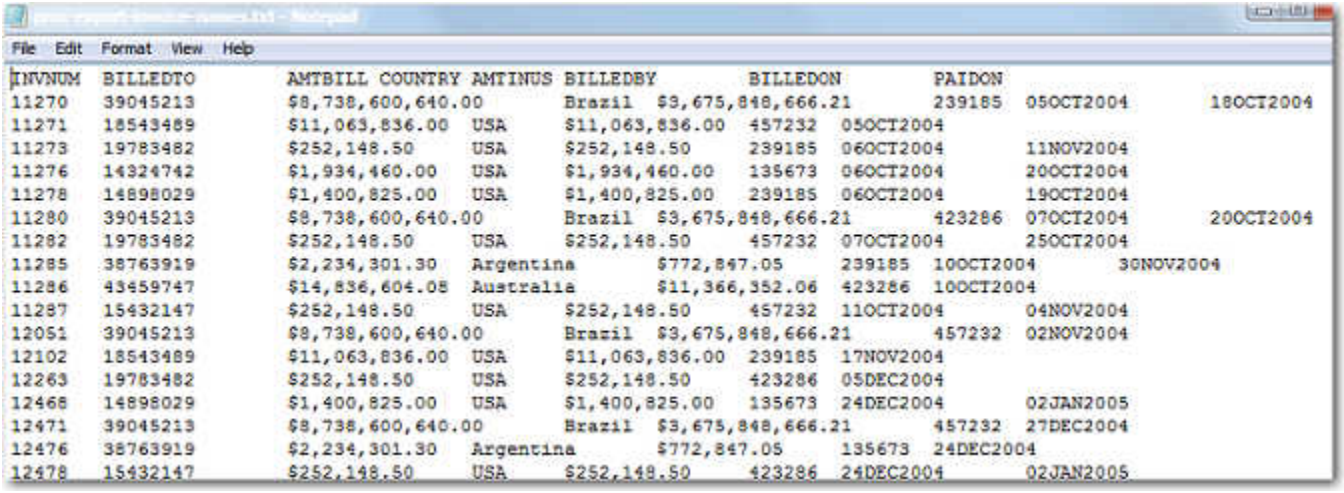
595
596  PROC PRINT; RUN;

NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds
```

Output Example

Using the PROC EXPORT PUTNAMES=YES statement, the SAS variable names are mapped to the column headings in the tab-delimited file. This is the default behavior.

Output 23.5 *SAS Data Exported to a Tab-Delimited File Using the PUTNAMES=YES Statement*



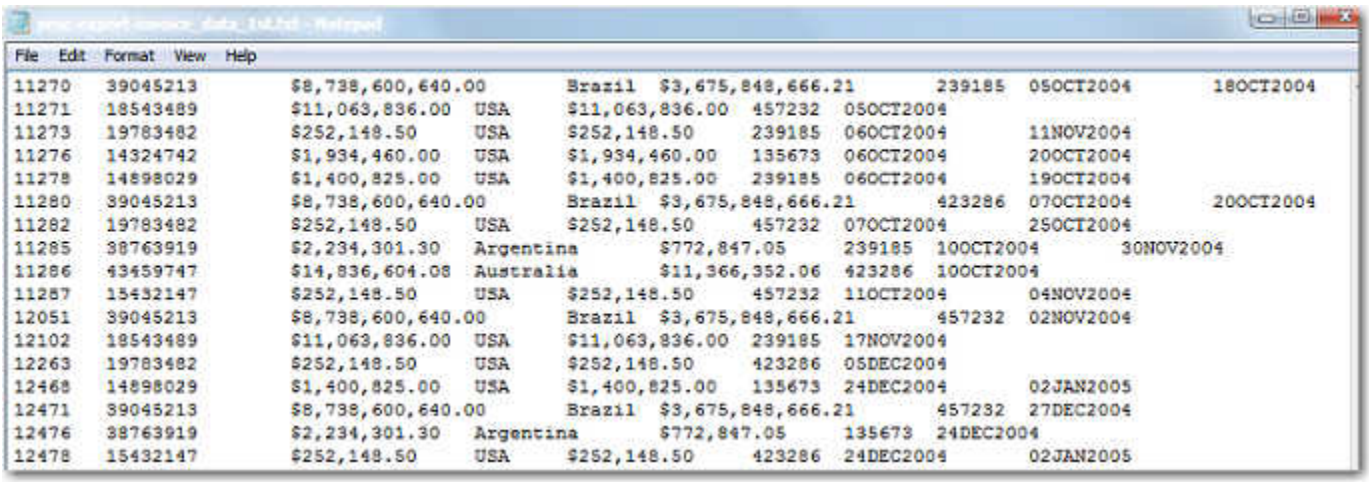
File Edit Format View Help

INVNUM	BILLEDTO	AMTBILL	COUNTRY	AMTINUS	BILLEDBY	BILLEDON	PAIDON		
11270	39045213	$8,738,600,640.00			Brazil	$3,675,848,666.21	239185	05OCT2004	18OCT2004
11271	18543489	$11,063,836.00	USA		$11,063,836.00	457232	05OCT2004		
11273	19783482	$252,148.50	USA		$252,148.50	239185	06OCT2004	11NOV2004	
11276	14324742	$1,934,460.00	USA		$1,934,460.00	135673	06OCT2004	20OCT2004	
11278	14898029	$1,400,825.00	USA		$1,400,825.00	239185	06OCT2004	19OCT2004	
11280	39045213	$8,738,600,640.00			Brazil	$3,675,848,666.21	423286	07OCT2004	20OCT2004
11282	19783482	$252,148.50	USA		$252,148.50	457232	07OCT2004	25OCT2004	
11285	38763919	$2,234,301.30	Argentina		$772,847.05	239185	10OCT2004	30NOV2004	
11286	43459747	$14,836,604.08	Australia		$11,366,352.06	423286	10OCT2004		
11287	15432147	$252,148.50	USA		$252,148.50	457232	11OCT2004	04NOV2004	
12051	39045213	$8,738,600,640.00			Brazil	$3,675,848,666.21	457232	02NOV2004	
12102	18543489	$11,063,836.00	USA		$11,063,836.00	239185	17NOV2004		
12263	19783482	$252,148.50	USA		$252,148.50	423286	05DEC2004		
12468	14898029	$1,400,825.00	USA		$1,400,825.00	135673	24DEC2004	02JAN2005	
12471	39045213	$8,738,600,640.00			Brazil	$3,675,848,666.21	457232	27DEC2004	
12476	38763919	$2,234,301.30	Argentina		$772,847.05	135673	24DEC2004		
12478	15432147	$252,148.50	USA		$252,148.50	423286	24DEC2004	02JAN2005	

Output Example

Using the PROC EXPORT PUTNAMES=NO statement results in unnamed columns in the tab-delimited file.

Output 23.6 *SAS Data Exported to a Tab-Delimited File Using the PUTNAMES=NO Statement*



File Edit Format View Help

11270	39045213	$8,738,600,640.00			Brazil	$3,675,848,666.21	239185	05OCT2004	18OCT2004
11271	18543489	$11,063,836.00	USA		$11,063,836.00	457232	05OCT2004		
11273	19783482	$252,148.50	USA		$252,148.50	239185	06OCT2004	11NOV2004	
11276	14324742	$1,934,460.00	USA		$1,934,460.00	135673	06OCT2004	20OCT2004	
11278	14898029	$1,400,825.00	USA		$1,400,825.00	239185	06OCT2004	19OCT2004	
11280	39045213	$8,738,600,640.00			Brazil	$3,675,848,666.21	423286	07OCT2004	20OCT2004
11282	19783482	$252,148.50	USA		$252,148.50	457232	07OCT2004	25OCT2004	
11285	38763919	$2,234,301.30	Argentina		$772,847.05	239185	10OCT2004	30NOV2004	
11286	43459747	$14,836,604.08	Australia		$11,366,352.06	423286	10OCT2004		
11287	15432147	$252,148.50	USA		$252,148.50	457232	11OCT2004	04NOV2004	
12051	39045213	$8,738,600,640.00			Brazil	$3,675,848,666.21	457232	02NOV2004	
12102	18543489	$11,063,836.00	USA		$11,063,836.00	239185	17NOV2004		
12263	19783482	$252,148.50	USA		$252,148.50	423286	05DEC2004		
12468	14898029	$1,400,825.00	USA		$1,400,825.00	135673	24DEC2004	02JAN2005	
12471	39045213	$8,738,600,640.00			Brazil	$3,675,848,666.21	457232	27DEC2004	
12476	38763919	$2,234,301.30	Argentina		$772,847.05	135673	24DEC2004		
12478	15432147	$252,148.50	USA		$252,148.50	423286	24DEC2004	02JAN2005	

24

FCMP Procedure

Overview: FCMP Procedure

What Does the FCMP Procedure Do?

The SAS Function Compiler (FCMP) procedure enables you to create, test, and store SAS functions, CALL routines, and subroutines before you use them in other SAS procedures or DATA steps. PROC FCMP provides the ability to build functions, CALL routines, and subroutines using DATA step syntax that is stored in a data set. The procedure accepts slight variations of DATA step statements, and you can use most features of the SAS programming language in functions and CALL routines that are created by PROC FCMP. You can call PROC FCMP functions and CALL routines from the DATA step just as you would any other SAS function, CALL routine, or subroutine. This feature enables programmers to more easily read, write, and maintain complex code with independent and reusable subroutines. You can reuse the PROC FCMP routines in any DATA step or SAS procedure that has access to their storage location.

The FCMP procedure uses the SAS language compiler to compile and execute SAS programs. The compiler subsystem generates machine language code for the computer on which SAS is running. By specifying values with the CMPOPT option, the machine language code can be optimized for efficient execution. For information about the type of code generation optimizations to use in the SAS language compiler, see "CMPOPT= System Option" in *SAS System Options: Reference*.

You can use the functions and subroutines that you create in PROC FCMP with the DATA step, the WHERE statement, the Output Delivery System (ODS), and with the following procedures:

PROC CALIS	PROC OPTMODEL
PROC FORMAT	PROC PHREG
PROC GA	PROC QUANTREG

PROC GENMOD	PROC REPORT COMPUTE blocks
PROC GLIMMIX	SAS Risk Dimensions procedures
PROC MCMC	PROC SEVERITY
PROC MODEL	PROC SIMILARITY
PROC NLIN	PROC SQL (functions with array arguments are not supported)
PROC NLMIXED	PROC SURVEYPHREG
PROC NLP	PROC TMODEL
PROC OPTLSO	PROC VARMAX

Concepts: FCMP Procedure

Creating Functions and Subroutines

PROC FCMP enables you to write functions and CALL routines using DATA step syntax. PROC FCMP functions and CALL routines are stored in a data set and can be called from the DATA step, as well as several SAS/STAT, SAS/ETS, or SAS/OR procedures such as the NLIN, MODEL, and NLP procedures. You can create multiple functions and CALL routines in a single FCMP procedure step.

Functions are equivalent to routines that are used in other programming languages. They are independent computational blocks that require zero or more arguments. A subroutine is a special type of function where return values are optional. All variables that are created within a function or subroutine block are local to that subroutine.

Creating Functions and Subroutines: An Example

This following example defines a function and a subroutine. The function begins with the FUNCTION statement, and the subroutine begins with the SUBROUTINE statement. The DAY_DATE function converts a date to a numeric day of the week,

and the INVERSE subroutine calculates a simple inverse. Each ends with an ENDSUB statement.

```
proc fcmp outlib=sasuser.MySubs.Fncs;
  function day_date(indate);
    wkday=weekday(indate);
    return(wkday);
  endsub;

  subroutine inverse(in, inv);
    outargs inv;
    if in=0
       then inv=.;
       else inv=1/in;
    endsub;
quit;

option cmplib=sasuser.MySubs;

data _null_;
daysDate=day_date(today());
put daysDate=;

CALL inverse(12, inverseValue);
put inverseValue=;
run;
```

These statements produce these results:

```
daysDate=2
inverseValue=0.0833333333
```

Note: The output will change based on the value of "today()".

The function and subroutine follow DATA step syntax. Functions and subroutines that are already defined in the current FCMP procedure step, as well as most DATA step functions, can be called from within these routines as well. In the example above, the DATA step function WEEKDAY is called by DAY_DATE.

The routines in the example are saved to the data set Sasuser.MySubs, inside a package called MathFncs. A package is any collection of related routines that are specified by the user. It is a way of grouping related subroutines and functions within the data set. The OUTLIB= option in the PROC FCMP statement tells PROC FCMP where to store the subroutines that it compiles, and the LIBRARY= option tells it where to read in libraries (C or SAS).

Note: Function and subroutine names must be unique within a package. However, different packages can have subroutines and functions with the same names. To select a specific subroutine when there is ambiguity, use the package name and a period as the prefix to the subroutine name. For example, to access the MthFncs version of INVERSE, use MthFncs.inverse.

Writing Your Own Functions

Advantages of Writing Your Own Functions and CALL Routines

PROC FCMP enables you to write functions and CALL routines by using DATA step syntax. The advantages of writing user-defined functions and CALL routines include the following:

- The function or CALL routine makes a program easier to read, write, and modify.
- The function or CALL routine is independent. A program that calls a routine is not affected by the routine's implementation.
- The function or CALL routine is reusable. Any program that has access to the data set where the function or routine is stored can call the routine.

Note: PROC FCMP routines that you create cannot have the same name as built-in SAS functions. If the names are the same, then SAS generates an error message stating that a built-in SAS function or subroutine already exists with the same name.

Writing a User-Defined Function

The following program shows the syntax that is used to create and call a PROC FCMP function from a DATA step. This example computes the study day during a drug trial.

The example creates a function named STUDY_DAY in a package named TRIAL. A package is a collection of routines that have unique names and is stored in the data set Sasuser.Funcs. STUDY_DAY accepts two numeric arguments, *intervention_date* and *event_date*. The body of the routine uses DATA step syntax to compute the difference between the two dates, where days that occur before *intervention_date* begin at -1 and become smaller, and days that occur after and including *intervention_date* begin at 1 and become larger. This function never returns 0 for a study day.

STUDY_DAY is called from DATA step code as if it were any other function. When the DATA step encounters a call to STUDY_DAY, it does not find this function in its traditional library of functions. Instead, SAS searches each of the libraries or data sets that are specified in the CMPLIB= system option for a package that contains STUDY_DAY. In this example, STUDY_DAY is located in Sasuser.Funcs.Trial. The

program calls the function, passing the variable values for *start_date* and *end_date*, and returns the result in the variable **sd**.

```
proc fcmp outlib=sasuser.funcs.trial;
   function study_day(intervention_date, event_date);
       n=event_date-intervention_date;
       if n <= 0 then
       n=n+1;
       return(n);
   endsub;

options cmplib=sasuser.funcs;
data _null_;
   start_date='15Feb2006'd;
   end_date='27Mar2006'd;
   sd=study_day(start, today);
   put sd=;
run;
```

Example Code 24.1 *Results from the STUDY_DAY User-Defined Function*

```
sd=40
```

Using Library Options

You can use PROC FCMP with the OUTLIB= or INLIB= options. The syntax for this procedure has the following form:

```
proc fcmp
outlib=libname.dataset.package
          inlib=in-libraries;
routine-declarations;
```

The OUTLIB= option is required and specifies the package where routines declared in the *routine-declarations* section are stored.

Routines that are declared in the *routine-declarations* section can call FCMP routines that exist in other packages. To find these routines and to check the validity of the call, SAS searches the data sets that are specified in the INLIB= option. The format for the INLIB= option is as follows:

```
inlib=library.dataset
inlib=(library1.dataset1 library2.dataset2 ... libraryN.datasetN)
inlib=library.datasetM - library.datasetN
```

If the routines that are being declared do not call FCMP routines in other packages, then you do not need to specify the INLIB= option.

Declaring Functions

You declare one or more functions or CALL routines in the *routine-declarations* section of the program. A routine consists of four parts:

- a name
- one or more parameters
- a body of code
- a RETURN statement

You specify these four parts between the FUNCTION or SUBROUTINE keyword and an ENDSUB keyword. For functions, the syntax has the following form:

```
function
name(argument-1 <, argument-2, ...>);
   program-statements;
   return(expression);
endsub;
```

After the FUNCTION keyword, you specify the name of the function and its arguments. Arguments in the function declaration are called formal arguments and can be used within the body of the function. To specify a string argument, place a dollar sign ($) after the argument name. For functions, all arguments are passed by value. This means that the value of the actual argument, variable, or value that is passed to the function from the calling environment is copied before being used by the function. This copying ensures that any modification of the formal argument by the function does not change the original value.

The RETURN statement is used to return a value to a function. The RETURN statement accepts an expression that is enclosed in parentheses, and contains the value that is returned to the calling environment. The function declaration ends with an ENDSUB statement.

Declaring CALL Routines

CALL routines are declared within *routine-declarations* by using the SUBROUTINE keyword instead of the FUNCTION keyword. Functions and CALL routines have the same form, except CALL routines do not return a value, and CALL routines can modify their parameters. You specify the arguments to be modified in an OUTARGS statement. The syntax of a CALL routine declaration is as follows:

```
subroutine
name(<argument-1 , argument-2, ...>);
   outargs <out-argument-1 , out-argument-2, ...>;
   program-statements;
   return;
endsub;
```

The formal arguments that are listed in the OUTARGS statement are passed by reference instead of by value. This means that any modification of the formal

argument by the CALL routine modifies the original variable that was passed. It also means that the value is not copied when the CALL routine is invoked. Reducing the number of copies can improve performance when you pass large amounts of data between a CALL routine and the calling environment.

A RETURN statement is optional within the definition of the CALL routine. When a RETURN statement executes, execution is immediately returned to the caller. A RETURN statement within a CALL routine does not return a value.

Writing Program Statements

The program-statements section of the program is a series of DATA step and or FCMP statements that describe the work to be done by the function or CALL routine. Most DATA step statements and functions are accessible from PROC FCMP routines. The DATA step file and the data set I/O statements (for example, INPUT, FILE, SET, and MERGE) are not available from PROC FCMP routines. However, some functionality of the PUT statement is supported. For more information, see "PROC FCMP and DATA Step Differences" on page 898.

Using Functions as Formats

PROC FCMP enables you to use functions to format values by first performing a function on a value. By using a function to format values, you can create customized formats.

Using DATA Step Statements with PROC FCMP

You can use DATA step statements with PROC FCMP. However, there are some differences in the syntax and functionality for PROC FCMP. For more information, see "PROC FCMP and DATA Step Differences" on page 898.

The behaviors of the DROP, KEEP, FORMAT, and LENGTH statements are the same in PROC FCMP and in the DATA step.

The following DATA step statements are not supported in PROC FCMP:

- DATA
- SET
- MERGE
- UPDATE
- MODIFY
- INPUT
- INFILE

The support for the FILE statement is limited to LOG and PRINT destinations in PROC FCMP. The OUTPUT statement is supported in PROC FCMP, but it is not supported within a function or subroutine.

The following statements are supported in PROC FCMP but not in the DATA step:

- FUNCTION
- STRUCT
- SUBROUTINE
- OUTARGS

Syntax: FCMP Procedure

PROC FCMP *options*;

ABORT;

ARRAY *array-name*[*dimensions*] </NOSYMBOLS> | <*variable(s)*> | <*constant(s)*> | <*initial-values)*>;

ATTRIB *variable(s)* <FORMAT=*format-name* ><LABEL='*label*'>< LENGTH=*length*>;

DELETEFUNC *function-name*;

DELETESUBR *subroutine-name*;

FUNCTION *function-name(argument(s))* <VARARGS> <$> <*length*> <KIND | GROUP='*string*' <LABEL='*string-2*'>>;

LABEL *variable*='*label*';

LISTFUNC *function-name*;

LISTSUBR *subroutine-name*;

STRUCT *structure-name variable*;

SUBROUTINE *subroutine-name (argument(s))* <VARARGS> <LABEL='*label*'> <KIND | GROUP='*string*'>;

OUTARGS *out-argument(s)*;

Statement	Task	Example
PROC FCMP	Create, test, and store SAS functions for use by other SAS procedures	Ex. 1, Ex. 2, Ex. 8, Ex. 7
ABORT	Terminate the execution of the current DATA step, SAS job, or SAS session	
ARRAY	Associate a name with a list of variables and constants	Ex. 8
ATTRIB	Specify format, label, and length information for a variable	

Statement	Task	Example
DELETEFUNC	Delete a function from the function library that is specified in the OUTLIB option	
DELETESUBR	Delete a subroutine from the function library that is specified in the OUTLIB option	
FUNCTION	Return changed variable values	Ex. 1, Ex. 2, Ex. 7
LABEL	Specify a label for variables	
LISTFUNC	Write the source code of a function in the SAS listing	
LISTSUBR	Write the source code for a subroutine in the SAS listing	
STATIC	retains a variable's value from a previous call until the variable is reassigned.	
STRUCT	Declare (create) structure types	
SUBROUTINE	Declare (create) independent computational blocks of code	Ex. 8
OUTARGS	(Use only with the SUBROUTINE statement.) Specify arguments from the argument list that the subroutine should update	Ex. 2, Ex. 8

PROC FCMP Statement

Creates, tests, and stores SAS functions, CALL routines, and subroutines.

Examples:

"Example 1: Creating a Function and Calling the Function from a DATA Step" on page 925

"Example 2: Creating and Saving Functions with PROC FCMP" on page 927

"Example 7: Using Graph Template Language (GTL) with User-Defined Functions" on page 932

"Example 8: Standardizing Each Row of a Data Set" on page 934

Syntax

PROC FCMP *options*;

Optional Arguments

DATA=*filename*
reads an input data set into the PROC FCMP step.

Note: The DATA option can send inputs to a function or subroutine that are defined in the PROC FCMP step. The PROC FCMP step iterates through each observation and calls the function or subroutine during each iteration.

Note: For more information about the DATA= and OUT= options, see "Data Set Input and Output" on page 899.

Note: This example demonstrates using the DATA= and OUT= options in the PROC FCMP statement.

Example

```
proc fcmp outlib=sasuser.funcs.trial;
   function priceWithTax_func(price);
     static taxRate;
      if (taxRate EQ .) then
         taxRate = (7.25 / 100);
     taxedPrice = (price * (1 + taxRate));
      return (taxedPrice);
   endsub;
run;

option CMPLIB=sasuser.funcs;

proc fcmp data=sashelp.cars out=work.carPriceWithTax;
   format msrpWithTax DOLLAR8.;
   msrpWithTax = priceWithTax_func(msrp);
run;

proc print data=work.carPriceWithTax(obs=5 keep=make model
invoice msrp msrpWithTax);
run;
```

ENCRYPT
specifies to encode the source code in a data set. The alias HIDE is also valid.

FLOW
specifies printing a message for each statement in a program as it is executed. This option produces extensive output.

LIBRARY | INLIB=*library.dataset*
LIBRARY | INLIB=(*library-1.dataset library-2.dataset ... library-n.dataset)*
LIBRARY | INLIB=*library.datasetM - library.datasetN*
specifies that previously compiled libraries are to be linked into the program. These libraries are created by a previous PROC FCMP step or by using PROC PROTO (for external C routines).

Tips Libraries are created by the OUTLIB= option and are stored as members of a SAS library that have the type CMPSUB. Only subroutines and functions are read into the program when you use the LIBRARY= option.

If the routines that are being declared do not call PROC FCMP routines in other packages, then you do not need to specify the INLIB= option. Use the *libref.dataset* format to specify the two-level name of a library. The *libref* and *dataset* names must be valid SAS names that are not longer than eight characters.

You can specify a list of files with the LIBRARY= option, and you can specify a range of names by using numeric suffixes. When you specify more than one file, you must enclose the list in parentheses, except in the case of a single range of names. The following are syntax examples:

```
proc fcmp library=sasuser.exsubs;
proc fcmp library=(sasuser.exsubs work.examples);
proc fcmp library=lib1-lib10;
```

LIST
specifies that both the LISTSOURCE and LISTPROG options are in effect.

Tip Printing both the source code and the compiled code and then comparing the two listings of assignment statements is one way of verifying that the assignments were compiled correctly.

LISTALL
specifies that the LISTCODE, LISTPROG, and LISTSOURCE options are in effect.

LISTCODE
specifies that the compiled program code be printed. LISTCODE lists the chain of operations that are generated by the compiler.

Tip Because LISTCODE output is somewhat difficult to read, use the LISTPROG option to obtain a more readable listing of the compiled program code.

LISTFUNCS
specifies that prototypes for all visible FCMP functions or subroutines be written to the SAS listing.

LISTPROG
specifies that the compiled program be printed. The listing for assignment statements is generated from the chain of operations that are generated by the compiler. The source statement text is printed for other statements.

Tip The expressions that are printed by the LISTPROG option do not necessarily represent how the expression is actually calculated, because intermediate results for common subexpressions can be reused. However, the expressions are printed in expanded form by the LISTPROG option. To see how the expression is actually evaluated, see the listing from the LISTCODE option.

LISTSOURCE
specifies that source code statements for the program be printed.

OUT=*filename*
creates an output data set.

OUTFILE=*filename*
writes referenced functions and the main program to a text file. Programs that have been parsed by PROC FCMP, including macro variables, can be exported.

OUTITEMSTORE=*path name*
exports symbols, referenced functions, and the main program to the specified item store. OUTITEMSTORE does not support a fileref. You must use a quoted path.

OUTLIB=*libname.dataset.package*
specifies the three-level name of an output data set to which the compiled subroutines and functions are written when the PROC FCMP step ends. This argument is required. The following are syntax examples:

```
proc fcmp outlib=sasuser.fcmpsubs.pkt1;
```

```
proc fcmp outlib=sasuser.mysubs.math;
```

Tips Use this option when you want to save subroutines and functions in an output library.

Only those subroutines that are declared inside the current PROC FCMP step are saved to the output file. Those subroutines that are loaded by using the LIBRARY= option are not saved to the output file. If you do not specify the OUTLIB= option, then no subroutines that are declared in the current PROC FCMP step are saved.

PRINT
specifies printing the result of each statement in a program as it is executed. This option produces extensive output.

TRACE
specifies printing the results of each operation in each statement in a program as it is executed. These results are produced in addition to the information that is printed by the FLOW option. The TRACE option produces extensive output.

Notes Specifying TRACE is equivalent to specifying FLOW, PRINT, and PRINTALL.

The TRACE option works when the data is contained within PROC FCMP, not when calling FCMP functions from the DATA step. This example and output demonstrate the functionality of the TRACE option.

Example
```
proc fcmp outlib=work.funcs.trial TRACE;
   function study_day(intervention_date, event_date);
   n=event_date - intervention_date;
   if n >= 0 then n=n + 1;
      return(n);
   endsub;
   start='15Feb2010'd;
   today='27Mar2010'd;
   sd=study_day(start, today);
run;
```

```
                                        The FCMP Procedure

--- Program Execution Starting.
    1    1 (20:4)    Executing Stmt            : ASSIGN start =
    1      (20:9)    start = 18308
    1    2 (21:4)    Executing Stmt            : ASSIGN today =
    1      (21:9)    today = 18348
    1    3 (22:4)    Executing Stmt            : ASSIGN sd =


--- Subroutine study_day Execution Starting.
    1    1 (15:4)    Executing Stmt            : FUNCTION
    1    2 (16:4)    Executing Stmt            : ASSIGN n =
    1      (16:17)   n = (event_date=18348) - (intervention_date=18308)
= 40
    1    3 (17:4)    Executing Stmt            : IF
    1      (17:10)   _temp1 = (n=40) >= 0
    1    4 (17:17)   Executing Stmt            : ASSIGN n =
    1      (17:21)   n = (n=41) + 1 = 41
    1    5 (18:7)    Executing Stmt            : RETURN _study_day_ =
    1      (18:14)   _study_day_ = (n=41) = 41
    1    6 (19:4)    Executing Stmt            : ENDSUB
--- Subroutine study_day Execution Finished.

    1      (22:16)   sd = study_day( start=18308, today=18348 ) = 41
--- Program Execution Finished.
```

ABORT Statement

Terminates the current DATA step, job, or SAS session.

Syntax

ABORT;

Without Arguments

The ABORT statement in PROC FCMP has no arguments.

ARRAY Statement

Associates a name with a list of variables and constants.

Example: "Example 8: Standardizing Each Row of a Data Set" on page 934

Syntax

ARRAY *array-name*[*dimensions*] </NOSYMBOLS> | <*variable(s)*> | <*constant(s)*> | <*initial-values*>;

Required Arguments

array-name
specifies the name of the array.

dimensions
is a numeric representation of the number of elements in a one-dimensional array or the number of elements in each dimension of a multidimensional array.

Optional Arguments

/NOSYMBOLS
specifies that an array of numeric or character values be created without the associated element variables. In this case, the only way that you can access elements in the array is by array subscripting.

Tips /NOSYMBOLS is used in exactly the same way as _TEMPORARY_.

You can save memory if you do not need to access the individual array element variables by name.

variable
specifies the variables of the array.

constant
specifies a number or a character string that indicates a fixed value. Enclose character constants in quotation marks.

initial-values
gives initial values for the corresponding elements in the array. You can specify internal values inside parentheses.

Details

ARRAY Statement Basics

The ARRAY statement in PROC FCMP is similar to the ARRAY statement that is used in the DATA step. The ARRAY statement associates a name with a list of variables and constants. You use the array name with subscripts to refer to items in the array.

The ARRAY statement that is used in PROC FCMP does not support all the features of the ARRAY statement in the DATA step. Here is a list of differences that apply only to PROC FCMP:

- All array references must have explicit subscript expressions.

- PROC FCMP uses parentheses after a name to represent a function call. When you reference an array, use square brackets [ ] or braces { }.
- The ARRAY statement in PROC FCMP does not support lower-bound specifications.
- You can use a maximum of six dimensions for an array.

You can use both variables and constants as array elements in the ARRAY statement that is used in PROC FCMP. You cannot assign elements to a constant array. Although dimension specification and the list of elements are optional, you must provide one of these values. If you do not specify a list of elements for the array, or if you list fewer elements than the size of the array, PROC FCMP creates array variables by adding a numeric suffix to the elements of the array to complete the element list.

Passing Array References to PROC FCMP Routines

If you want to pass an array to a CALL routine and the CALL routine modifies the values of the array, you must specify the name for the array argument in an OUTARGS statement in the CALL routine.

Example

Here are some examples of the ARRAY statement:

```
array spot_rate[3] 1 2 3;
array spot_rate[3] (1 2 3);
array y[4] y1-y4;
array xx[2,3] x11 x12 x13 x21 x22 x23;
array pp p1-p12;
array q[1000] /nosymbols;
```

ATTRIB Statement

Specifies format, label, and length information for variables.

Syntax

ATTRIB *variable(s)* <FORMAT=*format-name* LABEL='*label*' LENGTH=*length*>;

Required Argument

variable
specifies the variables that you want to associate with attributes.

Optional Arguments

FORMAT=*format-name*
associates a format with variables in the *variable* argument.

LABEL='*label*'
associates a label with variables in the *variable* argument.

LENGTH=*length*
specifies the length of the variable in the *variable* argument.

Example

Here are some examples of the ATTRIB statement:

```
attrib x1 format=date7. label='variable x1' length=5;

attrib x1 format=date7. label='variable x1' length=5
       x2 length=5
       x3 label='var x3' format=4.
       x4 length=$2 format=$4.;
```

DELETEFUNC Statement

Causes a function to be deleted from the function library that is specified in the OUTLIB option.

Syntax

DELETEFUNC *function-name*;

Required Argument

function-name
specifies the name of a function to be deleted from the function library that is specified in the OUTLIB option.

DELETESUBR Statement

Causes a subroutine to be deleted from the function library that is specified in the OUTLIB option.

Syntax

DELETESUBR *subroutine-name*;

Required Argument

subroutine-name
specifies the name of a subroutine to be deleted from the function library that is specified in the OUTLIB option.

FUNCTION Statement

Specifies a subroutine declaration for a routine that returns a value.

Examples:
"Example 1: Creating a Function and Calling the Function from a DATA Step" on page 925
"Example 2: Creating and Saving Functions with PROC FCMP" on page 927
"Example 3: Using Numeric Data in the FUNCTION Statement" on page 929
"Example 4: Using Character Data with the FUNCTION Statement" on page 929
"Example 5: Using Variable Arguments with an Array" on page 930
"Example 7: Using Graph Template Language (GTL) with User-Defined Functions" on page 932

Syntax

FUNCTION *function-name*(*argument-1* <, *argument-2, ...*>) <VARARGS> <$> <*length*>
<KIND | GROUP='*string*' ><LABEL='*string-2*'>;

... more-program-statements ...

RETURN (*expression*);

ENDSUB;

Required Arguments

function-name
specifies the name of the function.

argument
specifies one or more arguments for the function. You specify character arguments by placing a dollar sign ($) after the argument name. In the following example, `function myfunct(arg1, arg2 $, arg3, arg4 $);` arg1 and arg3 are numeric arguments, and arg2 and arg4 are character arguments.

expression
specifies the value that is returned from the function.

Optional Arguments

VARARGS
specifies that the function supports a variable number of arguments. If you specify VARARGS, then the last argument in the function must be an array.

Restriction You must specify a numeric variable with the VARARGS argument.

See "Example 5: Using Variable Arguments with an Array" on page 930

$
specifies that the function returns a character value. If $ is not specified, the function returns a numeric value.

length
specifies the length of a character value.

Default 8

KIND='*string*'
GROUP='*string*'
specifies a collection of items that have specific attributes and is limited to 32 characters.

LABEL='*string-2*'
specifies a label of up to 256 characters, including blanks.

Details

The FUNCTION statement is a special case of the subroutine declaration that returns a value. You do not use a CALL statement to call a function. The definition of a function begins with the FUNCTION statement and ends with an ENDSUB statement.

LABEL Statement

Specifies a label of up to 256 characters.

Syntax

LABEL *variable*='*label*';

Required Arguments

variable
names the variable that you want to label.

'label'
specifies a label of up to 256 characters, including blanks.

Example

Here are some examples of the LABEL statement:

```
label date='Maturity Date';
label bignum='Very very large numeric value';
```

LISTFUNC Statement

Causes the source code for a function to be written to the SAS listing.

Syntax

LISTFUNC *function-name* </NODEPENDENTS>;

Required Argument

function-name
specifies the name of the function for which source code is written to the SAS listing.

Note: All dependent functions are returned in addition to the specified function by default.

Optional Argument

/NODEPENDENTS
specifies that only the functions specified by *function-name* be returned and not any dependent functions.

Alias /NODEPS

LISTSUBR Statement

Causes the source code for a subroutine to be written to the SAS listing.

Syntax

LISTSUBR *subroutine-name*;

Required Argument

subroutine-name
specifies the name of the subroutine for which source code is written to the SAS listing.

OUTARGS Statement

Specifies arguments in an argument list that you want a subroutine to update.

Restriction: Many SAS analytical procedures perform analytical differentiation on FCMP functions. If you plan to use the function in this way, do not use the OUTARGS statement. In most cases, use the OUTARGS statement only with the SUBROUTINE statement.

Examples: "Example 2: Creating and Saving Functions with PROC FCMP" on page 927
"Example 8: Standardizing Each Row of a Data Set" on page 934
"Example 6: Using the SUBROUTINE Statement with a CALL Statement" on page 931

Syntax

OUTARGS *out-argument-1* <, *out-argument-2*, ...>;

Required Argument

out-argument
specifies arguments from the argument list that you want the subroutine to update.

Tip If an array is listed in the OUTARGS statement within a routine, then the array is passed "by reference." Otherwise, it is passed "by value."

Example See "SUBROUTINE Statement" on page 896 for an example of how to use the OUTARGS statement in a subroutine

STATIC Statement

Retains a variable's value from a previous call until the variable is reassigned.

Syntax

STATIC *variables*, <*initial-value(s)*>;

Required Argument

variables
specifies variable names, variable lists, or array names whose values you want to retain.

Optional Argument

initial-values
specifies an initial value, numeric or character, for one or more of the preceding elements.

Details

The STATIC statement can be used to initialize variables.

Local variables in a function or subroutine are usually not retained between calls to the function or subroutine. If there is an expensive initialization required, a STATIC variable can be used to perform the initialization. STATIC variables are not allocated on the stack, so they can be used for large local arrays to avoid reallocations and overflows on the stack.

Examples

Example 1

Here is a numeric static example:

```
proc fcmp;
   function fdef1(in);
      static x1  1;
      if x1 = 1 then do;
         x1 = 2;
      return(in);
   end;

      return (in*2);
   endsub;

   ans = fdef1( 1);
   put "Answer should be 1" ans=;
   ans = fdef1( 1);
   put "Answer should be 2" ans=;
```

```
run;
```

Example 2

Here is a character static example:

```
proc fcmp;
   function char_func( in $) $;
   length c1 $ 32;
   static c1  "Elephant";
      if c1 = "Elephant" then
         do;
          c1 = in || c1;
    return (c1);
    end;
    return( in);
   endsub;
   length ans $ 32;
   ans = char_func( "Big ");
   put "Answer should be >>Big Elephant<<" ans=;
   ans = char_func( "Big ");
   put "Answer should be >>Big<<" ans=;
run;
quit;
```

Example 3

Here is an array static example:

```
proc fcmp ;
  function array_func( in ) ;
  array a[5] ;
  array foo[5];
  static a  first 1;
  put a[1]= foo[1]=;
     If first  then do;
       do i=1 to dim(a);
          a[i]=i;
          foo[i]=i;
  end;
  first =0;
  end;
  else do;
    do i=1 to dim(a);
       a[i]=a[i]+1;
   end;
   end;
   put a[5];
   return( in);

  endsub;
```

```
  ans = array_func( 4);

/* should increase by 1 */
   ans = array_func( 4);

run;
```

STRUCT Statement

Declares (creates) structure types that are defined in C-Language packages.

Syntax

STRUCT *structure-name variable*;

Required Arguments

structure-name
specifies the name of a structure that is defined in a C-language package and declared in PROC FCMP.

variable
specifies the variable that you want to declare as this structure type.

Example

Here is an example of the STRUCT statement.

```
struct DATESTR matdate;
matdate.month=3;
matdate.day=22;
matdate.year=2009;
```

SUBROUTINE Statement

Declares (creates) an independent computational block of code that you can call using a CALL statement.

Examples: "Example 8: Standardizing Each Row of a Data Set" on page 934
"Example 2: Creating and Saving Functions with PROC FCMP" on page 927

Syntax

SUBROUTINE *subroutine-name* (*argument-1* <, *argument-2*, ...>) <VARARGS> <KIND | GROUP='*string*'>;

OUTARGS *out-argument-1* <, *out-argument-2*, ...>;

... more-program-statements ...

ENDSUB;

Required Arguments

subroutine-name
specifies the name of a subroutine.

argument
specifies one or more arguments for the subroutine. Character arguments are specified by placing a dollar sign ($) after the argument name. In the following example, `subroutine mysub(arg1, arg2 $, arg3, arg4 $);` arg1 and arg3 are numeric arguments, and arg2 and arg4 are character arguments.

OUTARGS
specifies arguments from the argument list that the subroutine should update.

out-argument
specifies arguments from the argument list that you want the subroutine to update.

Optional Arguments

VARARGS
specifies that the subroutine supports a variable number of arguments. If you specify VARARGS, then the last argument in the subroutine must be an array.

GROUP='*string*'
KIND='*string*'
specifies a collection of items that have specific attributes and is limited to 32 characters.

Details

The SUBROUTINE statement enables you to declare (create) an independent computational block of code that you can call with a CALL statement. The definition of a subroutine begins with the SUBROUTINE statement and ends with an ENDSUB statement. You can use the OUTARGS statement in a SUBROUTINE statement to specify arguments from the argument list that the subroutine should update.

Usage: FCMP Procedure

PROC FCMP and DATA Step Differences

Overview of PROC FCMP and DATA Step Differences

PROC FCMP was originally developed as a programming language for several SAS/STAT, SAS/ETS, and SAS/OR procedures. Because the implementation is not identical to the DATA step, differences exist between the two languages. The following section describes some of the differences between PROC FCMP and the DATA step.

Differences between PROC FCMP and the DATA Step

ABORT Statement

The ABORT statement in PROC FCMP does not accept arguments.

The ABORT statement is not valid within functions or subroutines in PROC FCMP. It is valid only in the main body of the procedure.

Arrays

PROC FCMP uses parentheses after a name to represent a function call. When referencing an array, the recommended practice is to use square brackets [ ] or braces { }. For an array named ARR, the code would be `ARR[i]` or `ARR{i}`. PROC FCMP limits the number of dimensions for an array to six.

For more information about the differences in the ARRAY statement for PROC FCMP, see “Details” on page 887.

Data Set Input and Output

PROC FCMP supports the DATA and OUTPUT statements for creating and writing to an output data set. The PROC FCMP statement supports the DATA= and OUT= options for specifying data input and output data sets. It does not support the SET, MERGE, UPDATE, or MODIFY statements for data set input. Data is typically transferred into and out of PROC FCMP routines by using parameters. If a large amount of data needs to be transferred, you can pass arrays to a PROC FCMP routine.

DATA Step Debugger

When you use the DATA step debugger, PROC FCMP routines perform like any other routine. That is, it is not possible to step into the function when debugging. Instead, use a PUT statement within the routine.

DO Statement

The following type of DO statement is supported by PROC FCMP:

```
do i=1, 2, 3;
```

The DO statement in PROC FCMP does not support character loop control variables. You can execute the following code in the DATA step, but not in PROC FCMP:

```
do i='a', 'b', 'c';
```

The DO statement does not support a character index variable. Therefore, the following code is not supported in PROC FCMP:

```
do i='one', 'two', 'three';
```

File Input and Output

PROC FCMP supports the PUT and FILE statements, but the FILE statement is limited to LOG and PRINT destinations. There are no INFILE or INPUT statements in PROC FCMP.

IF Expressions

An IF expression enables IF-THEN/ELSE conditions to be evaluated within an expression. IF expressions are supported by PROC FCMP but not by the DATA step. You can simplify some expressions with IF expressions by not having to split the expression among IF-THEN/ELSE statements. For example, the following two pieces of code are equivalent, but the IF expression (the first example) is not as complex:

```
x=if y < 100 then 1 else 0;
```

```
if y < 100 then
   x=1;
else
   x=0;
```

The alternative to IF expressions is expressions. This means that parentheses are used to group operations instead of DO/END blocks.

PUT Statement

The syntax of the PUT statement is similar in PROC FCMP and in the DATA step, but their operations can be different. In PROC FCMP, the PUT statement is typically used for program debugging. In the DATA step, the PUT statement is used as a report or file creation tool, as well as a debugging tool. The following list describes other differences:

- The PUT statement in PROC FCMP writes output to the SAS Output Window by default. The PUT statement in the DATA step writes output to the SAS log by default.
- The PUT statement in PROC FCMP does not support line pointers, format modifiers, column output, factored lists, iteration factors, overprinting, the _INFILE_ option, or the special character $. It does not support features that are provided by the FILE statement options, such as DLM= and DSD.
- The PUT statement in PROC FCMP supports evaluating an expression and writing the result by placing the expression in parentheses. The DATA step, however, does not support the evaluation of expressions in a PUT statement. In the following example for PROC FCMP, the expressions `x/100` and `sqrt(y)/2` are evaluated and the results are written to the SAS log:

  ```
  put (x/100) (sqrt(y)/2);
  ```

  Because parentheses are used for expression evaluation in PROC FCMP, they cannot be used for variable or format lists as in the DATA step.
- The PUT statement in PROC FCMP does not support subscripted array names unless they are enclosed in parentheses. For example, the statement `put (A[i]);` writes the i-th element of the array A, but the statement `put A[i];` results in an error message.
- An array name can be used in a PUT statement without subscripts. Therefore, the following statements are valid:
  - `put A=;` (when A is an array), writes all of the elements of array A with each value labeled with the name of the element variable.
  - `put (A)*=;` writes the same output as `put A=;`.
  - `put A;` writes all of the elements of array A.
- The PUT statement in PROC FCMP follows the output of each item with a space, which is similar to list mode output in the DATA step. Detailed control over column and line position are supported to a lesser extent than in the DATA step.
- The PUT statement in PROC FCMP supports the print item _PDV_, and prints a formatted listing of all of the variables in the routine's program data vector. The statement `put _PDV_;` prints a much more readable listing of the variables than is printed by the statement `put _ALL_;`.

WHEN and OTHERWISE Statements

The WHEN and OTHERWISE statements allow more than one target statement. That is, DO/END groups are not necessary for multiple WHEN statements. Here is an example:

```
SELECT;
   WHEN(expression-1)
   statement-1;
   statement-2;
   WHEN (expression-2)
   statement-3;
   statement-4;
END;
```

Additional Features in PROC FCMP

PROC REPORT and Compute Blocks

PROC REPORT uses the DATA step to evaluate compute blocks. Because the DATA step can call PROC FCMP routines, you can also call these routines from PROC REPORT compute blocks.

The FCmp Function Editor

The FCmp Function Editor is an application for traversing packages of functions and is built into the SAS Explorer. You can access the FCmp Function Editor from the **Solutions** menu in a traditional DMS session.

Computing Implicit Values of a Function

PROC FCMP uses a SOLVE function for computing implicit values of a function.

PROC FCMP and Microsoft Excel

Many Microsoft Excel functions, not typically available in SAS, are implemented in PROC FCMP. You can find these functions in the sashelp.slkwxl data set. You can view these functions at Excel functions in SAS.

You can also view these functions by using the following SAS code:

```
proc fcmp inlib=sashelp.slkwxl listall;
run;
```

The following example uses the ODD_SLK function:

```
options cmplib=sashelp.slkwxl;
data _null_;
   num    =4.2;
   odd_num=odd_slk(num);
   put 'Odd number nearest to' num ' is ' odd_num;
```

```
run;
```

```
Odd number nearest to 4.2  is 5
```

Working with Arrays

Passing Arrays

By default, PROC FCMP passes arrays "by value" between routines. However, if an array is listed in the OUTARGS statement within the routine, the array is passed "by reference."

This means that a modification to the formal parameter by the function modifies the array that is passed. Passing arrays by reference helps to efficiently pass large amounts of data between the function and the calling environment because the data does not need to be copied. The syntax for specifying a formal array has the following form:

```
function
name(numeric-array-parameter[*],
character-array-parameter[*] $);
```

You can pass DATA step temporary arrays to PROC FCMP routines.

Resizing Arrays

You can resize arrays in PROC FCMP routines by calling the built-in CALL routine DYNAMIC_ARRAY. The syntax for this CALL routine has the following form:

```
call dynamic_array(array, new-dim1-size <, new-dim2-size, ...>);
```

SAS passes to the DYNAMIC_ARRAY CALL routine both the array that is to be resized and a new size for each dimension of the array. A dynamic array enables the routine to allocate the amount of memory that is needed, instead of having to create an array that is large enough to handle all possible cases.

Support for dynamic arrays is limited to PROC FCMP routines. When an array is resized, the array is available only in the routine that resized it. It is not possible to resize a DATA step array or to return a PROC FCMP dynamic array to a DATA step.

Using Macros with PROC FCMP Routines

You can use the %SYSFUNC and %SYSCALL macros to call routines that you create with PROC FCMP. All SAS CALL routines are accessible with %SYSCALL except LABEL, VNAME, SYMPUT, and EXECUTE. %SYSFUNC and %SYSCALL macros support SAS function names up to 32 characters.

Variable Scope in PROC FCMP Routines

The Concept of Variable Scope

A critical part of keeping routines and programs independent of one another is variable scope. A variable's scope is the section of code where a variable's value can be used. In the case of PROC FCMP routines, variables that are declared outside a routine are not accessible inside a routine. Variables that are declared inside a routine is not accessible outside the routine. Variables that are created within a routine are called local variables because their scope is "local" to the routine.

Functions use local variables as scratch variables during computations, and the variables are not available when the function returns. When a function is called, space for local variables is pushed on the call stack. When the function returns, the space used by local variables is removed from the call stack.

When Local Variables in Different Routines Have the Same Name

The concept of variable scope can be confusing when local variables in different routines have the same name. When this occurs, each local variable is distinct. In the following example, the DATA step and CALL routines subA and subB contain a local variable named x. Each x is distinct from the other x variables. When the program executes, the DATA step calls subA and subA calls subB. Each environment writes the value of x to the log. The log output shows how each x is distinct from the others.

```
proc fcmp outlib=sasuser.funcs.math;
   subroutine subA();
      x=5;
      call subB();
      put 'In subA: ' x=;
   endsub;
```

```
   subroutine subB();
      x='subB';
      put 'In subB: ' x=;
   endsub;
run;

options cmplib=sasuser.funcs;
data _null_;
   x=99;
   call subA();
   put 'In DATA step: ' x=;
run;
```

Example Code 24.2 *Local Variables in Different Routines That Have the Same Name*

```
In subB:  x=subB
In subA:  x=5
In DATA step: x=99
```

Recursion

PROC FCMP routines can be recursive. Recursion is a problem-solving technique that reduces a problem to a smaller one that is simpler to solve and then combines the results of the simpler solution to form a complete solution. A recursive function is a function that calls itself, either directly or indirectly.

Each time a routine is called, space for the local variables is pushed on the call stack. The space on the call stack ensures independence of local variables for each call. When the routine returns, the space allocated on the call stack is removed, freeing the space used by local variables. Recursion relies on the call stack to store progress toward a complete solution.

When a routine calls itself, both the calling routine and the routine that is being called must have their own set of local variables for intermediate results. If the calling routine was able to modify the local variables of the routine that is being called, it would be difficult to program a recursive solution. A call stack ensures the independence of local variables for each call.

In the following example, the ALLPERMK routine in PROC FCMP has two arguments, *n* and *k*, and writes all `C(n, k) = n! /(n - k)!` combinations that contain exactly *k* out of the *n* elements. The elements are represented as binary values (0, 1). The function ALLPERMK calls the recursive function PERMK to traverse the entire solution space and output only the items that match a particular filter:

```
proc fcmp outlib=sasuser.funcs.math;
   subroutine allpermk(n, k);
      array scratch[1] / nosymbols;
      call dynamic_array(scratch, n);
      call permk(n, k, scratch, 1,0);
   endsub;
```

```
subroutine permk(n, k, scratch[*], m, i);
   outargs scratch;
   if m-1=n then do;
      if i=k then
         put scratch[*];
      end;
   else do;
      scratch[m]=1;
      call permk(n, k, scratch, m+1, i+1);
      scratch[m]=0;
      call permk(n, k, scratch, m+1, i);
   end;
endsub;
run;
quit;

options cmplib=sasuser.funcs;
data _null_;
   call allpermk(5,3);
run;
```

Example Code 24.3 *Recursion Example Results*

```
1 1 1 0 0
1 1 0 1 0
1 1 0 0 1
1 0 1 1 0
1 0 1 0 1
1 0 0 1 1
0 1 1 1 0
0 1 1 0 1
0 1 0 1 1
0 0 1 1 1
```

This program uses the /NOSYMBOLS option in the ARRAY statement to create an array without a variable for each array element. A /NOSYMBOLS array can be accessed only with an array reference, `scratch[m]`, and is equivalent to a DATA step _temporary_ array. A /NOSYMBOLS array uses less memory than a regular array because no space is allocated for variables. ALLPERMK also uses PROC FCMP dynamic arrays.

Directory Traversal

Overview of Directory Traversal

Implementing functionality that enables functions to traverse a directory hierarchy is difficult if you use the DATA step or macros. With the DATA step and macro code recursion or pseudo-recursion is not easy to code. This section describes how to develop a routine named DIR_ENTRIES that fills an array with the full pathname of all of the files in a directory hierarchy. This example shows the similarity between

PROC FCMP and DATA step syntax and underscores how PROC FCMP routines simplify a program and produce independent, reusable code. DIR_ENTRIES uses as input the following parameters:

- a starting directory
- a result array to fill with pathnames
- an output parameter that is the number of pathnames placed in the result array
- an output parameter that indicates whether the complete result set was truncated because the result array was not large enough

The flow of control for DIR_ENTRIES is as follows:

1. Open the starting directory.
2. For each entry in the directory, do one of the following tasks:
   - If the entry is a directory, call DIR_ENTRIES to fill the result array with the subdirectory's pathnames.
   - Otherwise, the entry is a file, and you must add the file's path to the result array.
3. Close the starting directory.

Directory Traversal Example

Opening and Closing a Directory

Opening and closing a directory are handled by the CALL routines DIROPEN and DIRCLOSE. DIROPEN accepts a directory path and has the following flow of control:

1. Create a fileref for the path by using the FILENAME function.
2. If the FILENAME function fails, write an error message to the log and then return.
3. Otherwise, use the DOPEN function to open the directory and retrieve a directory ID.
4. Clear the directory fileref.
5. Return the directory ID.

The DIRCLOSE CALL routine is passed a directory ID, which is passed to DCLOSE. DIRCLOSE sets the passed directory ID to missing so that an error occurs if a program tries to use the directory ID after the directory has been closed. The following code implements the DIROPEN and DIRCLOSE CALL routines:

```
proc fcmp outlib=sasuser.funcs.dir;
   function diropen(dir $);
   length dir $ 256 fref $ 8;
```

```
      rc=filename(fref, dir);
      if rc=0 then do;
         did=dopen(fref);
         rc=filename(fref);
      end;
      else do;
         msg=sysmsg();
         put msg '(DIROPEN(' dir= ')';
         did=.;
      end;
      return(did);
   endsub;

   subroutine dirclose(did);
      outargs did;
      rc=dclose(did);
      did=.;
   endsub;
```

Gathering Filenames

File paths are collected by the DIR_ENTRIES CALL routine. DIR_ENTRIES uses the following arguments:

- a starting directory
- a result array to fill
- an output parameter to fill with the number of entries in the result array
- an output parameter to set to 0 if all pathnames fit in the result array; or an output parameter to set to 1 if some of the pathnames do not fit into the array

The body of DIR_ENTRIES is almost identical to the code that is used to implement this functionality in a DATA step. Also, DIR_ENTRIES is a CALL routine that is easily reused in several programs.

DIR_ENTRIES calls DIROPEN to open a directory and retrieve a directory ID. The routine then calls DNUM to retrieve the number of entries in the directory. For each entry in the directory, DREAD is called to retrieve the name of the entry. Now that the entry name is available, the routine calls MOPEN to determine whether the entry is a file or a directory.

If the entry is a file, then MOPEN returns a positive value. In this case, the full path to the file is added to the result array. If the result array is full, the truncation output argument is set to 1.

If the entry is a directory, then MOPEN returns a value that is less than or equal to 0. In this case, DIR_ENTRIES gathers the pathnames for the entries in this subdirectory. It gathers the pathnames by recursively calling DIR_ENTRIES and passing the subdirectory's path as the starting path. When DIR_ENTRIES returns, the result array contains the paths of the subdirectory's entries.

```
   subroutine dir_entries(dir $, files[*] $, n, trunc);
      outargs files, n, trunc;
      length dir entry $ 256;

      if trunc then return;
```

```
   did=diropen(dir);
   if did <= 0 then return;

   dnum=dnum(did);
   do i=1 to dnum;
      entry=dread(did, i);
         /* If this entry is a file, then add to array, */
         /* else entry is a directory, recurse.         */
      fid=mopen(did, entry);
      entry=trim(dir) || '\' || entry;
      if fid > 0 then do;
         rc=fclose(fid);
         if n < dim(files) then do;
            trunc=0;
            n=n + 1;
            files[n]=entry;
         end;
         else do;
            trunc=1;
            call dirclose(did);
            return;
         end;
      end;
      else
         call dir_entries(entry, files, n, trunc);
   end;

   call dirclose(did);
   return;
endsub;
```

Calling DIR_ENTRIES from a DATA Step

You invoke DIR_ENTRIES like any other DATA step CALL routine. Declare an array with enough entries to hold all the files that might be found. Then call the DIR_ENTRIES routine. When the routine returns, the result array is looped over and each entry in the array is written to the SAS log.

```
options cmplib=sasuser.funcs;
data _null_;
   array files[1000] $ 256 _temporary_;
   dnum=0;
   trunc=0;
   call dir_entries("c:\logs", files, dnum, trunc);
   if trunc then put 'ERROR: Not enough result array entries. Increase
array
size.';
   do i=1 to dnum;
      put files[i];
   end;
run;
```

Example Code 24.4 *Results from Calling DIR_ENTRIES from a DATA Step*

```
c:\logs\2004\qtr1.log
c:\logs\2004\qtr2.log
c:\logs\2004\qtr3.log
c:\logs\2004\qtr4.log
c:\logs\2005\qtr1.log
c:\logs\2005\qtr2.log
c:\logs\2005\qtr3.log
c:\logs\2005\qtr4.log
c:\logs\2006\qtr1.log
c:\logs\2006\qtr2.log
```

This example shows the similarity between PROC FCMP syntax and the DATA step. For example, numeric expressions and flow of control statements are identical. The abstraction of DIROPEN into a PROC FCMP function simplifies DIR_ENTRIES. All of the PROC FCMP routines that are created can be reused by other DATA steps without any need to modify the routines to work in a new context.

Identifying the Location of Compiled Functions and Subroutines: The CMPLIB= System Option

Overview of the CMPLIB= System Option

The SAS system option CMPLIB= specifies where to look for previously compiled functions and subroutines. All procedures (including FCMP) that support the use of FCMP functions and subroutines use this system option.

Instead of specifying the LIBRARY= option on every procedure statement that supports functions and subroutines, you can use the CMPLIB= system option to set libraries that can be used by all procedures.

The _DISPLAYLOC_ option writes to the log the name of the data set from where SAS loaded a function. The _NO_DISPLAYLOC_ option prevents the data set name from being written to the log.

Syntax of the CMPLIB= System Option

The syntax for the CMPLIB= option has the following form:

OPTIONS CMPLIB=*library*

OPTIONS CMPLIB=*(library-1 <, library-2, ...>)*

OPTIONS CMPLIB=*list-1 <, list-2, ...*

OPTIONS CMPLIB=_DISPLAYLOC_

OPTIONS CMPLIB=_NO_DISPLAYLOC_

The following descriptions refer to the preceding syntax:

OPTIONS
identifies the statement as an OPTIONS statement.

library
specifies that the previously compiled libraries be linked into the program.

list
specifies a list of libraries.

DISPLAYLOC
when using PROC FCMP, specifies to display in the SAS log the data set from where SAS loaded the function.

Default _NO_DISPLAYLOC_

_NO_DISPLAYLOC_
when using PROC FCMP, specifies to not display in the SAS log the data set from where SAS loaded the function, and removes any library specifications as CMPLIB= option values.

Default _NO_DISPLAYLOC_

Tip When you specify CMPLIB=library-specification without the _DISPLAYLOC_ option, SAS does not display the data set name in the SAS log.

Example 1: Setting the CMPLIB= System Option

The following example shows how to set the CMPLIB= system option.

```
options cmplib=sasuser.funcs;
options cmplib=(sasuser.funcs work.functions mycat.funcs);
options cmplib=(sasuser.func1 - sasuser.func10);
```

Example 2: Compiling and Using Functions

In the following example, PROC FCMP compiles the SIMPLE function and stores it in the Sasuser.Models data set. Then the CMPLIB= system option is set, and the function is called by PROC MODEL.

The output from this example spans several pages. The output is divided into five parts.

```
proc fcmp outlib=sasuser.models.yval;
   function simple(a, b, x);
      y=a+b*x;
      return(y);
   endsub;
run;
```

```
options cmplib=sasuser.models nodate ls=80;

data a;
   input y @@;
   x=_n_;
   datalines;
08 06 08 10 08 10
;

proc model data=a;
   y=simple(a, b, x);
   fit y / outest=est1 out=out1;
quit;
```

Output 24.1 *Compiling and Using Functions: Part 1*

The SAS System

The MODEL Procedure

Model Summary	
Model Variables	1
Parameters	2
Equations	1
Number of Statements	1

Model Variables	y
Parameters	a b
Equations	y

The Equation to Estimate is	
y =	F(a, b)

NOTE: At OLS Iteration 1 CONVERGE=0.001 Criteria Met.

Output 24.2 *Compiling and Using Functions: Part 2*

The SAS System

The MODEL Procedure
OLS Estimation Summary

Data Set Options	
DATA=	A
OUT=	OUT1
OUTEST=	EST1

Minimization Summary	
Parameters Estimated	2
Method	Gauss
Iterations	1

Final Convergence Criteria	
R	0
PPC	0
RPC(a)	64685.48
Object	0.984333
Trace(S)	1.67619
Objective Value	1.11746

Observations Processed	
Read	6
Solved	6

Output 24.3 *Compiling and Using Functions: Part 3*

The SAS System

The MODEL Procedure

Nonlinear OLS Summary of Residual Errors							
Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
y	2	4	6.7048	1.6762	1.2947	0.4084	0.2605

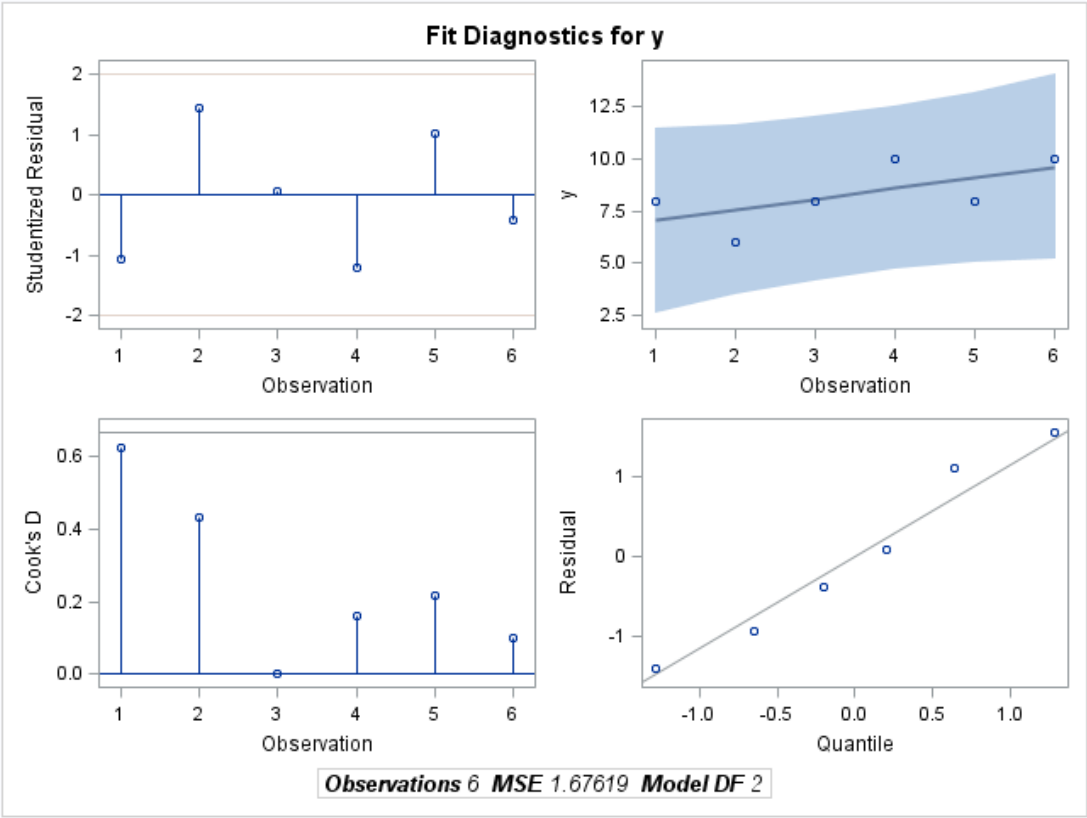
Nonlinear OLS Parameter Estimates				
Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
a	6.533333	1.2053	5.42	0.0056
b	0.514286	0.3095	1.66	0.1719

Number of Observations		Statistics for System	
Used	6	Objective	1.1175
Missing	0	Objective*N	6.7048

Output 24.4 *Compiling and Using Functions: Part 4*

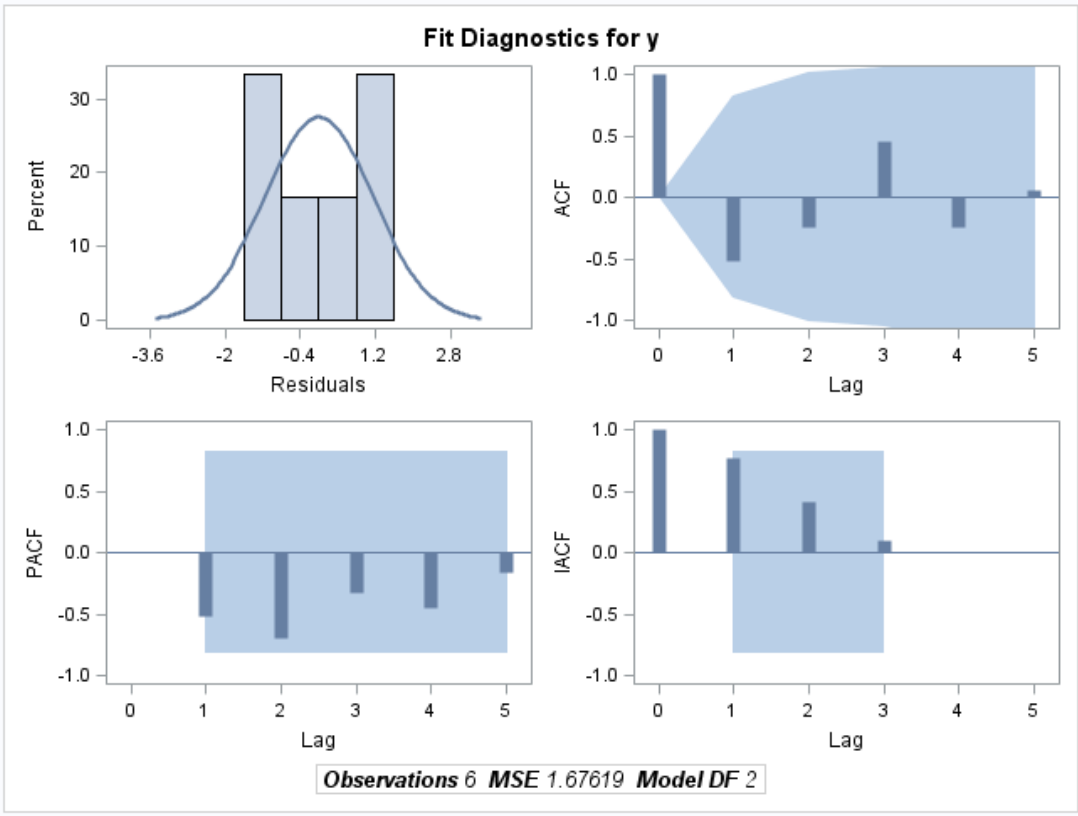
The SAS System

The MODEL Procedure



Observations *6* ***MSE*** *1.67619* ***Model DF*** *2*

Output 24.5 *Compiling and Using Functions: Part 5*



For information about PROC MODEL, see the *SAS/ETS User's Guide*.

Example 3: Identifying the Data Set Name from Where SAS Loaded a Function

The following example uses the _DISPLAYLOC_ and _NO_DISPLAYLOC_ options. When you use the _DISPLAYLOC_ option, SAS writes to the log the name of the data set from where SAS loaded a function. With the _NO_DISPLAYLOC_ option, the name of the data set is not written to the log.

```
proc fcmp outlib=work.myfuncs1.pkg;
   function myfunc();
      return(1);
   endsub;
run;

proc fcmp outlib=work.myfuncs2.pkg;
   function myfunc();
      return(2);
   endsub;
run;

proc fcmp outlib=work.myfuncs3.pkg;
   function myfunc();
```

```
      return(3);
   endsub;
run;

option CMPLIB=(myfuncs1-myfuncs3 _DISPLAYLOC_);

proc fcmp;

  a = myfunc();
  put a=;
run;

/*- turning _DISPLAYLOC_ off -*/
option CMPLIB=(myfuncs1-myfuncs3);


proc fcmp;

  a = myfunc();
  put a=;
run;

option CMPLIB=(myfuncs1 myfuncs2 _DISPLAYLOC_);

proc fcmp;

  a = myfunc();
  put a=;
run;

option CMPLIB=_DISPLAYLOC_;

proc fcmp inlib=work.myfuncs1;
  a = myfunc();
  put a=;
run;

option CMPLIB=_NO_DISPLAYLOC_;

proc fcmp inlib=work.myfuncs1;
  a = myfunc();
  put a=;
run;
```

The following results show a partial SAS log. The _DISPLAYLOC_ and _NO_DISPLAYLOC options produce different results:

```
116  option CMPLIB=(myfuncs1-myfuncs3 _DISPLAYLOC_);
117
118  proc fcmp;
119
120    a = myfunc();
121    put a=;
122  run;

NOTE: Function 'myfunc' loaded from WORK.myfuncs3.PKG.
NOTE: PROCEDURE FCMP used (Total process time):
      real time           0.06 seconds
      cpu time            0.04 seconds


123
124  /*- turning _DISPLAYLOC_ off -*/
125  option CMPLIB=(myfuncs1-myfuncs3);
126
127
128  proc fcmp;
129
130    a = myfunc();
131    put a=;
132  run;

NOTE: PROCEDURE FCMP used (Total process time):
      real time           0.06 seconds
      cpu time            0.06 seconds


133
134  option CMPLIB=(myfuncs1 myfuncs2 _DISPLAYLOC_);
135
136  proc fcmp;
137
138    a = myfunc();
139    put a=;
140  run;

NOTE: Function 'myfunc' loaded from WORK.myfuncs2.PKG.
NOTE: PROCEDURE FCMP used (Total process time):
      real time           0.05 seconds
      cpu time            0.04 seconds


141
142  option CMPLIB=_DISPLAYLOC_;
143
144  proc fcmp inlib=work.myfuncs1;
145    a = myfunc();
146    put a=;
147  run;

NOTE: Function 'myfunc' loaded from work.myfuncs1.PKG.
NOTE: PROCEDURE FCMP used (Total process time):
      real time           0.04 seconds
      cpu time            0.03 seconds
```

```
149  option CMPLIB=_NO_DISPLAYLOC_;
150
151  proc fcmp inlib=work.myfuncs1;
152    a = myfunc();
153    put a=;
154  run;

NOTE: PROCEDURE FCMP used (Total process time):
      real time           0.04 seconds
      cpu time            0.03 seconds
```

Using PROC FCMP Component Objects

Hash Object and Hash Iterator Object

Starting with SAS 9.3, hashing is available in user-defined subroutines through the FCMP procedure. Hashing enables you to extend the scope of your programs so that you can solve larger problems without sacrificing simplicity. Embedding a hash object in PROC FCMP functions and subroutines can improve performance and streamline existing programs.

For more information about hash and hash iterator component objects, see "Using the PROC FCMP Hash Object and PROC FCMP Hash Iterator Object" in *SAS Component Objects: Reference*.

Dictionaries

Dictionaries create references to numeric and character data, and they also give you fast in-memory hashing to arrays, other dictionaries, and PROC FCMP hash objects.

For information about how to use dictionaries in PROC FCMP, and to review examples, see "Using FCMP Dictionary Objects" in *SAS Component Objects: Reference* and Dictionaries: Referencing a New PROC FCMP Data Type.

PROC FCMP and ASTORE

CMP supports ASTORE (Analytic Store) scoring models. Data movement is reduced by performing the score and the computations together within the same TKCMP program. PROC FCMP supports ASTORE models on the SAS client.

What is an Analytic Store?

An analytic store is a binary file that contains the state from a predictive analytic procedure. This state from a predictive analytic procedure, such as a random forest, is created using the results from the training phase of model development. A key feature of an analytic store is that it is easily transported from one host to another. An analytic store is a compact and universal file form. The store names the only SAS component that can restore the state of the computation (memory) that can restore the post training memory. It is also called a warm restart for scoring.

What is a State?

State is a copy of all the memory items that are relevant to the next task, for example, scoring. SAVESTATE takes a snapshot of this information:

- Public information (that is, information common to all analytic engines). Examples of public information include the list of input variables, the list of output variables, the formats, and other elements.
- Private information (that is, information specific to that particular analysis, for example, random forests). Examples of private information include the number of trees, the trees themselves, the scores, and other types.

What is Scoring?

Historic data is where the outcomes are known. You train your model with this historic data, and then you score the new data by using the input variables. Scoring new data is predicting the outcome with new data, using the model that is built using the historic data.

What Does PROC ASTORE Do?

PROC ASTORE scores an input data set and produces an output data set using the analytic store that you specify. It is an interactive procedure in which each statement runs immediately. PROC ASTORE produces these outputs:

- Types of DS2 scoring code that can run locally using the DS2 procedure
- DS2 scoring code that can run in SAS Viya.

PROC ASTORE can also move analytic stores between the client and the server and it can provide descriptive information about the analytic store. The syntax is shown below:

SCORE
Scores the model.

DESCRIBE
Specifies the name of the analytic store and produces DS2 basic scoring code.

DOWNLOAD
Retrieves from the CAS session the specified analytic store and stores it in the local file system

UPLOAD
Moves the specified analytic store from the local file system into a data table in CAS.

Note: See The ASTORE Procedure for more information about PROC ASTORE.

Example: Using ASTORE in PROC FCMP

This example demonstrates using ASTORE in PROC FCMP. It also demonstrates TKCMP scoring of ASTORE models.

Note: The code for declaring a CMP object is the same for all platforms:

```
declare object myscore(astore);
```

Note: In a SAS client, the score() method takes a single parameter file path:

- Windows:

```
call myscore.score("C:\models\_va_model208");
```

- UNIX:

```
call myscore.score("/userid/models/_va_model208");
```

Note: In CAS, the score() method requires two arguments, the caslib and the CAS table name:

```
call myscore.score('CASUSER','_va_model208');
```

Note: The score object also supports the describe() method, which prints the input/output variables from the ASTORE to the log. The method takes no arguments:

```
call myscore.describe();
```

This code runs a previously created SVM CAS action in FCMP.

Example Code 24.1 *ASTORE.SAS*

```
title 'CMP ASTORE Test 1';

libname mydata "C:\project\my_data";
libname mymodel "C:\project\my_models";

/* Test a simple object model using the describe method */
/* Note: No input dataset is specified.   */
proc fcmp;
   declare object myscore(astore);
   call myscore.score("C:\project\my_models\_va_model208");

   /* Can use Proc FCMP to describe the local model */
   call myscore.describe();
run;quit;


/* Run the ASTORE model over an input dataset.  */
/* Write the results to an output dataset.      */
proc fcmp data=mydata.hmeq out=astore_fcmp_out;
   declare object myscore(astore);
   call myscore.score("C:\project\my_models\_va_model208");
run;quit;

proc print data=astore_fcmp_out(obs=10);
run;

title 'CMP ASTORE Test 2';

/* Using ASTORE scoring from a FCMP function */
proc fcmp outlib=work.score.funcs;

/* Return the probability value */
function astore(clage, clno, debtinc, delinq, ninq, value);
   declare object myscore(astore);
   call myscore.score("C:\project\my_models\_va_model208");
   return(_P_);
endsub;

/* Pass input values as arguments into the function */
/* Return all probability values from the score     */
subroutine astore2(clage, clno, debtinc, delinq, ninq, value,
                   _P_, P__EVENT_0, P__EVENT_1, I__EVENT_ $, _WARN_ $);
   outargs _P_, P__EVENT_0, P__EVENT_1, I__EVENT_, _WARN_;

   declare object myscore(astore);
   call myscore.score("C:\project\my_models\_va_model208");
endsub;
run;
quit;

/* Call these functions from Proc FCMP */

title 'CMP ASTORE Test 3';

proc fcmp data=mydata.hmeq inlib=work.score out=astore_fcmp_out2;
```

```
ds_p2 = astore(clage, clno, debtinc, delinq, ninq, value);
run;
quit;
proc print data=astore_fcmp_out2(obs=10);
run;

title 'CMP ASTORE Test 4';

proc fcmp data=mydata.hmeq(obs=10) inlib=work.score
out=astore_fcmp_out3;
_P_=.;
P__EVENT_0=.;
P__EVENT_1=.;
I__EVENT_="";
_WARN_="";

call astore2(clage, clno, debtinc, delinq, ninq, value,
             _P_, P__EVENT_0, P__EVENT_1, I__EVENT_, _WARN_);
run;
quit;
proc print data=astore_fcmp_out3(obs=10);
run;


title 'CMP ASTORE Test 5';

/* You can call the function from the data step   */
/* We can perform ASTORE scoring using the data step */
options cmplib=work.score;
data astore_ds_out;
set mydata.hmeq;
ds_p = astore(clage, clno, debtinc, delinq, ninq, value);
run;
proc print data=astore_ds_out(obs=10);
run;
```

PROC ASTORE transports data from CAS into a local analytic store (local file). Once in that form, the data is used by CMP and the new ASTORE object.

Example Code 24.2 *ASTORE_CAS.SAS*

```
title 'CMP ASTORE Test 1';

/* CASPORT=0 means generate a port number for session connection */
/*options casuser=<userid> cashost="<machine>" casport=<port>;*/
options casuser=<userid> cashost="<machine>" casport=<port>;

/* This is how to start a CAS session */
/* CAS sessions live for the life of the SAS session, unless redefined or closed. */
/* Unix: cas mysession AUTHINFO='/userid/.authinfo';*/
/* Windows */
cas mysession authinfo='/userid/.authinfo';
libname sascas1 cas sessref="mysession" caslib="CASUSER";

libname mydata "C:\project\my_data";
libname mymodel "C:\project\my_models";
```

```
/* Our input data for SVM; Load into CAS */
data sascas1.hmeq;
set mydata.hmeq;
run;

/* Run action from VDMML */
proc cas;
    action builtins.loadactionset / actionSet='tkaasvm';
    action tkaasvm.svmtrain result=r /
c=1.0,
code={comment=false,fmtWdth=15,lineSize=200},
includeMissing=false,
maxiter=25,
noscale=false,
savestate={caslib="CASUSER",name="_va_model208"},
table={caslib="CASUSER",compOnDemand="false",compPgm="_va_calculated_208_1=round('BAD'n,1
.0);
if (('_va_calculated_208_1'n = 0.0))then do;
_va_calculated_208_11= 0.0;
end;
else do;
_va_calculated_208_11= 1.0;
end;
;
_EVENT_=_va_calculated_208_11;
_va_FILTER_=(NOT(MISSING('_va_calculated_208_1'n))
AND NOT(MISSING('CLAGE'n)) AND NOT(MISSING('CLNO'n)) AND NOT(MISSING('DEBTINC'n))
AND NOT(MISSING('DELINQ'n)) AND NOT(MISSING('NINQ'n)) AND NOT(MISSING('VALUE'n)));
_va_calculated_208_14=NOT(('_va_FILTER_'n = 0.0));;",compVars={"_va_calculated_208_1","
_va_calculated_208_11","_EVENT_","_va_FILTER_","_va_calculated_208_14"},name="HMEQ",
onDemand="false",where="NOT('_va_calculated_208_14'n = 0)"},
emtarget={name="_EVENT_",options={levelType="BINARY"}},
tolerance=1.0E-6,
var={"CLAGE","CLNO","DEBTINC","DELINQ","NINQ","VALUE"}
outputTables={names={nobs="NObs",modelinfo="ModelInfo"}, replace="TRUE"};
run;

quit;

/* Use Proc ASTORE to describe the model in CAS */
/* Download the model locally                   */
proc astore;
   describe rstore=sascas1._va_model208;
   download rstore=sascas1._va_model208;
 store="C:\project\my_models\_va_model208";
   describe store="C:\project\my_models\_va_model208";
run;
quit;

options pagesize=max;
proc cas;
    loadactionset "table";
   table.fetch
   format=false
   maxRows=1
   sasTypes=TRUE
```

```
   table = {
      compOnDemand=TRUE
      caslib="CASUSER"
       name="hmeq"
      compPgm=
"declare object myscore(astore);
call myscore.score('CASUSER','_va_model208');"
       singlePass=TRUE
       compVars={"_P_", "P__EVENT_0" , "P__EVENT_1" , "I__EVENT_" ,"_WARN_"}
   };
run;
quit;
```

The SETOPTION Method

The CMP ASTORE method, SETOPTION, passes options to ASTORE objects that take different option values. Here is code using PROC FCMP:

```
routineCode = "
   declare object model_glmstore(astore);
   call model_glmstore.setoption('alpha', 0.05);
   call model_glmstore.setoption('COMPUTE_CONFIDENCE_LIMIT', 1);
   call model_glmstore.score('CASUSER','glmstore');
"
;
run;
quit;
```

Here is code using the FCMPACT action:

```
routineCode = "
declare object model_glmstore(astore);
call model_glmstore.setoption('alpha', 0.05);
call model_glmstore.setoption('COMPUTE_CONFIDENCE_LIMIT', 1);
call model_glmstore.score('CASUSER','glmstore');
"
;
run;
quit;
```

Using Python Functions in PROC FCMP

Starting with SAS 9.4M6, PROC FCMP supports submitting and executing functions written in Python by using the Python object. A complete guide for using the Python object is located in the Using Python Objects chapter in the SAS Component Objects: Reference.

Examples: FCMP Procedure

Example 1: Creating a Function and Calling the Function from a DATA Step

Features: PROC FCMP statement option
OUTLIB=
DATA step

Details

This example shows how to compute a study day during a drug trial by creating a function in PROC FCMP and using that function in a DATA step.

Program

```
proc fcmp outlib=sasuser.funcs.trial;

   function study_day(intervention_date, event_date);

      n=event_date - intervention_date;
         if n >= 0 then
            n=n + 1;
         return(n);
   endsub;

options cmplib=sasuser.funcs;

data _null_;
   start='15Feb2010'd;
   today='27Mar2010'd;
   sd=study_day(start, today);

   put sd=;

run;
```

Program Description

Specify the name of an output package to which the compiled function and CALL routine are written. The package is stored in the data set Sasuser.Funcs.

```
proc fcmp outlib=sasuser.funcs.trial;
```

Create a function called STUDY_DAY. STUDY_DAY is created in a package called Trial, and contains two numeric input arguments.

```
   function study_day(intervention_date, event_date);
```

Use a DATA step IF statement to calculate EVENT_DATE. Use DATA step syntax to compute the difference between EVENT_DATE and INTERVENTION_DATE. The days before INTERVENTION_DATE begin at -1 and become smaller. The days after and including INTERVENTION_DATE begin at 1 and become larger. (This function never returns 0 for a study date.)

```
      n=event_date - intervention_date;
         if n >= 0 then
            n=n + 1;
         return(n);
   endsub;
```

Use the CMPLIB= system option to specify a SAS data set that contains the compiler subroutine to include during program compilation.

```
options cmplib=sasuser.funcs;
```

Create a DATA step to produce a value for the function STUDY_DAY. The function uses a start date and today's date to compute the value. STUDY_DAY is called from the DATA step. When the DATA step encounters a call to STUDY_DAY, it does not find this function in its traditional library of functions. It searches each of the data sets that are specified in the CMPLIB system option for a package that contains STUDY_DAY. In this case, it finds STUDY_DAY in Sasuser.Funcs.Trial.

```
data _null_;
   start='15Feb2010'd;
   today='27Mar2010'd;
   sd=study_day(start, today);
```

Write the output to the SAS log.

```
   put sd=;
```

Execute the SAS program.

```
run;
```

Log

Example Code 24.5 *Results from Creating and Calling a Function from a DATA Step*

```
sd=41
```

Example 2: Creating and Saving Functions with PROC FCMP

Features: PROC FCMP statement option
OUTLIB=
OUTARGS statement

Details

This example shows how to use PROC FCMP to create and save the functions that are used in the example.

Program

```
proc fcmp outlib=sasuser.exsubs.pkt1;

   subroutine calc_years(maturity, current_date, years);
      outargs years;
      years=(maturity - current_date) / 365.25;
   endsub;

function garkhprc(type$, buysell$, amount,E, t, S, rd, rf, sig);
      if buysell="Buy" then sign=1.;
      else do;
         if buysell="Sell" then sign=-1.;
         else sign=.;
      end;

      if type="Call" then
         garkhprc=sign * amount * garkhptprc(E, t, S, rd, rf, sig);
      else do;
         if type="Put" then
            garkhprc=sign * amount * garkhptprc(E, t, S, rd, rf, sig);
         else garkhprc=.;
      end;

return(garkhprc);

run;

endfunc;
```

Program Description

Specify the entry where the function package information is saved. The package is a three-level name.

```
proc fcmp outlib=sasuser.exsubs.pkt1;
```

Create a function to calculate years to maturity. A generic function called CALC_YEARS is declared to calculate years to maturity from date variables that are stored as the number of days. The OUTARGS statement specifies the variable that is updated by CALC_YEARS.

```
subroutine calc_years(maturity, current_date, years);
   outargs years;
   years=(maturity - current_date) / 365.25;
endsub;
```

Create a function for Garman-Kohlhagen pricing for FX options. A function called GARKHPRC is declared, which calculates Garman-Kohlhagen pricing for FX options. The function uses the SAS functions GARKHCLPRC and GARKHPTPRC.

```
function garkhprc(type$, buysell$, amount,E, t, S, rd, rf, sig);
      if buysell="Buy" then sign=1.;
      else do;
         if buysell="Sell" then sign=-1.;
         else sign=.;
      end;

      if type="Call" then
         garkhprc=sign * amount * garkhptprc(E, t, S, rd, rf, sig);
      else do;
         if type="Put" then
            garkhprc=sign * amount * garkhptprc(E, t, S, rd, rf, sig);
         else garkhprc=.;
      end;
```

The RETURN statement returns the value of the GARKHPRC function.

```
return(garkhprc);
```

Execute the FCMP procedure. The RUN statement executes the FCMP procedure.

```
run;
```

Close the function. The endfunc statement closes the function.

```
endfunc;
```

Log

Example Code 24.6 *Location of Functions That Are Saved*

```
NOTE: Function garkhprc saved to sasuser.exsubs.pkt1.
NOTE: Function calc_years saved to sasuser.exsubs.pkt1.
```

Example 3: Using Numeric Data in the FUNCTION Statement

Details

The following example uses numeric data as input to the FUNCTION statement of PROC FCMP.

Program

```
proc fcmp;
   function inverse(in);
      if in=0 then inv=.;
      else inv=1/in;
      return(inv);
   endfunc;
run;
```

Example 4: Using Character Data with the FUNCTION Statement

Details

The following example uses character data as input to the FUNCTION statement of PROC FCMP. The output from FUNCTION TEST is assigned a length of 12 bytes.

Program

```
options cmplib=work.funcs;

proc fcmp outlib=work.funcs.math;
   function test(x $) $ 12;
```

```
   if x='yes' then
      return('si si si');
      else
      return('no');
   endfunc;
run;

data _null_;
   spanish=test('yes');
   put spanish=;
run;
```

Log

Example Code 24.7 *Results from Using Character Data with the FUNCTION Statement in PROC FCMP*

```
spanish=si si si
```

Example 5: Using Variable Arguments with an Array

Details

The following example shows an array that accepts variable arguments. The example implies that the summation function can be called as follows:
`sum=summation(1,2,3,4,5);`

Note: When calling this function from a DATA step, you must provide the *VARARGS* as an array.

Program

```
options cmplib=sasuser.funcs;

proc fcmp outlib=sasuser.funcs.temp;
function summation (b[*]) varargs;
    total=0;
    do i=1 to dim(b);
        total=total + b[i];
    end;
return(total);
```

```
endfunc;
sum=summation(1, 2, 3, 4, 5);
   put sum=;
run;
```

Example 6: Using the SUBROUTINE Statement with a CALL Statement

Details

Here is an example of the SUBROUTINE statement. The SUBROUTINE statement creates an independent computational block of code that can be used with a CALL statement.

Program

```
proc fcmp outlib=sasuser.funcs.temp;
subroutine inverse(in,inv) group="generic";
   outargs inv;
   if in=0 then inv=.;
   else inv=1/in;
endsub;

options cmplib=sasuser.funcs;
data _null_;
   x=5;
   call inverse(x, y);
   put x= y=;
run;
```

Log

Example Code 24.8 *Results from Using the SUBROUTINE Statement in PROC FCMP*

```
x=5 y=0.2
```

Example 7: Using Graph Template Language (GTL) with User-Defined Functions

Features:

PROC FCMP functions
- OSCILLATE
- OSCILLATEBOUND

Other procedures
- PROC TEMPLATE
- PROC SGRENDER

Details

The following example shows how to use functions in a GTL EVAL function. It shows how to define functions that define new curve types (oscillate and oscillateBound). These functions can be used in a GTL EVAL function to compute new columns that are presented with a seriesplot and bandplot.

Program

```
proc fcmp outlib=sasuser.funcs.curves;
   function oscillate(x,amplitude,frequency);
         if amplitude le 0 then amp=1; else amp=amplitude;
            if frequency le 0 then freq=1; else freq=frequency;
         y=sin(freq*x)*constant("e")**(-amp*x);
         return (y);
  endfunc;

 function oscillateBound(x,amplitude);
       if amplitude le 0 then amp=1; else amp=amplitude;
       y=constant("e")**(-amp*x);
       return(y);
  endfunc;
 run;


 options cmplib=sasuser.funcs;

data range;
   do time=0 to 2 by .01;
   output;
   end;
run;

proc template ;
```

```
   define statgraph damping;
   dynamic X AMP FREQ;
   begingraph;
       entrytitle "Damped Harmonic Oscillation";
       layout overlay / yaxisopts=(label="Displacement");
          if (exists(X) and exists(AMP) and exists(FREQ))
                bandplot x=X  limitlower=eval(-oscillateBound(X,AMP))
                limitupper=eval(oscillateBound(X,AMP));
                seriesplot x=X y=eval(oscillate(X,AMP,FREQ));
          endif;
        endlayout;
   endgraph;
   end;
   run;

proc sgrender data=range template=damping;
     dynamic x="Time" amp=10 freq=50 ;
run;
```

Program Description

Create the OSCILLATE function.

```
proc fcmp outlib=sasuser.funcs.curves;
   function oscillate(x,amplitude,frequency);
         if amplitude le 0 then amp=1; else amp=amplitude;
            if frequency le 0 then freq=1; else freq=frequency;
         y=sin(freq*x)*constant("e")**(-amp*x);
         return (y);
  endfunc;
```

Create the OSCILLATEBOUND function.

```
 function oscillateBound(x,amplitude);
       if amplitude le 0 then amp=1; else amp=amplitude;
       y=constant("e")**(-amp*x);
       return(y);
  endfunc;
 run;
```

Create a data set called Range that is used by PROC SGRENDER.

```
 options cmplib=sasuser.funcs;

data range;
   do time=0 to 2 by .01;
   output;
   end;
run;
```

Use the TEMPLATE procedure to customize the appearance of your SAS output.

```
proc template ;
   define statgraph damping;
   dynamic X AMP FREQ;
   begingraph;
```

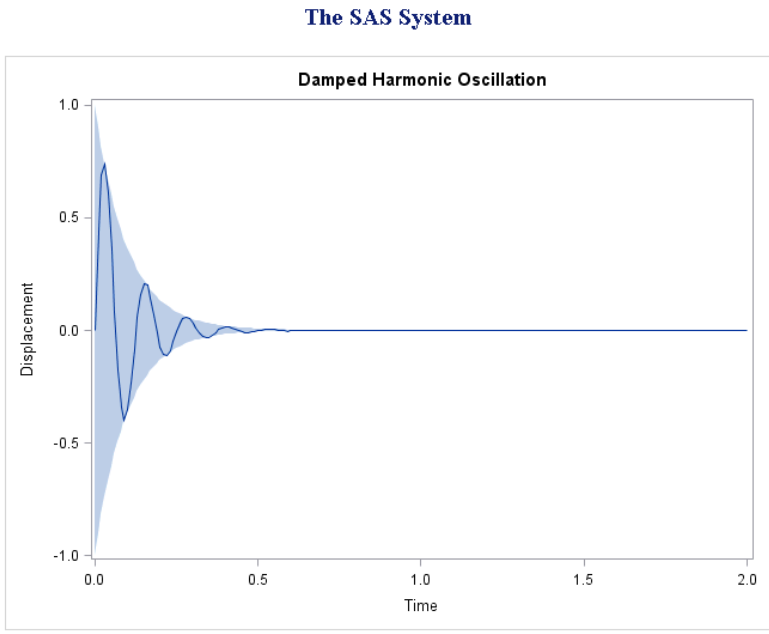
```
      entrytitle "Damped Harmonic Oscillation";
      layout overlay / yaxisopts=(label="Displacement");
         if (exists(X) and exists(AMP) and exists(FREQ))
               bandplot x=X  limitlower=eval(-oscillateBound(X,AMP))
               limitupper=eval(oscillateBound(X,AMP));
               seriesplot x=X y=eval(oscillate(X,AMP,FREQ));
         endif;
       endlayout;
  endgraph;
  end;
  run;
```

Use the SGRENDER procedure to identify the data set that contains the input variables and to assign a statgraph template for the output.

```
proc sgrender data=range template=damping;
     dynamic x="Time" amp=10 freq=50 ;
run;
```

Output: Using GTL with Functions

Output 24.6 *Results from Using GTL with User-Defined Functions*



Example 8: Standardizing Each Row of a Data Set

Features: PROC FCMP functions
- RUN_MACRO
- RUN_SASFILE
- READ_ARRAY
- WRITE_ARRAY

Details

This example shows how to standardize each row of a data set.

Program

```
data numbers;
   drop i j;
   array a[5];
   do j=1 to 5;
   do i=1 to 5;
         a[i] = ranuni(12345) * (i+123.234);
      end;
      output;
      end;
   run;

%macro standardize;
%let dsname=%sysfunc(dequote(&dsname));
%let colname=%sysfunc(dequote(&colname));
proc standard data=&dsname mean=&MEAN std=&STD out=_out;
   var &colname;
run;
data &dsname;
   set_out;
run;
%mend standardize;

proc fcmp outlib=sasuser.ds.functions;
   subroutine standardize(x[*], mean, std);
      outargs x;

      rc=write_array('work._TMP_', x, 'x1');
      dsname='work._TMP_';
         colname='x1';
         rc=run_macro('standardize', dsname, colname, mean, std);
      array x2[1]_temporary_;
         rc=read_array('work._TMP_', x2);
      if dim(x2)=dim(x) then do;
         do i=1 to dim(x);
            x[i]=x2[i];
          end;
         end;
   endsub;
run;

options cmplib=(sasuser.ds);
data numbers2;
   set numbers;
   array a[5];
```

```
   array t[5]_temporary_;
   do i=1 to 5;
      t[i]=a[i];
   end;
   call standardize(t, 0, 1);
   do i=1 to 5;
      a[i]=t[i];
   end;
   output;
run;

proc print data=work.numbers2;
run;
```

Program Description

Create a data set that contains five rows of random numbers.

```
data numbers;
   drop i j;
   array a[5];
   do j=1 to 5;
   do i=1 to 5;
         a[i] = ranuni(12345) * (i+123.234);
      end;
      output;
      end;
   run;
```

Create a macro to standardize a data set with a given value for mean and std.

```
%macro standardize;
%let dsname=%sysfunc(dequote(&dsname));
%let colname=%sysfunc(dequote(&colname));
proc standard data=&dsname mean=&MEAN std=&STD out=_out;
   var &colname;
run;
data &dsname;
   set_out;
run;
%mend standardize;
```

Use the FCMP function to call WRITE_ARRAY, which writes the data to a data set. Call RUN_MACRO to standardize the data in the data set. Call WRITE_ARRAY to write data to a data set. Call READ_ARRAY to read the standardized data back into the array.

```
proc fcmp outlib=sasuser.ds.functions;
   subroutine standardize(x[*], mean, std);
      outargs x;

      rc=write_array('work._TMP_', x, 'x1');
      dsname='work._TMP_';
         colname='x1';
         rc=run_macro('standardize', dsname, colname, mean, std);
      array x2[1]_temporary_;
```

```
         rc=read_array('work._TMP_', x2);
      if dim(x2)=dim(x) then do;
         do i=1 to dim(x);
            x[i]=x2[i];
          end;
         end;
   endsub;
run;
```

Execute the function for each row in the DATA step.

```
options cmplib=(sasuser.ds);
data numbers2;
   set numbers;
   array a[5];
   array t[5]_temporary_;
   do i=1 to 5;
      t[i]=a[i];
   end;
   call standardize(t, 0, 1);
   do i=1 to 5;
      a[i]=t[i];
   end;
   output;
run;
```

Write the output.

```
proc print data=work.numbers2;
run;
```

Output: Standardizing Rows in a Data Set

Output 24.7 *Results from Standardizing Each Row of a Data Set*

The SAS System

Obs	a1	a2	a3	a4	a5
1	45.088	93.3237	104.908	35.152	23.5725
2	90.552	9.7548	92.696	89.987	97.9810
3	60.596	22.7409	19.284	50.079	58.9264
4	106.778	49.1589	22.885	20.641	30.1756
5	34.812	71.3746	44.248	101.808	79.3731

References

SAS Institute Inc. 2013. *SAS Component Objects: Reference*. Cary, NC: SAS Institute Inc.

Henrick, A., D. Erdman, and S. Christian. 2013. "Hashing in PROC FCMP to Enhance Your Productivity." *Proceedings of the SAS Global Forum 2013 Conference*, Cary, NC. SAS Institute Inc., 1–15. Available at http://support.sas.com/resources/papers/proceedings13/129-2013.pdf.

25

FCMP Special Functions and Call Routines

Overview of Special Functions and CALL Routines

The FCMP procedure provides a small set of special use functions. You can call these functions from user-defined FCMP functions but you cannot call these functions directly from the DATA step. To use these functions in a DATA step, you must wrap the special function inside another user-defined FCMP function.

Note: You can call special functions directly in a procedure, but not in the DATA step.

Functions and CALL Routines by Category

Table 25.1 *Categories of FCMP Functions and CALL Routines*

Category	Description
Calling SAS Code from within Functions	Two functions are available that enable you to call SAS code from within functions. The RUN_MACRO function executes a predefined SAS macro. The RUN_SASFILE function executes SAS code from a fileref that you specify.
C Helper	Several helper functions are provided with the package to handle C-language constructs in PROC FCMP. Most C-language constructs must be defined in a package that is created by PROC PROTO before the constructs can be referenced or used by PROC FCMP. The ISNULL function and the SETNULL and STRUCTINDEX CALL routines have been added to extend the SAS language to handle C-language constructs that do not naturally fit into the SAS language.
Arrays	PROC FCMP provides the READ_ARRAY function to read arrays, and the WRITE_ARRAY function to write arrays to a data set. This functionality enables PROC FCMP array data to be processed by SAS programs, macros, and procedures.

Category	Description
Matrix Operations	The FCMP procedure provides you with a number of CALL routines for performing simple matrix operations on declared arrays. These CALL routines are automatically provided by the FCMP procedure. With the exception of ZEROMATRIX, FILLMATRIX, and IDENTITY, the CALL routines listed below do not support matrices or arrays that contain missing values.
Special Purpose	The FCMP procedure provides two special purpose functions: INVCDF and LIMMOMENT. The INVCDF function computes the quantile from any distribution for which you have defined a cumulative distribution function (CDF). The LIMMOMENT function computes the limited moment of any distribution for which you have defined a cumulative distribution function (CDF).

Category	Language Elements	Description
Array	CALL DYNAMIC_ARRAY Routine (p. 946)	Enables an array that is declared within a function to change size in an efficient manner.
	READ_ARRAY Function (p. 969)	Reads data from a SAS data set into a PROC FCMP array variable.
	WRITE_ARRAY Function (p. 982)	Writes data from a PROC FCMP array variable to a data set that can then be used by SAS programs, macros, and procedures.
C Helper	CALL SETNULL Routine (p. 955)	Sets a pointer element of a structure to null.
	CALL STRUCTINDEX Routine (p. 956)	Enables you to access each structure element in an array of structures.
	ISNULL Function (p. 964)	Determines whether a pointer element of a structure is null.
Calling SAS Code from within Functions	RUN_MACRO Function (p. 971)	Executes a predefined SAS macro.
	RUN_SASFILE Function (p. 976)	Executes SAS code in a fileref that you specify.
Compute Implicit Values	SOLVE Function (p. 977)	Computes implicit values of a function using the Gauss-Newton method.
Matrix Operations	CALL ADDMATRIX Routine (p. 942)	Performs an elementwise addition of two matrices or a matrix and a scalar.
	CALL CHOL Routine (p. 943)	Calculates the Cholesky decomposition for a given symmetric matrix.
	CALL DET Routine (p. 945)	Calculates the determinant of a specified matrix that should be square.

Category	Language Elements	Description
	CALL ELEMMULT Routine (p. 948)	Performs an elementwise multiplication of two matrices.
	CALL EXPMATRIX Routine (p. 949)	Returns a matrix etA given the input matrix A and a multiplier t.
	CALL FILLMATRIX Routine (p. 950)	Replaces all of the element values of the input matrix with the specified value.
	CALL IDENTITY Routine (p. 951)	Converts the input matrix to an identity matrix.
	CALL INV Routine (p. 952)	Calculates a matrix that is the inverse of the provided input matrix that should be a square, non-singular matrix.
	CALL MULT Routine (p. 953)	Calculates the multiplicative product of two input matrices.
	CALL POWER Routine (p. 954)	Raises a square matrix to a given scalar value.
	CALL SUBTRACTMATRIX Routine (p. 957)	Performs an element-wide subtraction of two matrices or a matrix and a scalar.
	CALL TRANSPOSE Routine (p. 958)	Returns the transpose of a matrix.
	CALL ZEROMATRIX Routine (p. 959)	Replaces all of the element values of the numeric input matrix with 0.
Special Purpose Functions	INVCDF Function (p. 960)	Computes the quantile from any distribution for which you have defined a cumulative distribution function (CDF).
	LIMMOMENT Function (p. 965)	Computes the limited moment of any distribution for which you have defined a cumulative distribution function (CDF).

Dictionary

CALL ADDMATRIX Routine

Performs an elementwise addition of two matrices or a matrix and a scalar.

Category: Matrix Operations

Requirement: All input and output matrices must have the same dimensions.

Syntax

CALL ADDMATRIX(*X*, *Y*, *Z*);

Required Arguments

X

specifies an input matrix with dimensions *m* x *n* (that is, X[*m*, *n*]) or a scalar.

Y

specifies an input matrix with dimensions *m* x *n* (that is, Y[*m*, *n*]) or a scalar.

Z

specifies an output matrix with dimensions *m* x *n* (that is, Z[*m*, *n*]), such that

$$Z = X + Y$$

Example

The following example uses the ADDMATRIX CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array mat1[3,2] (0.3, -0.78, -0.82, 0.54, 1.74, 1.2);
   array mat2[3,2] (0.2, 0.38, -0.12, 0.98, 2, 5.2);
   array result[3,2];
   call addmatrix(mat1, mat2, result);
   call addmatrix(2, mat1, result);
   put result=;
quit;
```

Output 25.1 *Results from the ADDMATRIX CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

result[1, 1]=2.3 result[1, 2]=1.22 result[2, 1]=1.18 result[2, 2]=2.54
result[3, 1]=3.74 result[3, 2]=3.2
```

CALL CHOL Routine

Calculates the Cholesky decomposition for a given symmetric matrix.

Category: Matrix Operations

Alias: CHOLESKY_DECOMP

Requirement: Both input and output matrices must be square and have the same dimensions. X must be symmetric positive-definite, and Y a lower triangle matrix.

Syntax

CALL CHOL(*X*, *Y* <, *validate*>);

Required Arguments

X

specifies a symmetric positive-definite input matrix with dimensions *m* x *m* (that is, X[*m*, *m*]).

Y

specifies an output matrix with dimensions *m* x *m* (that is, Y[*m*, *m*]). This variable contains the Cholesky decomposition, such that

$$Z = YY*$$

where Y is a lower triangular matrix with strictly positive diagonal entries and Y* denotes the conjugate transpose of Y.

Note: If X is not symmetric positive-definite, then Y is filled with missing values.

Optional Argument

validate

specifies an optional argument that can increase the processing speed by avoiding error checking. The argument can take the following values:

0 the matrix X checks for symmetry. This is the default if the *validate* argument is omitted.

1 the matrix is assumed to be symmetric.

Example

The following example uses the CHOL CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array xx[3,3] 2 2 3 2 4 2 3 2 6;
   array yy[3,3];
   call chol(xx, yy, 0);
   do i=1 to 3;
      put yy[i, 1] yy[i, 2] yy[i, 3];
   end;
```

```
run;
```

Output 25.2 *Results from PROC FCMP and the CHOL CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

1.4142135624 0 0
1.4142135624 1.4142135624 0
2.1213203436 -0.707106781 1
```

CALL DET Routine

Calculates the determinant of a specified matrix that should be square.

Category: Matrix Operations

Requirement: The input matrix X must be square.

Syntax

CALL DET(*X*, *a*);

Required Arguments

X

specifies an input matrix with dimensions *m* x *n* (that is, X[*m*, *n*]).

a

specifies the returned determinate value, such that

$a = |X|$

Details

The determinant, the product of the eigenvalues, is a single numeric value. If the determinant of a matrix is zero, then that matrix is singular (that is, it does not have an inverse). The method performs an LU decomposition and collects the product of the diagonals (Forsythe, Malcolm, and Moler 1967). For more information, see the *SAS/IML User's Guide*.

Example

The following example uses the DET CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array mat1[3,3] (.03, -0.78, -0.82, 0.54, 1.74,
                    1.2, -1.3, 0.25, 1.49);
   call det(mat1, result);
   put result=;
quit;
```

Output 25.3 *Results from the DET CALL Routine*

```
                                The SAS System                          1

                              The FCMP Procedure

result=-0.052374
```

CALL DYNAMIC_ARRAY Routine

Enables an array that is declared within a function to change size in an efficient manner.

Category: Array

Syntax

CALL DYNAMIC_ARRAY(*array–name*, *new-dimension1–size* <, *new-dimension2–size*, ...>);

Required Arguments

array-name
specifies the name of a temporary array.

new-dimension-size
specifies a new size for the temporary array.

Details

Arrays that are declared in functions and CALL routines can be resized, as well as arrays that are declared with the /NOSYMBOLS option. No other array can be resized.

The DYNAMIC_ARRAY CALL routine attempts to dynamically resize the array to match the dimensions of the target that you provide. This means that the array must be dynamic. That is, the array must be declared either in a function or subroutine, or declared with the /NOSYMBOLS option.

The DYNAMIC_ARRAY CALL routine is passed the array to be resized and a new size for each dimension of the array. In the ALLPERMK routine, a scratch array that is the size of the number of elements being permuted is needed. When the function is created, this value is not known because it is passed in as parameter *n*. A dynamic array enables the routine to allocate the amount of memory that is needed, instead of having to create an array that is large enough to handle all possible cases.

When using dynamic arrays, support is limited to PROC FCMP routines. When an array is resized, the resized array is available only within the routine that resized it. It is not possible to resize a DATA step array or to return a PROC FCMP dynamic array to the DATA step.

Example

The following example creates a temporary array named TEMP. The size of the array area depends on parameters that are passed to the function.

```
proc fcmp;
   function avedev_wacky(data[*]);

   length=dim(data);
   array temp[1] /nosymbols;
   call dynamic_array(temp, length);

   mean=0;
   do i=1 to length;
      mean += data[i];
      if i>1 then temp[i]=data[i-1];
      else temp[i]=0;
   end;
   mean=mean/length;

   avedev=0;
   do i=1 to length;
      avedev += abs((data[i])-temp[i] /2-mean);
   end;
   avedev=avedev/length;

   return(avedev);
endsub;

array data[10];

do i = 1 to 10;

   data[i] = i;
end;
```

```
avedev = avedev_wacky(data);
run;
```

CALL ELEMMULT Routine

Performs an elementwise multiplication of two matrices.

Category: Matrix Operations

Requirement: All input and output matrices must have the same dimensions.

Syntax

CALL ELEMMULT(*X*, *Y*, *Z*);

Required Arguments

X
specifies an input matrix with dimensions *m* x *n* (that is, X[*m*, *n*]).

Y
specifies an input matrix with dimensions *m* x *n* (that is, Y[*m*, *n*]).

Z
specifies an output matrix with dimensions *m* x *n* (that is, Z[*m*, *n*]).

Example

The following example uses the ELEMMULT CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array mat1[3,2] (0.3, -0.78, -0.82, 0.54, 1.74, 1.2);
   array mat2[3,2] (0.2, 0.38, -0.12, 0.98, 2, 5.2);
   array result[3,2];
   call elemmult(mat1, mat2, result);
   call elemmult(2.5, mat1, result);
   put result=;
 quit;
```

Output 25.4 *Results from the ELEMMULT CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

result[1, 1]=0.75 result[1, 2]=-1.95 result[2, 1]=-2.05 result[2, 2]=1.35
result[3, 1]=4.35 result[3, 2]=3
```

CALL EXPMATRIX Routine

Returns a matrix e^{tA} given the input matrix *A* and a multiplier *t*.

Category: Matrix Operations

Requirement: Both input and output matrices must be square and have the same dimensions. *t* can be any scalar value.

Syntax

CALL EXPMATRIX(*X*, *t*, *Y*);

Required Arguments

X
specifies an input matrix with dimensions *m* x *m* (that is, X[*m*, *m*]).

t
specifies a double scalar value.

Y
specifies an output matrix with dimensions *m* x *m* (that is, Y[*m*, *m*]), such that

$$Y = \varepsilon^{tX}$$

Details

The EXPMATRIX CALL routine uses a Padé approximation algorithm as presented in Golub and van Loan (1989), p. 558. Note that this module does not exponentiate each entry of a matrix. For more information, see the EXPMATRIX documentation in the *SAS/IML User's Guide*.

Example

The following example uses the EXPMATRIX CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array mat1[3,3] (0.3, -0.78, -0.82, 0.54, 1.74,
                    1.2, -1.3, 0.25, 1.49);
   array result[3,3];
   call expmatrix(mat1, 3, result);
   put result=;
quit;
```

Output 25.5 *Results from the EXPMATRIX CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

result[1, 1]=365.58043585 result[1, 2]=-589.6358476 result[1, 3]=-897.1034008
result[2, 1]=-507.0874798 result[2, 2]=838.64570481 result[2, 3]=1267.3598426
result[3, 1]=-551.588816 result[3, 2]=858.97629382 result[3, 3]=1324.8187125
```

CALL FILLMATRIX Routine

Replaces all of the element values of the input matrix with the specified value.

Category: Matrix Operations

Note: You can use the FILLMATRIX CALL routine with multidimensional numeric arrays.

Syntax

CALL FILLMATRIX(*X*, *Y*);

Required Arguments

X
specifies an input numeric matrix.

Y
specifies the numeric value that fills the matrix.

Example

The following example uses the FILLMATRIX CALL routine.

```
options pageno=1 nodate ls=80 ps=64;

proc fcmp;
   array mat1[3, 2] (0.3, -0.78, -0.82, 0.54, 1.74, 1.2);
   call fillmatrix(mat1, 99);
   put mat1=;
quit;
```

Output 25.6 *Results from the FILLMATRIX CALL Routine*

```
                                The SAS System                                1

                               The FCMP Procedure

mat1[1, 1]=99 mat1[1, 2]=99 mat1[2, 1]=99 mat1[2, 2]=99 mat1[3, 1]=99
mat1[3, 2]=99
```

CALL IDENTITY Routine

Converts the input matrix to an identity matrix.

Category: Matrix Operations

Requirement: The input matrix must be square.

Note: Diagonal element values of the matrix are set to 1, and the rest of the values are set to 0.

Syntax

CALL IDENTITY(*X*);

Required Argument

X
specifies an input matrix with dimensions *m* x *m* (that is, X[*m*, *m*]).

Example

The following example uses the IDENTITY CALL routine:

```
options pageno=1 nodate;
```

```
proc fcmp;
   array mat1[3,3] (0.3, -0.78, -0.82, 0.54, 1.74, 1.2,
                    -1.3, 0.25, 1.49);
   call identity(mat1);
   put mat1=;
quit;
```

Output 25.7 *Results from the IDENTITY CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

mat1[1, 1]=1 mat1[1, 2]=0 mat1[1, 3]=0 mat1[2, 1]=0 mat1[2, 2]=1 mat1[2, 3]=0
mat1[3, 1]=0 mat1[3, 2]=0 mat1[3, 3]=1
```

CALL INV Routine

Calculates a matrix that is the inverse of the provided input matrix that should be a square, non-singular matrix.

Category: Matrix Operations

Requirement: Both the input and output matrices must be square and have the same dimensions.

Syntax

CALL INV(*X*, *Y*);

Required Arguments

X

specifies an input matrix with dimensions *m* x *m* (that is, X[*m*, *m*]).

Y

specifies an output matrix with dimensions *m* x *m* (that is, Y[*m*, *m*]), such that

$$Y[m,m] = X'[m,m]$$

where ′ denotes inverse

$$X \times Y = Y \times X = I$$

and I is the identity matrix.

Example

The following example uses the INV CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array mat1[3,3] (0.3, -0.78, -0.82, 0.54, 1.74,
                    1.2, -1.3, 0.25, 1.49);
   array result[3,3];
   call inv(mat1, result);
   put result=;
quit;
```

Output 25.8 *Results from the INV CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

result[1, 1]=4.0460407887 result[1, 2]=1.6892917399 result[1, 3]=0.8661767509
result[2, 1]=-4.173108283 result[2, 2]=-1.092427483 result[2, 3]=-1.416802558
result[3, 1]=4.230288655 result[3, 2]=1.6571719011 result[3, 3]=1.6645841716
```

CALL MULT Routine

Calculates the multiplicative product of two input matrices.

Category: Matrix Operations

Requirement: The number of columns for the first input matrix must be the same as the number of rows for the second matrix.

Syntax

CALL MULT(*X*, *Y*, *Z*);

Required Arguments

X
specifies an input matrix with dimensions *m* x *n* (that is, X[*m*, *n*]).

Y
specifies an input matrix with dimensions *n* x *p* (that is, Y[*n*, *p*]).

Z
specifies an output matrix with dimensions *m* x *p* (that is, Z[*m*, *p*]), such that

$$Z[m,p] = X[m,n] \times Y[n,p]$$

Example

The following example uses the MULT CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array mat1[2,3] (0.3, -0.78, -0.82, 0.54, 1.74, 1.2);
   array mat2[3,2] (1, 0, 0, 1, 1, 0);
   array result[2,2];
   call mult(mat1, mat2, result);
   put result=;
quit;
```

Output 25.9 *Results from the MULT CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

result[1, 1]=-0.52 result[1, 2]=-0.78 result[2, 1]=1.74 result[2, 2]=1.74
```

CALL POWER Routine

Raises a square matrix to a given scalar value.

Category: Matrix Operations

Restriction: Large scalar values should be avoided because the POWER CALL routine's internal use of the matrix multiplication routine might cause numerical precision problems.

Requirement: Both input and output matrices must be square and have the same dimensions.

Syntax

CALL POWER(*X*, *a*, *Y*);

Required Arguments

X
specifies an input matrix with dimensions *m* x *m* (that is, X[*m*, *m*]).

a
specifies an integer scalar value (power).

Y
specifies an output matrix with dimensions *m* x *m* (that is, Y[*m*, *m*]), such that

$$Y = X^a$$

Details

If the scalar is not an integer, it is truncated to an integer. If the scalar is less than 0, then it is changed to 0. For more information, see the *SAS/IML User's Guide*.

Example

The following example uses the POWER CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array mat1[3,3] (0.3, -0.78, -0.82, 0.54, 1.74,
                    1.2, -1.3, 0.25, 1.49);
   array result[3,3];
   call power(mat1, 3, result);
   put result=;
quit;
```

Output 25.10 *Results from the POWER CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

result[1, 1]=2.375432 result[1, 2]=-4.299482 result[1, 3]=-6.339638
result[2, 1]=-3.031224 result[2, 2]=6.272988 result[2, 3]=8.979036
result[3, 1]=-4.33592 result[3, 2]=5.775695 result[3, 3]=9.326529
```

CALL SETNULL Routine

Sets a pointer element of a structure to null.

Category: C Helper

Syntax

CALL SETNULL(*pointer-element*);

Required Argument

pointer-element
is a pointer to a structure.

Example

The following example assumes that the same LINKLIST structure that is described in "Example 1: Generating a Linked List" on page 964 is defined using PROC PROTO. The CALL SETNULL routine can be used to set the NEXT element to null:

```
struct linklist list;
call setnull(list.next);
```

CALL STRUCTINDEX Routine

Enables you to access each structure element in an array of structures.

Category: C Helper

Syntax

CALL STRUCTINDEX(*structure-array*, *index*, *structure-element*);

Required Arguments

structure-array
specifies an array.

index
is a 1–based index as used in most SAS arrays.

structure-element
points to an element in the array.

Example

In the first part of this example, the following structures and function are defined by using PROC PROTO.

```
proc proto package=sasuser.mylib.str2;
struct point{
   short s;
   int i;
   long l;
   double d;
};

struct point_array {
   int            length;
   struct point p[2];
   char           name[32];
};
```

```
run;
```

In the second part of this example, the PROC FCMP code segment shows how to use the STRUCTINDEX CALL routine to retrieve and set each point structure element of an array called P in the POINT_ARRAY structure:

```
options pageno=1 nodate ls=80 ps=64;

proc fcmp libname=sasuser.mylib;
   struct point_array pntarray;
   struct point pnt;

   pntarray.length=2;
   pntarray.name="My funny structure";

   /* Get each element using the STRUCTINDEX CALL routine and set
values. */
do i=1 to 2;
   call structindex(pntarray.p, i, pnt);
   put "Before setting the" i "element: " pnt=;
   pnt.s=1;
   pnt.i=2;
   pnt.l=3;
   pnt.d=4.5;
   put "After setting the" i "element: " pnt=;
end;
run;
```

Output 25.11 *Results of Setting the Point Structure Elements of an Array*

```
                                The SAS System                                1

                              The FCMP Procedure

Before setting the 1 element:  pnt {s=0, i=0, l=0, d=0}
After setting the 1 element:  pnt {s=1, i=2, l=3, d=4.5}
Before setting the 2 element:  pnt {s=0, i=0, l=0, d=0}
After setting the 2 element:  pnt {s=1, i=2, l=3, d=4.5}
```

CALL SUBTRACTMATRIX Routine

Performs an element-wide subtraction of two matrices or a matrix and a scalar.

Category: Matrix Operations

Requirement: All input and output matrices must have the same dimensions.

Syntax

CALL SUBTRACTMATRIX(*X*, *Y*, *Z*);

Required Arguments

X

specifies an input matrix with dimensions *m* x *n* (that is, X[*m*, *n*]) or a scalar.

Y

specifies an input matrix with dimensions *m* x *n* (that is, Y[*m*, *n*]) or a scalar.

Z

specifies an output matrix with dimensions *m* x *n* (that is, Z[*m*, *n*]), such that

$Z = X - Y$

Example

The following example uses the SUBTRACTMATRIX CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array mat1[3,2] (0.3, -0.78, -0.82, 0.54, 1.74, 1.2);
   array mat2[3,2] (0.2, 0.38, -0.12, 0.98, 2, 5.2);
   array result[3,2];
   call subtractmatrix(mat1, mat2, result);
   call subtractmatrix(2, mat1, result);
   put result=;
 quit;
```

Output 25.12 *Results from the SUBTRACTMATRIX CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

result[1, 1]=1.7 result[1, 2]=2.78 result[2, 1]=2.82 result[2, 2]=1.46
result[3, 1]=0.26 result[3, 2]=0.8
```

CALL TRANSPOSE Routine

Returns the transpose of a matrix.

Category: Matrix Operations

Syntax

CALL TRANSPOSE(*X*, *Y*);

Required Arguments

X
specifies an input matrix with dimensions *m* x *n* (that is, X[*m*, *n*]).

Y
specifies an output matrix with dimensions *n* x *m* (that is, Y[*n*, *m*])

Details

$$Y = X'$$

Note that the number of rows for the input matrix should be equal to the number of columns of the output matrix, and the number of rows for the output matrix should be equal to the number of columns of the input matrix.

Example

The following example uses the TRANSPOSE CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array mat1[3,2] (0.3, -0.78, -0.82, 0.54, 1.74, 1.2);
   array result[2,3];
   call transpose(mat1, result);
   put result=;
quit;
```

Output 25.13 *Results from the TRANSPOSE CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

result[1, 1]=0.3 result[1, 2]=-0.82 result[1, 3]=1.74 result[2, 1]=-0.78
result[2, 2]=0.54 result[2, 3]=1.2
```

CALL ZEROMATRIX Routine

Replaces all of the element values of the numeric input matrix with 0.

Category: Matrix Operations

Note: You can use the ZEROMATRIX CALL routine with multi-dimensional numeric arrays.

Syntax

CALL ZEROMATRIX(*X*);

Required Argument

X
specifies a numeric input matrix.

Example

The following example uses the ZEROMATRIX CALL routine:

```
options pageno=1 nodate;

proc fcmp;
   array mat1[3,2]  (0.3, -0.78, -0.82, 0.54, 1.74, 1.2);
   call zeromatrix(mat1);
   put mat1=;
quit;
```

Output 25.14 *Results from the ZEROMATRIX CALL Routine*

```
                                The SAS System                                1

                              The FCMP Procedure

mat1[1, 1]=0 mat1[1, 2]=0 mat1[2, 1]=0 mat1[2, 2]=0 mat1[3, 1]=0 mat1[3,
2]=0
```

INVCDF Function

Computes the quantile from any distribution for which you have defined a cumulative distribution function (CDF).

Category: Special Purpose Functions

Notes: INVCDF is a special purpose function that is automatically provided by the FCMP procedure for your convenience.

If you specify a probability *p* for a distribution with CDF denoted by *F(x; <parameters>)*, then the INVCDF function returns a quantile *q* that satisfies *F(q;<parameters>) = p*. In other words, $q=F^{-1}(p)$.

Syntax

quantile=**INVCDF**('*CDF-function-name*', *options-array*, *cumulative-probability*, *parameter-1 <, parameter-2, ...>*);

Required Arguments

quantile
specifies the quantile that is returned from the INVCDF function.

'CDF-function-name'
specifies the name of the CDF function. Enclose *CDF-function-name* in quotation marks.

Requirement *CDF-function-name* must be a function defined using the FCMP procedure. It must have a signature as follows:

```
function <CDF-function-name> (x, parameter-1 <, parameter-2, …>);
endsub;
```

Note It is recommended that the CDF be a continuous function. For discrete CDF, the INVCDF function might not be able to compute the quantile.

options-array
specifies an array of options to use with the INVCDF function. *Options-array* is used to control and monitor the process of inverting the CDF. *Options-array* can be a missing value (.), or it can have up to four of the following elements in the following order:

initial-value
specifies the initial guess for the quantile at which the inversion process starts. This is useful when you have an idea of the approximate value for quantile (for example, from the empirical estimate of the CDF).

Default 0.1

desired-accuracy
specifies the desired relative accuracy of the quantile. You can specify any value in the range (0,0.1). If you specify a smaller value, the result is a more accurate estimate of the quantile, but it might take longer to invert the CDF.

Default 1.0e-8

domain-type
specifies the domain for the CDF function. A missing value or a value of 0 indicates a nonnegative support, that is [0,∞). Any other value indicates a support over the entire real line, that is (-∞,∞).

Default 0

return-code
specifies the return status. If *options-array* is of dimension 4 or more, then the fourth element contains the return status. *Return-code* can have one of the following values:

<=0
indicates success. If negative, then the absolute value is the number of times the CDF function was evaluated in order to compute the quantile. A larger absolute value indicates longer convergence time.

1
indicates that the quantile could not be computed.

cumulative-probability
specifies the cumulative probability value for which the quantile is desired.

Range [0,1)

parameter
specifies the parameters of the distribution at which the quantile is desired. You must specify exactly the same number of parameters as required by the specified CDF function, and they should appear exactly in the same order as required by the specified CDF function.

Details

The INVCDF function finds the quantile for the specified cumulative probability from a distribution whose cumulative distribution function is specified by the *CDF-function-name* argument. In other words, it inverts the CDF function such that the following expression is true:

```
cumulative-probability = CDF-function-name(quantile,<parameters>)
```

If ε denotes the desired accuracy of the quantile for cumulative probability *p*, then INVCDF attempts to compute the quantile *q* such that $|p - F(q)| < \varepsilon p$, where *F(x)* denotes the CDF evaluated at *x*.

You can control the inversion process with various options. Here is an example of an options array:

```
array opts[4] initial epsilon support (1.5 1.0e-6 0);
```

These values refer to the preceding line of code:

```
initial(initial-value)=1.5

epsilon(desired-accuracy)=1.0e-6

support(domain-type)=0
```

You can examine the return status of the function by checking opts[4].

Comparisons

You can regard this function as a generic extension of the QUANTILE function, which computes quantiles only from specific distributions. The INVCDF function enables you to compute quantiles from any continuous distribution as long as you can programmatically define that distribution's CDF function. Unlike the QUANTILE function, this function cannot be used directly in a DATA step. It only can be used inside the definition of an FCMP function or subroutine. However, this is not a limitation because you can invoke the FCMP function that uses it from a DATA step. See the following example.

Example: Generating a Random Sample from an Exponential Distribution

The following example demonstrates how you can generate a random sample from any parametric distribution in a DATA step using the INVCDF function. The example uses the exponential distribution for illustration, but it can be extended to any distribution for which you can programmatically define a CDF function. The following statements define an FCMP function EXP_QUANTILE that uses the INVCDF function and the CDF function to compute a quantile from the exponential distribution.

```
proc fcmp library=work.mycdf outlib=work.myquantile.functions;
   function exp_quantile(cdf, theta, rc);
      outargs rc;
      array opts[4] / nosym(0.1 1.0e-8 .);
      q=invcdf("exp_cdf", opts, cdf, theta);
      rc=opts[4];  /* return code */
      return(q);
   endsub;
quit;
```

The preceding code assumes that you have stored the definition of the EXP_CDF function in an FCMP library called Work.Mycdf using a PROC FCMP step as follows:

```
proc fcmp outlib=work.mycdf.functions;
   function exp_cdf(x, theta);
      return(1.0 - exp(-x/Theta));
   endsub;
quit;
```

Now you can invoke the EXP_QUANTILE function from a DATA step to generate a random sample from the exponential distribution with a scale parameter (theta) that has a value of 50. Note that the locations of the EXP_CDF and EXP_QUANTILE functions need to be specified with the appropriate value for the CMPLIB= option before you execute the DATA step:

```
options cmplib=(work.mycdf work.myquantile);

data exp_sample(keep=q);
   n=0;k=0;
   do k=1 to 500;
      if (n=100) then leave;
```

```
      rcode=.;
      q=exp_quantile(rand('UNIFORM'), 50, rcode);
      if (rcode <= 0) then do;
         n=n+1;
         output;
      end;
   end;
run;
```

ISNULL Function

Determines whether a pointer element of a structure is null.

Category: C Helper

Syntax

numeric-variable = **ISNULL** (*pointer-element*);

Required Arguments

numeric-variable
specifies a numeric value.

pointer-element
specifies a variable that contains the address of another variable.

Examples

Example 1: Generating a Linked List

In the following example, the LINKLIST structure and GET_LIST function are defined by using PROC PROTO. The GET_LIST function is an external C routine that generates a linked list with as many elements as requested.

```
struct linklist{
   double value;
   struct linklist * next;
};

struct linklist * get_list(int);
```

Example 2: Using the ISNULL C Helper Function in a Loop

The following code segment shows that the ISNULL C helper function loops over the linked list that is created by GET_LIST and writes out the elements.

```
proc proto package=sasuser.mylib.str2;
```

```
struct linklist{
   double value;
   struct linklist * next;
};

struct linklist * get_list(int);

externc get_list;
   struct linklist * get_list(int len){
      int i;
      struct linklist * list=0;
      list=(struct linklist*)
         malloc(len*sizeof(struct linklist));
      for (i=0;i<len-1;i++){
         list[i].value=i;
         list[i].next=&list[i+1];
      }
      list[i].value=i;
      list[i].next=0;
      return list;
   }
externcend;
run;

options pageno=1 nodate ls=80 ps=64;
proc fcmp libname=sasuser.mylib;
   struct linklist list;
   list=get_list(3);
   put list.value=;

   do while (^isnull(list.next));
      list=list.next;
      put list.value=;
   end;
run;
```

Output 25.15 *Results from Using the ISNULL C Helper Function*

```
                                The SAS System                                1

                              The FCMP Procedure

list.value=0
list.value=1
list.value=2
```

LIMMOMENT Function

Computes the limited moment of any distribution for which you have defined a cumulative distribution function (CDF).

Category: Special Purpose Functions

Notes: LIMMOMENT is a special purpose function that is automatically provided by the FCMP procedure for your convenience.

If you specify order *k* and upper limit *u*, then the LIMMOMENT function computes the limited moment as $E[min(X,u)^k]$, where *E* denotes an expectation taken over the distribution of a random variable X that is defined by the specified CDF function.

Syntax

imom=**LIMMOMENT**('*CDF-function-name*', *options-array*, *order*, *limit*, *parameter-1 <, parameter-2, ...>*);

Required Arguments

imom
specifies the limited moment that is returned from the LIMMOMENT function.

'CDF-function-name'
specifies the name of the CDF function. Enclose *CDF-function-name* in quotation marks.

Requirement *CDF-function-name* must be a function defined using the FCMP procedure. It must have a signature as follows:

```
function <CDF-function-name> (x, parameter-1 <, parameter-2, …>);

endsub;
```

Note It is recommended that the CDF be a continuous function. For discrete CDF, the LIMMOMENT function might not be able to compute the limited moment.

options-array
specifies an array of options to use with the LIMMOMENT function. *Options-array* is used to control and monitor the process of numerical integration used to compute the limited amount. *Options-array* can be a missing value (.), or it can have up to four of the following elements in the following order:

desired-accuracy
specifies the desired accuracy of the numerical integration. You can specify any value in the range (0,0.1). If you specify a smaller value, the result is a more accurate estimate of the moment, but it takes longer to compute the desired-accuracy.

Default 1.0e-8

initial-step-size
specifies the step size that is used initially by the numerical integration process. An increase in the value results in a linear decrease in the number of times the integrand is evaluated. Typically, using the default value of 1 produces good results.

Default 1

maximum-iterations
specifies the maximum number of iterations that are used to refine the integration result in order to achieve the desired accuracy. An increase in this value results in an exponential increase in the number of times the integrand is evaluated.

Default 8

return-code
specifies the return status. If *options-array* is of dimension 4 or more, then the fourth element contains the return status. *Return-code* can have one of the following values:

<=0
indicates success. If negative, then the absolute value is the number of times the integrand function was evaluated in order to compute the limited moment. A larger absolute value indicates longer convergence time.

1
indicates that the limited moment could not be computed.

order
specifies the order of the desired limited moment.

Range [1,10]

limit
specifies the upper limit that is used to compute the desired limited moment.

Requirement The value of *limit* must be greater than 0.

parameter
specifies the parameters of the distribution at which the limited moment is desired. You must specify exactly the same number of parameters as required by the specified CDF function, and they should appear exactly in the same order as required by the specified CDF function.

Details

Let a random variable *X* have a probability distribution with probability density function *f(x;θ)* and cumulative distribution function *F(x;θ)*, where θ denotes the parameters of the distribution. For a specified upper limit *u*, the k^{th}–order limited moment of this distribution is defined as follows:

$$E[(X \wedge u)^k] = \int_0^u x^k f(x)dx + u^k \int_u^\infty f(x)dx = \int_0^u x^k f(x)dx + u^k(1 - F(u))$$

The LIMMOMENT function uses the following alternate expression:

$$E[(X \wedge u)^k] = k \int_0^u x^{k-1}[1 - F(x)]dx$$

Because the expression needs only *F(x)*, you need to specify only the CDF function for the distribution. Limited moments are often used in insurance applications to compute the maximum amount expected to be paid if the policy limit is set at a certain value.

You can control the numerical integration process with various options. Here is an example of an options array:

```
array opts[4] epsilon initial maxiter (1.0e-5 1 6);
```

These values refer to the preceding line of code.

```
epsilon(desired-accuracy)=1.0e-5

initial(initial-step)=1

maxiter(maximum-iterations)=6
```

You can examine the return status of the function by checking opts[4].

Example: Computing a Limited Moment for a Lognormal Distribution

This example demonstrates how you can compute the limited moment for any parametric distribution in a DATA step using the LIMMOMENT function. The example uses the lognormal distribution for illustration, but it can be extended to any distribution for which you can programmatically define a CDF function. The following statements define an FCMP function LOGN_LIMMOMENT that uses the LIMMOMENT function and the CDF function to compute limited moments from the lognormal distribution:

```
proc fcmp library=work.mycdf outlib=work.mylimmom.functions;
        function logn_limmoment(order, limit, mu, sigma, rc);
            outargs rc;
            array opts[4] / nosym (1.0e-8 . . .);

            m=limmoment("logn_cdf", opts, order, limit, mu, sigma);
            rc=opts[4]; /* return code */

            return(m);
        endsub;
    quit;
```

The preceding code assumes that you have stored the definition of the LOGN_CDF function in an FCMP library called Work.Mycdf using a PROC FCMP step as follows:

```
proc fcmp outlib=work.mycdf.functions;
        function logn_cdf(x, Mu, Sigma);
            if (x >= constant('MACEPS')) then do;
                z=(log(x) - Mu)/Sigma;
                return(CDF('NORMAL',z));
            end;
            return (0);
        endsub;
    quit;
```

You can now invoke the LOGN_LIMMOMENT function from a DATA step as shown below. Note that the location of the LOGN_CDF and LOGN_LIMMOMENT functions must be specified with an appropriate value for the CMPLIB= option before you execute the DATA step:

```
options cmplib=(work.mycdf work.mylimmom);

    data _null_;
        do order=1 to 3;
            rcode=.;
            m=logn_limmoment(order, 100, 5, 0.5, rcode);
            if (rcode > 0) then
                put "ERROR: Limited moment could not be computed.";
            else
                put 'Moment of order ' order ' with limit 100 = ' m;
        end;
    run;
```

READ_ARRAY Function

Reads data from a SAS data set into a PROC FCMP array variable.

Category: Array

Syntax

rc = **READ_ARRAY**(*data_set_name*, *array_variable* <, *'column_name_1'*, *'column_name_2'* , ... >);

Required Arguments

rc
is 0 if the function is able to successfully read the data set.

data_set_name
specifies the name of the data set from which the array data is read. *Data_set_name* must be a character literal or variable that contains the member name (libname.memname) of the data set to be read from.

array_variable
specifies the PROC FCMP array variable into which the data is read. *Array_variable* must be a local temporary array variable because the function might need to grow or shrink its size to accommodate the size of the data set.

Optional Argument

column_name
specifies optional names for the specific columns of the data set that are read.

If specified, *column_name* must be a literal string enclosed in quotation marks. *Column_name* cannot be a PROC FCMP variable. If column names are not specified, PROC FCMP reads all of the columns in the data set.

Details

When SAS translates between an array and a data set, the array is indexed as [row,column].

Arrays that are declared in functions and CALL routines can be resized, as well as arrays that are declared with the /NOSYMBOLS option. No other arrays can be resized.

The READ_ARRAY function attempts to dynamically resize the array to match the dimensions of the input data set. This means that the array must be dynamic. That is, the array must be declared either in a function or CALL routine or declared with the /NOSYMBOLS option.

Example

This example creates and reads a SAS data set into an FCMP array variable.

```
options nodate pageno=1;

data account;
   input acct price cost;
   datalines;
1 2 3
4 5 6
;
run;

proc fcmp;
   array x[2,3] / nosymbols;
   rc=read_array('account',x);
   put x=;
run;

proc fcmp;
   array x[2,2] / nosymbols;
   rc=read_array('account', x, 'price', 'acct');
   put x=;
run;
```

Output 25.16 *Results from the READ_ARRAY Function*

```
                                The SAS System                                1

                              The FCMP Procedure

x[1, 1]=1 x[1, 2]=2 x[1, 3]=3 x[2, 1]=4 x[2, 2]=5 x[2, 3]=6
```

```
                                The SAS System                                2

                              The FCMP Procedure

x[1, 1]=2 x[1, 2]=1 x[2, 1]=5 x[2, 2]=4
```

RUN_MACRO Function

Executes a predefined SAS macro.

Category: Calling SAS Code from within Functions

Note: The behavior of this function is similar to executing `%macro_name;` in SAS.

Syntax

rc = **RUN_MACRO** (*'macro_name'* <, *variable_1*, *variable_2, ...*>);

Required Arguments

rc
is 0 if the function is able to submit the macro. The return code indicates only that the macro call was attempted. The macro itself should set the value of a SAS macro variable that corresponds to a PROC FCMP variable to determine whether the macro executed as expected.

macro_name
specifies the name of the macro to be run.

Requirement *Macro_name* must be a string enclosed in quotation marks or a character variable that contains the macro to be executed.

Optional Argument

variable
specifies optional PROC FCMP variables, which are set by macro variables of the same name. These arguments must be PROC FCMP double or character variables.

Before SAS executes the macro, SAS macro variables are defined with the same name and value as the PROC FCMP variables. After SAS executes the macro, the macro variable values are copied back to the corresponding PROC FCMP variables.

Examples

Example 1: Executing a Predefined Macro with PROC FCMP

This example creates a macro called %TESTMACRO, and then uses the macro within PROC FCMP to subtract two numbers.

```
      /* Create a macro called %TESTMACRO. */
%macro testmacro;
   %let p=%sysevalf(&a - &b);
%mend testmacro;

    /* Use %TESTMACRO within a function in PROC FCMP to subtract two
numbers. */
proc fcmp outlib=sasuser.ds.functions;
   function subtract_macro(a, b);
      rc=run_macro('testmacro', a, b, p);
      if rc eq 0 then return(p);
      else return(.);
   endsub;
run;

   /* Make a call from the DATA step. */
option cmplib=(sasuser.ds);

data _null_;
   a=5.3;
   b=0.7;
   p=.;
   p=subtract_macro(a, b);
   put p=;
run;
```

Example Code 25.1 *Results from Executing a Predefined Macro with PROC FCMP*

```
p=4.6
```

Example 2: Comparing Results from the RUN_MACRO and the DOSUBL Functions

This example creates the %TESTMACRO macro, and compares how the DOSUBL function invokes the same %TESTMACRO as RUN_MACRO. In the RUN_MACRO invocation, all variables are passed as arguments so that they can be set. In the DOSUBL invocation, all macro variables are imported to the code to be executed, then exported on completion. The macro variables &a and &b are made available to %TESTMACRO and the macro variable &p is made available to the caller of

DOSUBL. For more information, see "DOSUBL Function" in *SAS Functions and CALL Routines: Reference*.

```
    /* Create a macro called %TESTMACRO. */
%macro testmacro;
   %let p=%sysevalf(&a - &b);
%mend testmacro;

    /* Use %TESTMACRO within a function in PROC FCMP to subtract two
numbers. */
proc fcmp outlib=sasuser.ds.functions;
   function subtract_macro(a, b);
      rc=run_macro('testmacro', a, b, p);
      if rc eq 0 then return(p);
      else return(.);
   endsub;
run;

   /* Make a call from the DATA step. */
option cmplib=(sasuser.ds);

data _null_;
   a=5.3;
   b=0.7;
   p=.;
   p=subtract_macro(a, b);
   put p= '(RUN_MACRO function and a DATA step)';
run;

%global a b p;
%put p=&p;
    /* The value should not yet be known. */
   %let a=5.3;
   %let b=0.7;
data _null_;
   rc=dosubl('%testmacro');
   run;
%put p=&p (DOSUBL function);
```

Example Code 25.2 *Results from the RUN_MACRO and the DOSUBL Functions*

```
p=4.6 (RUN_MACRO function and a DATA step)
p=4.6 (DOSUBL function)
```

Example 3: Executing a DATA Step within a DATA Step

This example shows how to execute a DATA step from within another DATA step. The program consists of the following sections:

- The first section of the program creates a macro called APPEND_DS. This macro can write to a data set or append a data set to another data set.
- The second section of the program calls the macro from function writeDataset in PROC FCMP.

- The third section of the program creates the SALARIES data set and divides the data set into four separate data sets depending on the value of the variable Department.
- The fourth section of the program writes the results to the output window.

```
   /* Create a macro called APPEND_DS. */
%macro append_ds;
   /* Character values that are passed to RUN_MACRO are put
*/
   /* into their corresponding macro variables inside of quotation
*/
   /* marks. The quotation marks are part of the macro variable value.
*/
   /* The DEQUOTE function is called to remove the quotation marks.
*/
   %let dsname=%sysfunc(dequote(&dsname));
   data &dsname;
      %if %sysfunc(exist(&dsname)) %then %do;
         modify &dsname;
      %end;
      Name=&Name;
      WageCategory=&WageCategory;
      WageRate=&WageRate;
      output;
      stop;
   run;
%mend append_ds;

   /* Call the APPEND_DS macro from function writeDataset in PROC
FCMP. */
proc fcmp outlib=sasuser.ds.functions;
   function writeDataset (DsName $, Name $, WageCategory $, WageRate);
      rc=run_macro('append_ds', DsName, Name, WageCategory, WageRate);
      return(rc);
   endsub;
run;

   /* Use the DATA step to separate the salaries data set into four
separate */
   /* departmental data sets (NAD, DDG, PPD, and
STD).                        */
data salaries;
   input Department $ Name $ WageCategory $ WageRate;
   datalines;
BAD Carol Salaried 20000
BAD Beth Salaried 5000
BAD Linda Salaried 7000
BAD Thomas Salaried 9000
BAD Lynne Hourly 230
DDG Jason Hourly 200
DDG Paul Salaried 4000
PPD Kevin Salaried 5500
PPD Amber Hourly 150
PPD Tina Salaried 13000
STD Helen Hourly 200
STD Jim Salaried 8000
```

```
;
run;

options cmplib=(sasuser.ds) pageno=1 nodate;
data _null_;
   set salaries;
   by Department;
   length dsName $ 64;
   retain dsName;
   if first.Department then do;
      dsName='work.' || trim(left(Department));
   end;
   rc=writeDataset(dsName, Name, WageCategory, wageRate);
run;

proc print data=work.BAD; run;
proc print data=work.DDG; run;
proc print data=work.PPD; run;
proc print data=work.STD; run;
```

Output 25.17 *Results for Calling a DATA Step within a DATA Step*

```
                    The SAS System
                                                1

                                Wage       Wage
   Obs      Name              Category     Rate

    1       Carol             Salaried    20000
    2       Beth              Salaried     5000
    3       Linda             Salaried     7000
    4       Thomas            Salaried     9000
    5       Lynne             Hourly        230
```

```
                    The SAS System
                                                2

                                Wage       Wage
     Obs    Name              Category     Rate

      1     Jason             Hourly        200
      2     Paul              Salaried     4000
```

```
                    The SAS System
                                                3

                                Wage       Wage
     Obs    Name              Category     Rate

      1     Kevin             Salaried     5500
      2     Amber             Hourly        150
      3     Tina              Salaried    13000
```

```
                         The SAS System
                                                          4

                                  Wage        Wage
                 Obs    Name      Category    Rate

                  1     Helen     Hourly       200
                  2     Jim       Salaried    8000
```

RUN_SASFILE Function

Executes SAS code in a fileref that you specify.

Category: Calling SAS Code from within Functions

Syntax

rc = **RUN_SASFILE** (*'fileref_name'* <, *variable-1*, *variable-2*, ...>);

Required Arguments

rc
is 0 if the function is able to submit a request to execute the code that processes the SAS file. The return code indicates only that the call was attempted.

fileref_name
specifies the name of the SAS fileref that points to the SAS code.

Requirement *Fileref_name* must be a string enclosed in quotation marks or a character variable that contains the name of the SAS fileref.

Optional Argument

variable
specifies optional PROC FCMP variables that are set by macro variables of the same name. These arguments must be PROC FCMP double or character variables.

Before SAS executes the code that references the SAS file, the SAS macro variables are defined with the same name and value as the PROC FCMP variables. After execution, these macro variable values are copied back to the corresponding PROC FCMP variables.

Example

The following example is similar to the first example for RUN_MACRO except that RUN_SASFILE uses a SAS file instead of a predefined macro. This example assumes that `test.sas(a, b, c)` is located in the current directory.

```
      /* test.sas(a,b,c) */
data _null_;
   call symput('p', &a * &b);
run;

   /* Set a SAS fileref to point to the data set. */
filename myfileref "test.sas";

   /* Set up a function in PROC FCMP and call it from the DATA step. */
proc fcmp outlib=sasuser.ds.functions;
   function subtract_sasfile(a, b);
   rc=run_sasfile('myfileref', a, b,
p);
   if rc=0 then return(p);
      else return(.);
   endsub;
run;

options cmplib=(sasuser.ds);
data _null_;
   a=5.3;
   b=0.7;
   p=.;
   p=subtract_sasfile(a, b);
   put p=;
run;
```

SOLVE Function

Computes implicit values of a function using the Gauss-Newton method.

Category: Compute Implicit Values

Note: This special purpose function is automatically provided by the FCMP procedure for convenience.

Syntax

answer = **SOLVE**('*function-name*', *options-array*, *expected-value*, *argument-1* <, *argument-2*, ...>);

Required Arguments

answer
specifies the value that is returned from the SOLVE function.

'function-name'
specifies the name of the function. Enclose *function-name* in quotation marks.

options-array
specifies an array of options to use with the SOLVE function. *Options-array* is used to control and monitor the root-finding process. *Options-array* can be a missing value (.), or it can have up to five of the following elements in the following order:

initial-value
specifies the starting value for the implied value. The default for the first call is 0.001. If the same line of code is executed again, then *options-array* uses the previously found implied value.

absolute-criterion
specifies a value for convergence. The absolute value of the difference between the expected value and the predicted value must be less than the value of *absolute-criterion* for convergence.

Default 1.0e–12

relative-criterion
specifies a value for convergence. If the change in the computed implied value is less than the value of *relative-criterion*, then convergence is assumed.

Default 1.0e–6

maximum-iterations
specifies the maximum number of iterations to use to find the solution.

Default 100

solve-status
can be one of the following values:

0 successful.

1 could not decrease the error.

2 could not compute a change vector.

3 maximum number of iterations exceeded.

4 initial objective function is missing.

expected-value
specifies the expected value of the function of interest.

argument
specifies the arguments to pass to the function that is being minimized.

Details

The SOLVE function finds the value of the specified argument that makes the expression of the following form equal to zero.

```
expected-value - function-name
(argument-1, argument-2, ...)
```

You specify the argument of interest with a missing value (.), which appears in place of the argument in the parameter list that is shown above. If the SOLVE function finds the value, then the value that is returned for this function is the implied value.

Here is an example of an options array:

```
array opts[5] initial abconv relconv maxiter (.5 .001 1.0e-6 100);
```

These values refer to the preceding line of code.

- **initial** (initial-value)=.5
- **abconv** (absolute-criterion)=.001
- **relconv** (relative-criterion)=1.0e-6
- **maxiter** (maximum-iterations)=100

The solve status is the fifth element in the array. You can display this value by specifying opts[5] in the output list.

Examples

Example 1: Computing a Square Root Value

The following SOLVE function example computes a value of x that satisfies the equation y=1/sqrt(x). Note that you must first define functions and subroutines before you can use them in the SOLVE function. In this example, the function INVERSESQRT is first defined and then used in the SOLVE function.

```
options pageno=1 nodate ls=80 ps=64;

proc fcmp;
      /* define the function */
   function inversesqrt(x);
      return(1/sqrt(x));
   endsub;

   y=20;
   x=solve("inversesqrt", {.}, y, .);
   put x;
run;
```

Output 25.18 *Results from Computing a Square Root Value*

```
                                The SAS System                                1

                              The FCMP Procedure

0.0025
```

Example 2: Calculating the Garman-Kohlhagen Implied Volatility

In this example, the subroutine GKIMPVOL calculates the Garman-Kohlhagen implied volatility for FX options by using the SOLVE function with the GARKHPRC function.

In this example, note the following:

- The options_array is SOLVOPTS, which requires an initial value.
- The expected value is the price of the FX option.
- The missing argument in the subroutine is the volatility (sigma).

```
proc fcmp;
   function garkhprc(type$, buysell$, amount, E, t, S, rd, rf, sig)
      kind=pricing label='FX option pricing';

   if buysell='Buy' then sign=1.;
   else do;
      if buysell='Sell' then sign=-1.;
      else sign=.;
   end;

   if type='Call' then
      garkhprc=sign*amount*(E+t+S+rd+rf+sig);
   else do;
      if type='Put' then
         garkhprc=sign*amount*(E+t+S+rd+rf+sig);
      else garkhprc=.;
   end;
   return(garkhprc);
   endsub;

   subroutine gkimpvol(n, premium[*], typeflag[*], amt_lc[*],
                       strike[*], matdate[*], valudate, xrate,
                       rd, rf, sigma);
   outargs sigma;

   array solvopts[1] initial (0.20);
   sigma=0;
   do i=1 to n;
      maturity=(matdate[i] - valudate) / 365.25;
      stk_opt=1./strike[i];
      amt_opt=amt_lc[i] * strike[i];
      price=premium[i] * amt_lc[i];
```

```
      if typeflag[i] eq 0 then type="Call";
      if typeflag[i] eq 1 then type="Put";

         /* solve for volatility */
      sigma=sigma + solve("GARKHPRC", solvopts, price,
                          type, "Buy", amt_opt, stk_opt,
                          maturity, xrate, rd, rf, .);
   end;
   sigma=sigma / n;
endsub;
run;
```

Example 3: Calculating the Black-Scholes Implied Volatility

This SOLVE function example defines the function BLKSCH by using the built-in SAS function BLKSHCLPRC. The SOLVE function uses the BLKSCH function to calculate the Black-Scholes implied volatility of an option.

In this example, note the following:

- The options_array is OPTS.
- The missing argument in the function is the volatility (VOLTY).
- PUT statements are used to write the implied volatility (BSVOLTY), the initial value, and the solve status.

```
options pageno=1 nodate ls=80 ps=64;

proc fcmp;
   opt_price=5;
   strike=50;
   today='20jul2010'd;
   exp='21oct2010'd;
   eq_price=50;
   intrate=.05;
   time=exp - today;
   array opts[5] initial abconv relconv maxiter status
                 (.5 .001 1.0e-6 100 -1);
   function blksch(strike, time, eq_price, intrate, volty);
      return(blkshclprc(strike, time/365.25,
                        eq_price, intrate, volty));
   endsub;
   bsvolty=solve("blksch", opts, opt_price, strike,
                           time, eq_price, intrate, .);

   put 'Option Implied Volatility:' bsvolty
       'Initial value: ' opts[1]
       'Solve status: ' opts[5];
run;
```

Output 25.19 *Results of Calculating the Black-Scholes Implied Volatility*

```
                                The SAS System                                1

                              The FCMP Procedure

Option Implied Volatility: 0.4687011859 Initial value:  0.5 Solve status:  0
```

Note: SAS functions and external C functions cannot be used directly in the SOLVE function. They must be enclosed in a PROC FCMP function. In this example, the built-in SAS function BLKSHCLPRC is enclosed in the PROC FCMP function BLKSCH, and then BLKSCH is called in the SOLVE function.

WRITE_ARRAY Function

Writes data from a PROC FCMP array variable to a data set that can then be used by SAS programs, macros, and procedures.

Category: Array

Note: When SAS translates between an array and a data set, the array is indexed as [row, column].

Syntax

rc = **WRITE_ARRAY**(*data_set_name*, *array_variable* <, '*column_name_1*', '*column_name_2*', ...>);

Required Arguments

rc
is 0 if the function is able to successfully write the data set.

data_set_name
specifies the name of the data set to which the array data is written. *Data_set_name* must be a character literal or variable that contains the member name (libname.memname) of the data set to be created.

array_variable
specifies the PROC FCMP array or matrix variable whose contents are written to *data_set_name*.

Optional Argument

column_name
specifies optional names for the columns of the data set that are created.

If specified, *column_name* must be a literal string enclosed in quotation marks. *Column_name* cannot be a PROC FCMP variable. If column names are not specified, the column name is the array name with a numeric suffix.

Examples

Example 1: Using the WRITE_ARRAY Function with a PROC FCMP Array Variable

This example uses the ARRAY statement and the WRITE_ARRAY function with PROC FCMP to write output to a data set.

```
options nodate pageno=1 ls=80 ps=64;

proc fcmp;
   array x[4,5] (11 12 13 14 15 21 22 23 24 25 31 32 33 34 35 41 42 43
44 45);
   rc=write_array('work.numbers', x);
run;

proc print data=work.numbers;
run;
```

Output 25.20 *Results from Using the WRITE_ARRAY Function*

```
                    The SAS System                                    1
               Obs     x1     x2     x3     x4     x5

                 1     11     12     13     14     15
                 2     21     22     23     24     25
                 3     31     32     33     34     35
                 4     41     42     43     44     45
```

Example 2: Using the WRITE_ARRAY Function to Specify Column Names

This example uses the optional *colN* variable to write column names to the data set.

```
options pageno=1 nodate ps=64 ls=80;

proc fcmp;
   array x[2,3] (1 2 3 4 5 6);
   rc=write_array('numbers2', x, 'col1', 'col2', 'col3');
run;

proc print data=numbers2;
run;
```

Output 25.21 *Results from Using the WRITE_ARRAY Function to Specify Column Names*

```
                              The SAS System                              1

                         Obs     col1     col2     col3

                           1        1        2        3
                           2        4        5        6
```

26

FCmp Function Editor

Introduction to the FCmp Function Editor

SAS language functions and CALL routines that are created with PROC FCMP are stored in SAS data sets that are contained in package declarations. Each package declaration contains one or more functions or CALL routines. The FCmp Function Editor displays all of the functions and CALL routines that are included in a package.

With the FCmp Function Editor, you can view functions in a package declaration as well as create new functions. You can add these new functions to an existing package, or create a new package declaration.

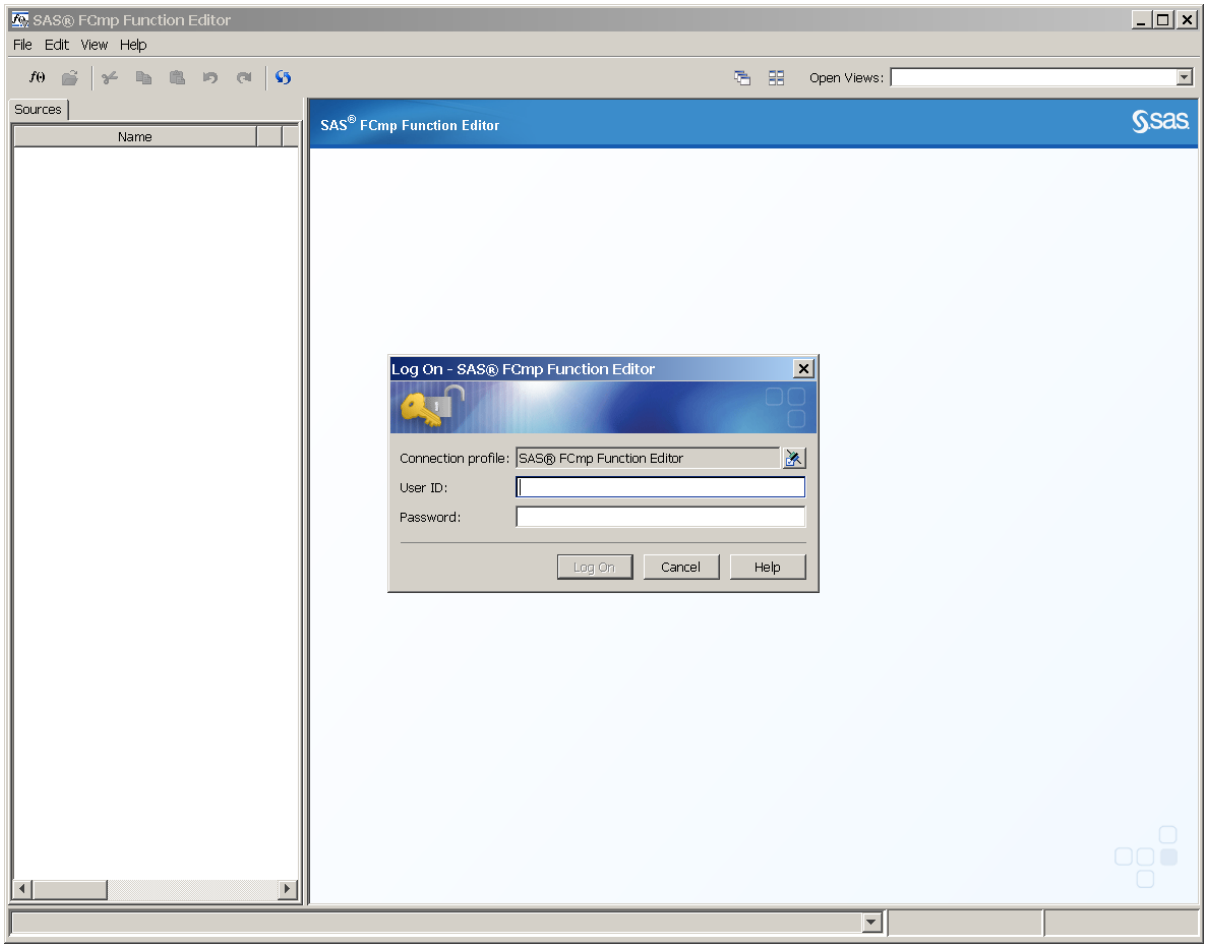
Open the FCmp Function Editor

If you are working in the Windows operating environment and SAS is installed locally on your computer, the sign-on dialog box is bypassed because Windows supports single sign-on functionality.

If you are not working in the Windows operating environment, or if SAS is not installed locally, then you are prompted for your authorization credentials, which are your user ID and password.

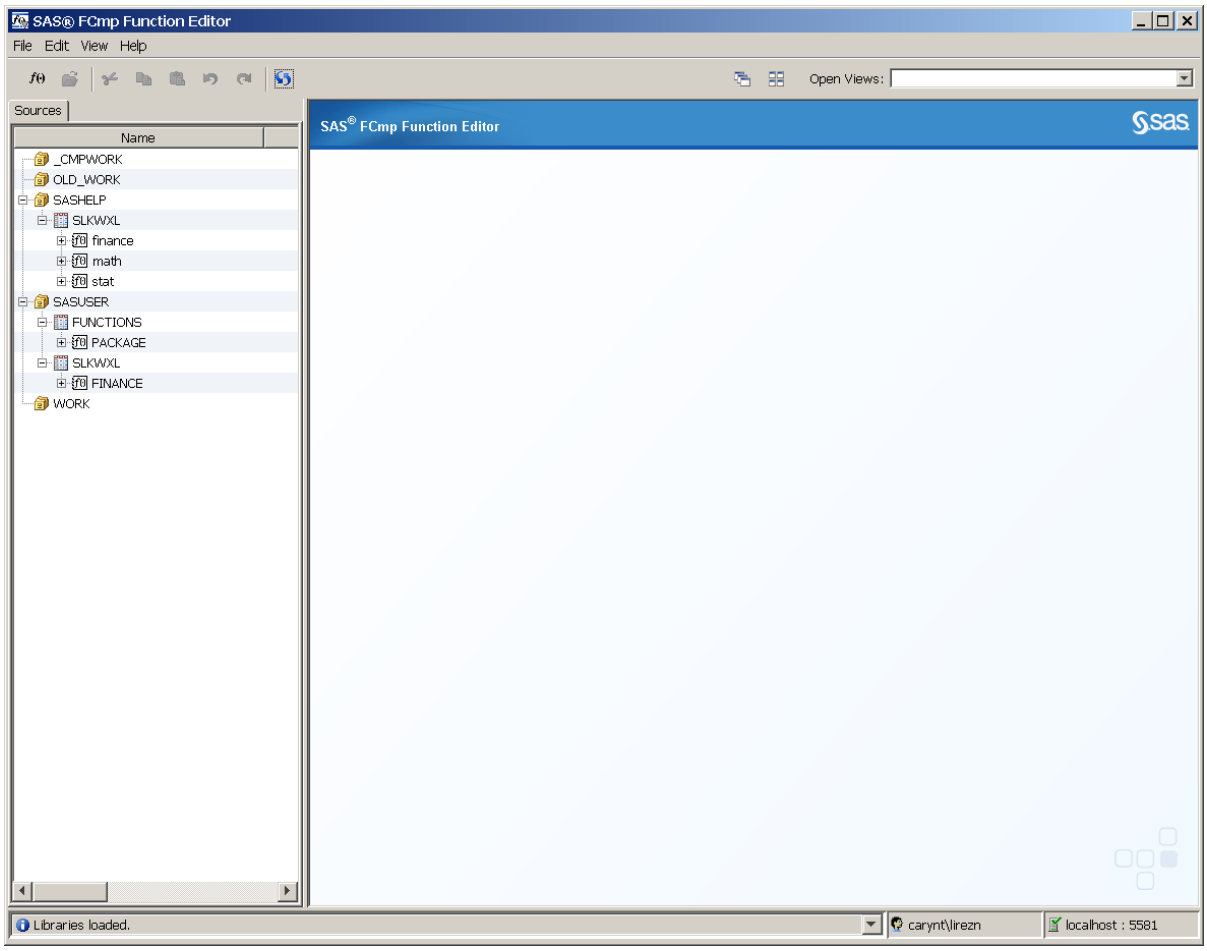
To open the FCmp Function Editor, select **Solutions** ⇨ **Analysis** ⇨ **FCmp Function Editor** from the menu in your SAS session. The following dialog box appears:

Figure 26.1 *Initial Dialog Box for the FCmp Function Editor*



After you enter your user ID and password and click **Log On**, SAS establishes a connection to a port. A window that displays your libraries appears:

Figure 26.2 *The FCmp Function Editor with Libraries Displayed*



In the window above, you can see that the left pane lists the functions that are in the SASHELP and SASUSER libraries. The WORK library is empty. You cannot access the WORK library directly from a spawning SAS session. The FCmp Function Editor remaps the WORK library from the spawning SAS session to the location of OLD_WORK so that you can access the contents of WORK from OLD_WORK.

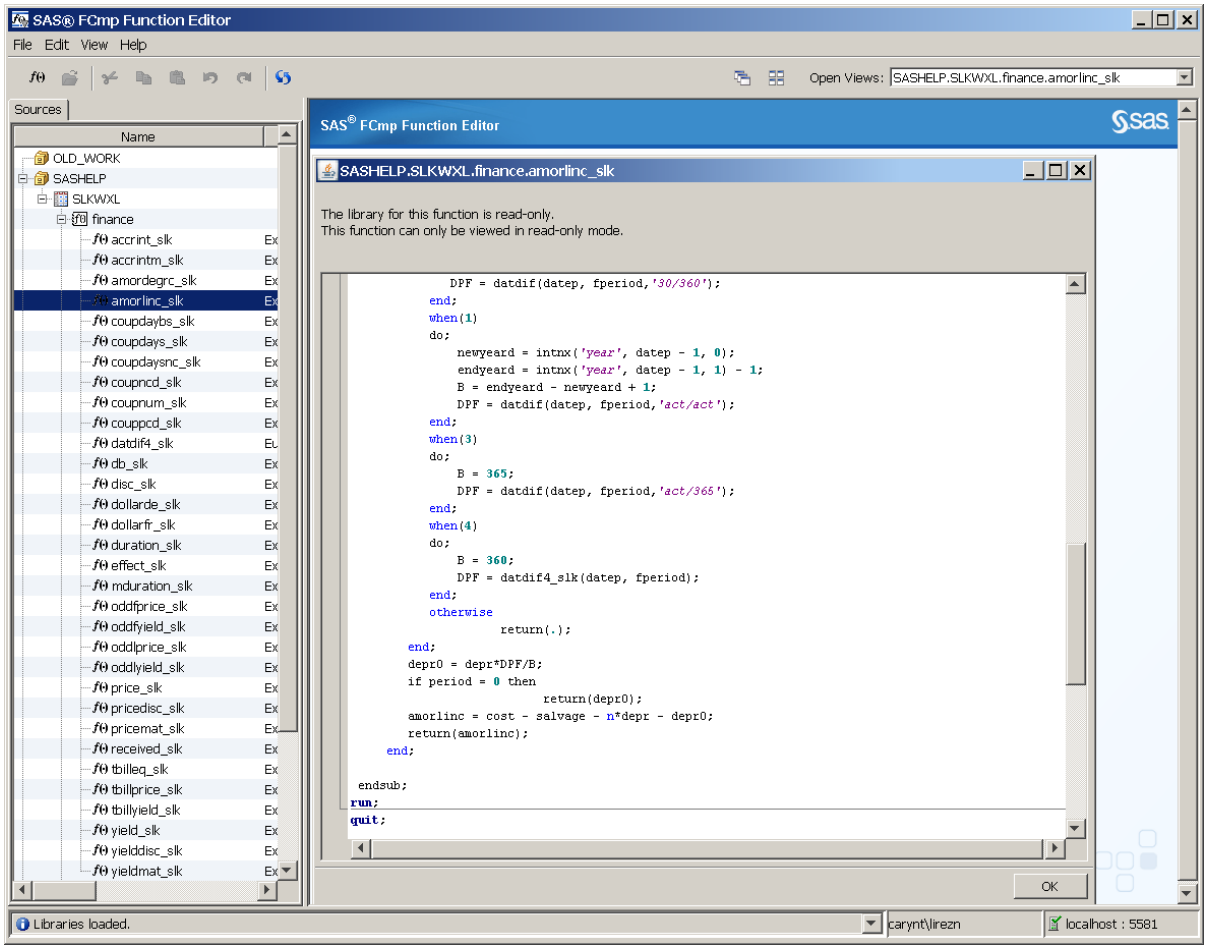
Working with Existing Functions

Open a Function

To open a function, select a library from the left pane, expand the library, and drill down until a list of functions appears. Double-click the name of the function that you want to open.

If you open a function from a read-only library, a window similar to the following appears:

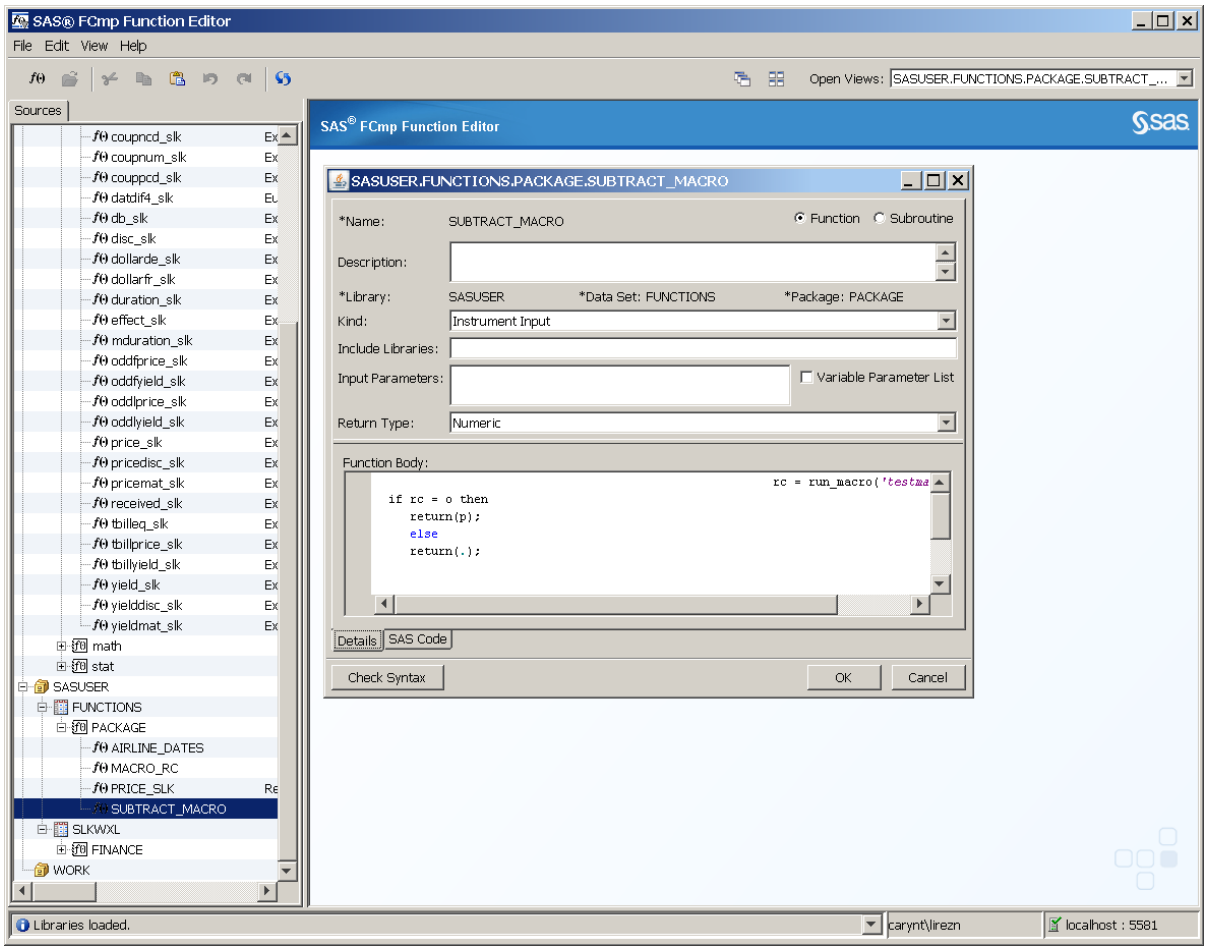
Figure 26.3 *A Function in a Library That Has Read-Only Access*



In the window above, the AMORLINC_SLK function is selected from the read-only SASHELP library. Use the scroll bar to scroll to the top of the function.

If you open a function from a library to which you have Write access, a window similar to the following appears:

Figure 26.4 *A Function in a Library That Has Write Access*



In the window above, SUBTRACT_MACRO is selected from the write-enabled SASUSER library.

You can see that there is a difference in the windows that appear depending on whether the library has Read-Only access or Write access. If the library has Write access, you can enter information in the top section of the window that you are viewing. These fields are the same fields that you use when you create a new function. For a description of the fields, see "Creating a New Function" on page 993.

Opening Multiple Functions

Opening multiple functions results in multiple windows being opened. For example, if you open a second function, a second window appears that shows the code for that function.

The upper right corner of the FCmp Function Editor contains a field called **Open Views**. Click the arrow to list the functions that are open. When you select a function, the window for that function is brought to the foreground.

Two icons that you can use to alter the display of your functions are located to the left of the **Open Views** field:

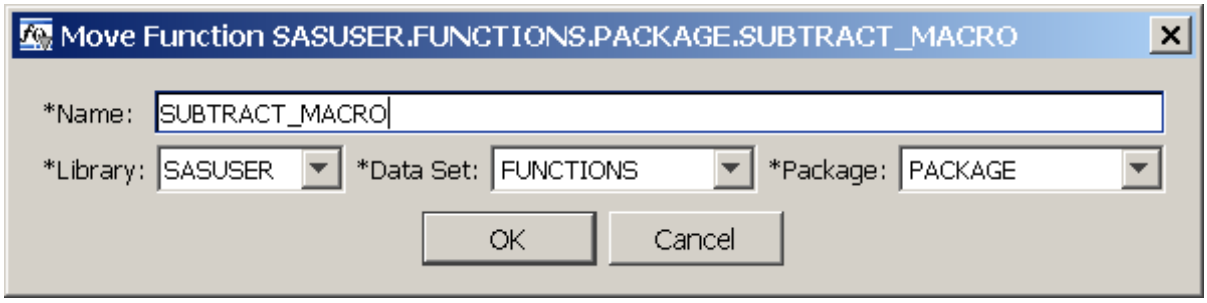
cascades the display of the functions that are open.

arranges the functions to display side by side.

Move a Function

You can move a function to a different library, data set, or package. To move a function, select a function in the left pane. Right-click the function, and select **Move** from the menu. The following dialog box appears:

Figure 26.5 *The Move Function Dialog Box*



In the Move Function dialog box, you can perform the following tasks:

- enter a new name for the function
- select a library into which the function is to be moved
- enter a new data set name
- enter a package name

The descriptions of the fields in the Move Function dialog box are listed below:

Name
specifies the new name for the function.

Library
specifies the library that contains the function that you move. Use the menu in the **Library** field to select a library.

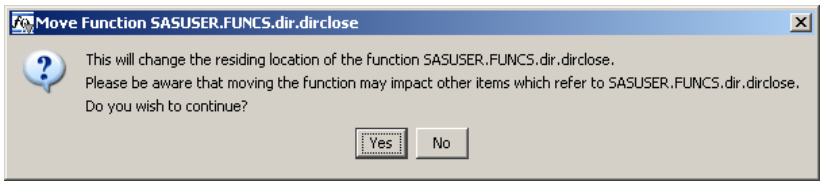
Data Set
specifies the data set that contains the function that you move. Enter the name of the data set, or click the down arrow in the **Data Set** field to select a data set.

If you do not choose a data set, then the value in this field defaults to FUNCTIONS.

Package
specifies the name of the package that contains the new function that you move. Enter the name of the package, or click the down arrow in the **Package** field to select a package. If you do not choose a package, then the value in this field defaults to PACKAGE.

When you click **OK**, the following dialog box appears, cautioning you about the move:

Figure 26.6 *The Move Function Confirmation Dialog Box*



CAUTION
Other functions and macros that reference the function that you want to move is not updated with the new function location. This situation can cause referencing objects such as macros to be out of synchronization.

Click **Yes** or **No**.

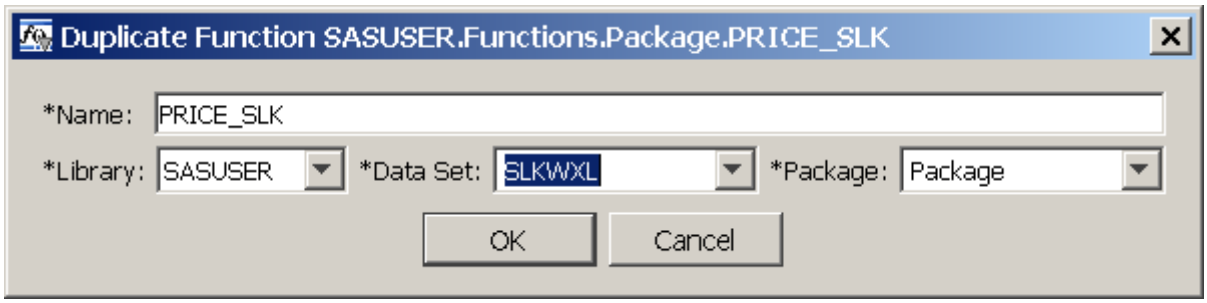
Close a Function

When you right-click the function name in the left pane and select **Close**, the window that displays that function closes. You can also close the function by clicking **OK** in the bottom right corner of the window that displays the function.

Duplicate a Function

You can duplicate (copy) a function that you are viewing to an existing or new package or library to which you have Write access. To duplicate a function, select the function in the left pane. Right-click the function and select **Duplicate** from the menu. The following dialog box appears:

Figure 26.7 *The Duplicate Function Dialog Box*



The fields in this dialog box automatically display the function name, library, data set, and package of the function that you want to duplicate. You can change these fields when you duplicate the function.

For a description of these fields, see "Move a Function" on page 990.

Rename a Function

Use the Rename dialog box to rename a function within a given package. You must have Write access to the library that contains the function. When you rename a function, the new function resides in the same library as the original function.

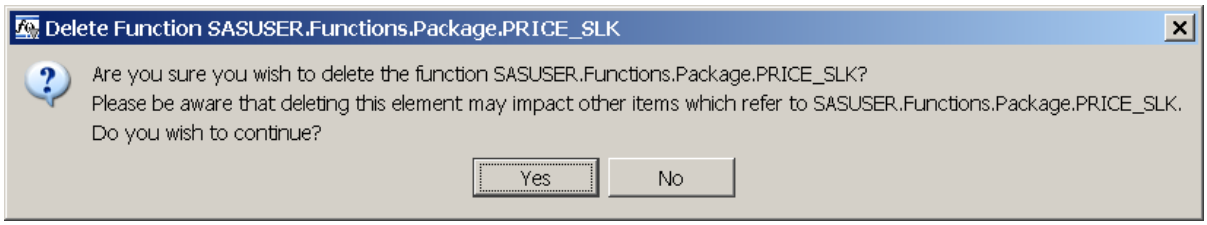
To rename a function, select the function in the left pane. Right-click the function and select **Rename** from the menu. Enter the new name of the function and click **OK**.

CAUTION
Rename enables you to rename a function within a given package. Just as with moving a function, the renaming of a function does not modify dependent macros and other entities.

Delete a Function

You can delete a function from a library to which you have Write access. To delete a function, select the function that you want to delete. Right-click the function and select **Delete** from the menu. The following dialog box appears, cautioning you about the impact that **Delete** has on other items:

Figure 26.8 *Delete Function Confirmation Dialog Box*



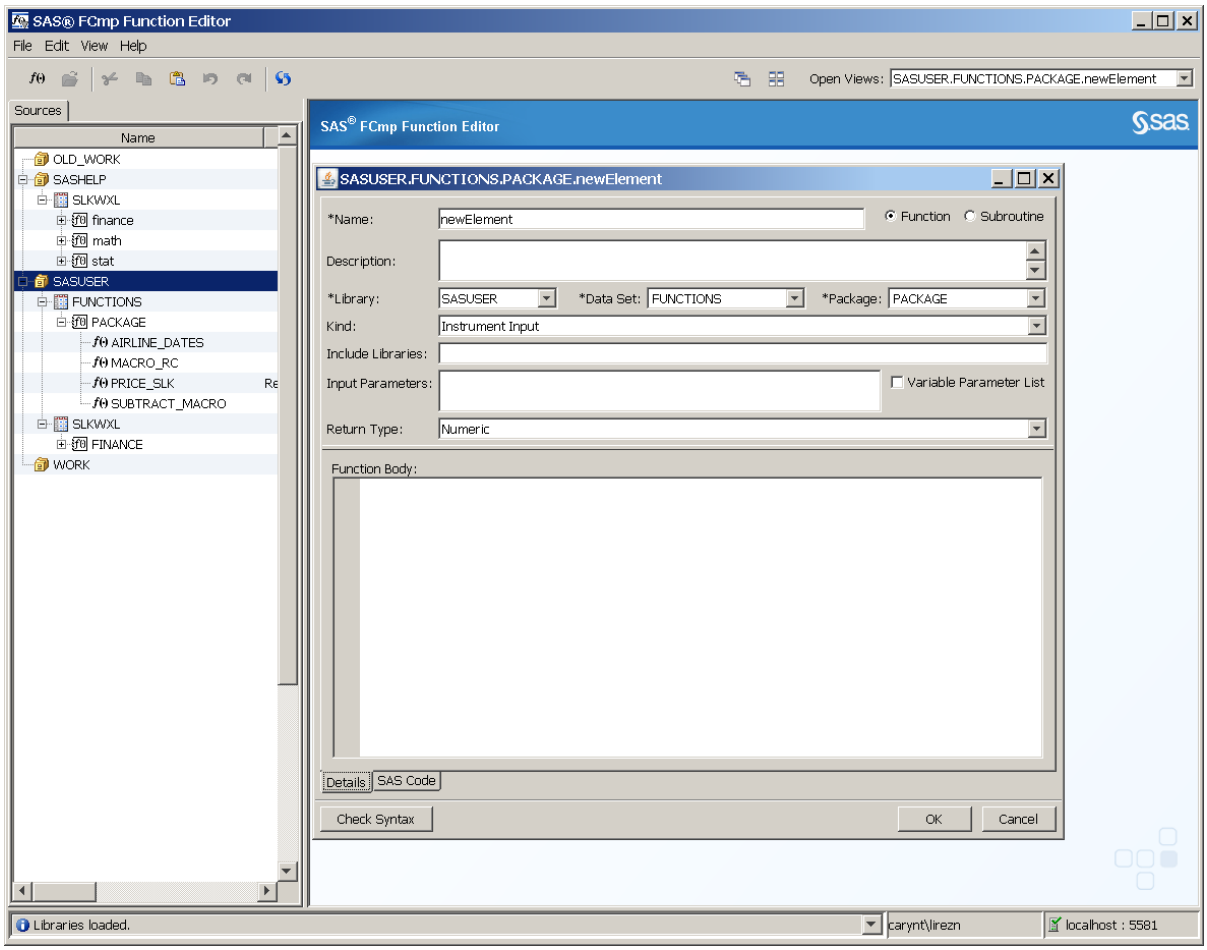
Click **Yes** or **No**.

Creating a New Function

You can create a new function whenever you have a library, data set, or package selected. To create a new function in a library, position your cursor on the library into which the new function is added. Right-click the library and select **New Function**. You can also select **File** ⇨ **New Function** from the menu or click $f(\cdot)$ in the upper left corner below the menu bar.

The following window appears:

Figure 26.9 *The newElement Window*



The upper right corner of the window contains two buttons: **Function** and **Subroutine**. Click one of the buttons depending on whether you want to create a new function or a new subroutine.

The newElement window contains the following fields:

Name
specifies the name of the new function or subroutine.

Description
describes the new function or subroutine.

Library
specifies the library that contains the new function or subroutine. Enter the name of the library, or click the down arrow in the **Library** field to select a library.

Data Set
specifies the data set that contains the new function or subroutine. Enter the name of the data set, or click the down arrow in the **Data Set** field to select a data set. If you do not specify a value, the value in this field defaults to FUNCTIONS.

Package
specifies the name of the package that contains the new function or subroutine. Enter the name of the package, or click the down arrow in the **Package** field to select a package. The **Package** field is a required field. If you do not specify a value, the value in this field defaults to PACKAGE.

Kind
enables you to group functions or subroutines within a given package. Four predefined kind groupings are available and are typically used with SAS Risk Management:

- Project
- Risk Factor Transformation
- Instrument Pricing
- Instrument Input

You can use one of these four groupings, or enter your own kind value in the **Kind** field. The function tree in the left pane groups the functions in a package into their kind grouping, if you specified a value for **Kind**.

Include Libraries
specifies libraries that contain SAS code that you want to include in your function or subroutine.

Input Parameters
specifies the arguments that you use as input to the function or subroutine.

Variable Parameter List
specifies whether the function or subroutine supports a variable number of arguments.

Return Type
specifies whether the function or subroutine returns a character or numeric value.

Function Body
is the area in the window in which you code your function or subroutine.

Three buttons are located at the bottom left of the newElement window:

Details
provides you with an area in which to write descriptive information (name of the new function, list of include libraries, input parameters, and so on) about your function or subroutine. You code your new function or subroutine in the **Function Body** section. The **Details** tab is selected by default.

SAS Code
enables you to view the function or subroutine that you have written. The **SAS Code** selection provides read-only capabilities.

Check Syntax
enables you to check the syntax for the code that you have written. If the syntax is correct, a dialog box appears, stating that the syntax is correct. If the syntax contains an error, a dialog box appears that describes the error. An error message also appears in the lower left bar of the window. Syntax errors are written to the log, which you can access from the **View** ⇨ **Show Log** menu.

When you enter information in the descriptive portion of the **Details** tab, as well as in the **Function Body** section, the information is converted to SAS code that you can see when you select the **SAS Code** button.

Displaying New Libraries in the FCmp Function Editor

You can create a new library in a SAS session while still being logged on to the FCmp Function Editor. However, clicking the refresh button in the FCmp Function Editor does not display the new library. You must log off from the FCmp Function Editor and then log back in to see the new library.

Viewing the Log Window, Function Browser, and Data Explorer

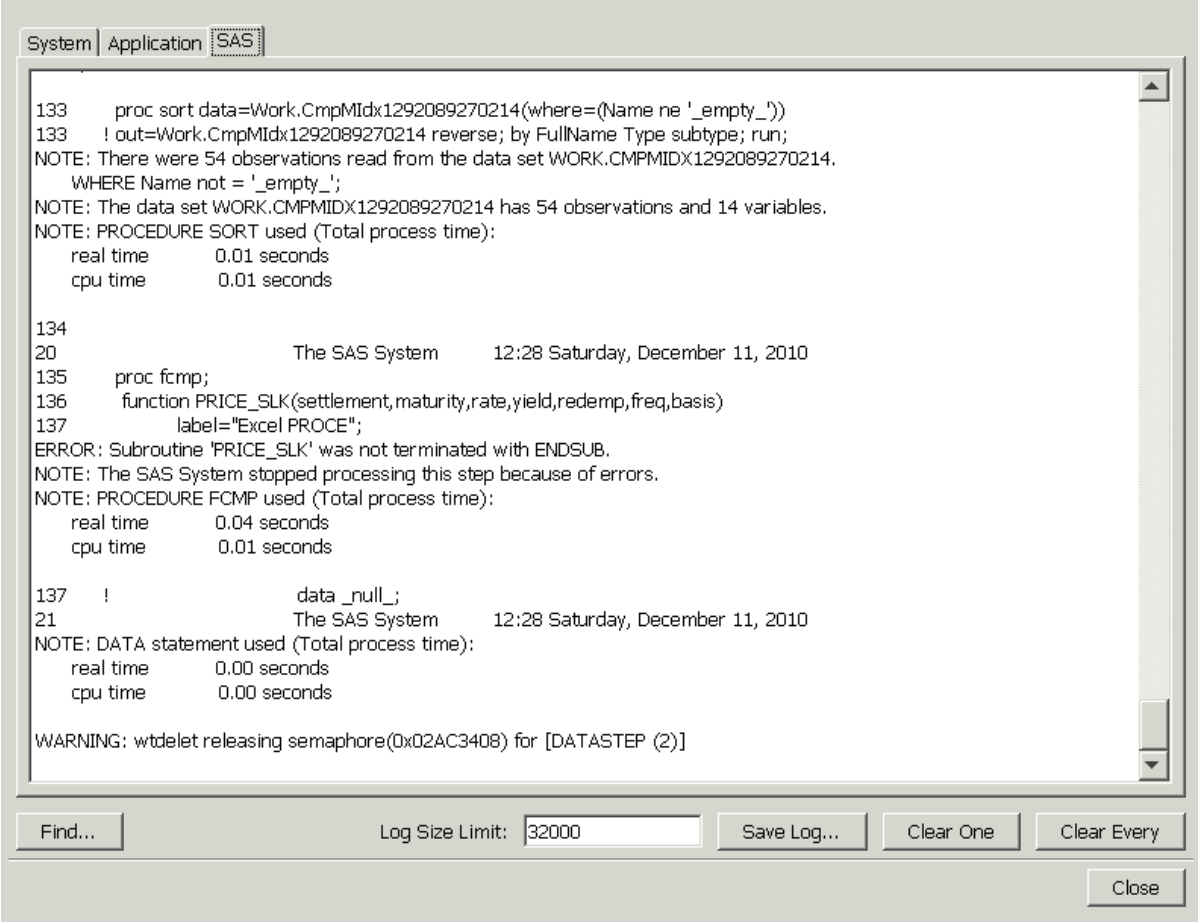
Log Window

To display the Log window, select **View** ⇨ **Show Log** from the menu. When you display the Log window, you can view system, application, and program results by selecting the tabs that are located in the upper left corner of the window.

Click the **SAS** tab to view the contents of the SAS log. The content of the log represents output from the SAS server. In addition, commands that are sent to SAS are also present to add context to the log output.

The following display shows the Log window with a SAS log displayed:

Figure 26.10 The Log Window



Tabs and Buttons in the Log Window

The **System** tab in the Log window shows detailed information in the form of system messages. The window is blank if no messages are logged.

The System window contains two vertical tabs that are located in the upper right section of the window. These tabs provide information about messages that might be of interest:

System.out
displays system output if messages are routed to this location.

System.err
displays error messages if the messages are routed to this location.

The Log window contains three buttons that are located at the bottom right of the window:

Save Log
saves the log output to a file that you choose.

Clear One
clears the results in the active window.

Clear Every
clears the results in all three of the windows.

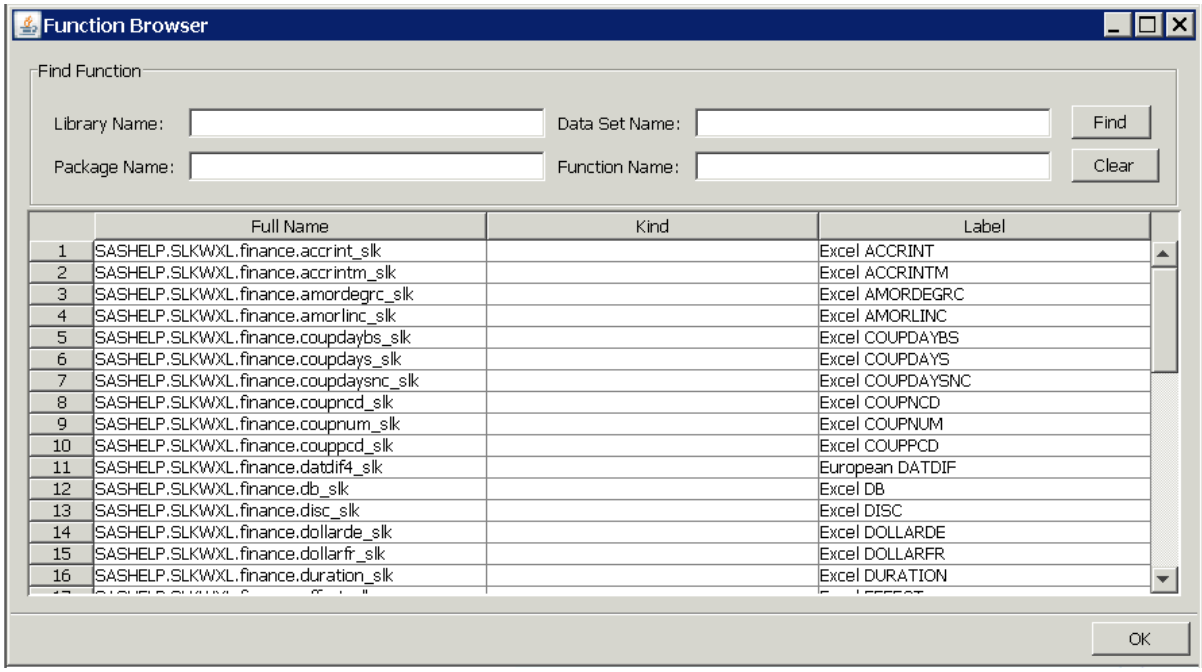
The **Find** button is located at the bottom left of the window. This button opens a dialog box that enables you to search your output. For example, searching for ERROR when the **SAS** tab is selected enables you to quickly find errors in the SAS log.

Function Browser

The Function Browser displays all of the functions that are listed in the left pane of the window. You can filter this list of functions to display a subset of the functions.

To display the Function Browser, select **View** ⇨ **Show Function Browser** from the menu. A window similar to the following appears:

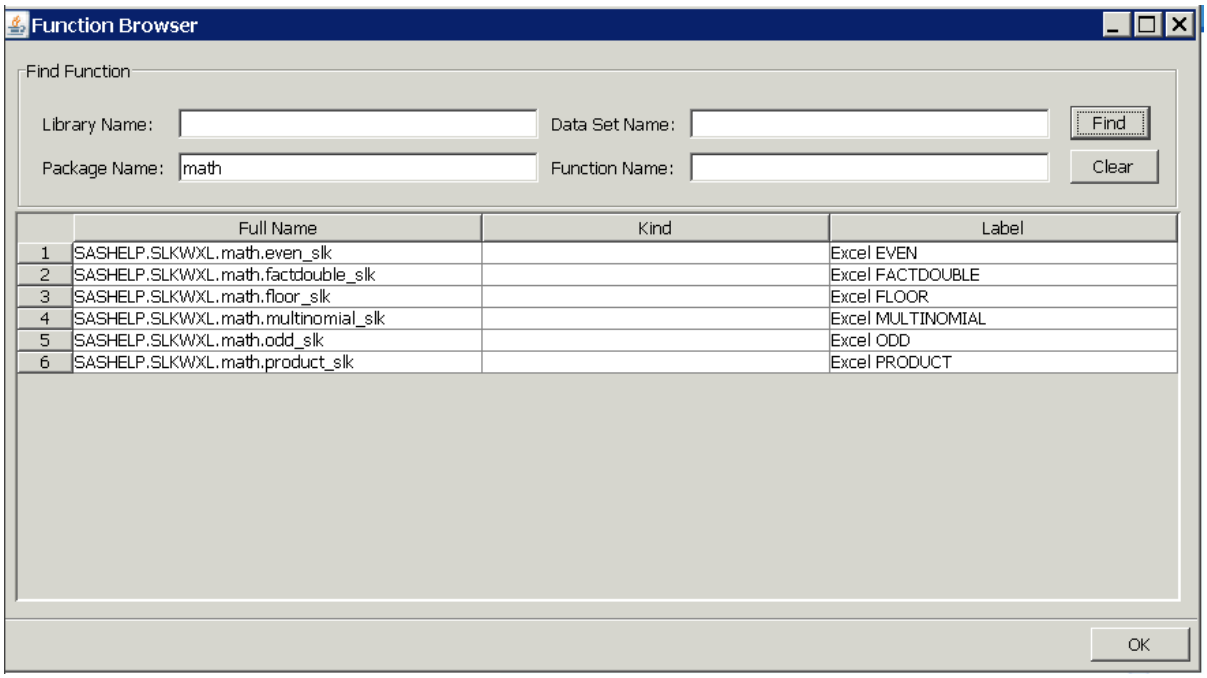
Figure 26.11 *The Function Browser Window*



The partial output that is displayed above shows the functions in the application tree. You can filter the output and create a subset of the functions by entering your criteria in the Function Browser fields that are located above the list of functions. These fields are **Library Name**, **Data Set Name**, **Package Name**, and **Function Name**.

In the following display, the **Package Name** field is used as the filter. When you press the **OK** button that is located in the bottom right corner of the window, or if you press the **Find** button that is located in the upper right corner, the following window appears:

Figure 26.12 *Filtered Output from the Function Browser*



The math functions that are listed are a subset of all of the functions.

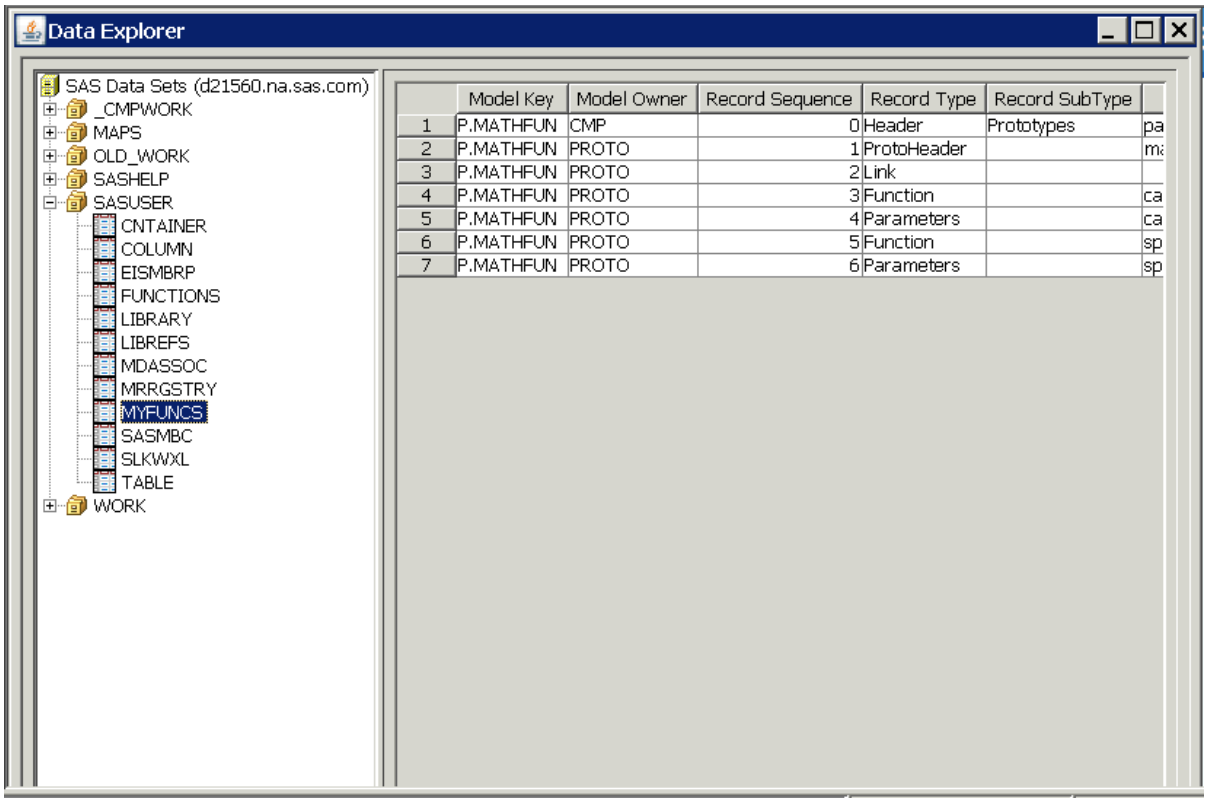
You can enter information in the fields that you choose, depending on your filter criteria. For example, if you enter a value, such as SASHELP, in the **Library Name** field, then all of the functions that are in the SASHELP library appear.

Data Explorer

The Data Explorer enables you to view the data in a data set that you select.

To display the Data Explorer, select **View** ⇨ **Show Data Explorer** from the menu. A window similar to the following appears:

Figure 26.13 The Data Explorer Window



The Data Explorer window displays data set information based on the data set you select from the left pane.

By clicking the column headings, you can move the columns to reposition them in the display. When you click **OK** in the lower right section of the window, the changes that you made are saved.

Using Functions in Your DATA Step Program

For an example of how PROC FCMP and DATA step syntax work together, see "Directory Traversal" on page 905.

27

FEDSQL Procedure

Overview: FEDSQL Procedure

What Does the FEDSQL Procedure Do?

The FEDSQL procedure enables you to submit FedSQL language statements from a Base SAS session. The FEDSQL procedure is supported in both SAS 9.4 and SAS Viya.

The FedSQL language is the SAS implementation of the ANSI SQL:1999 core standard. It provides support for extended data types, such as DECIMAL, INTEGER, and VARCHAR, and other ANSI 1999 core compliance features and proprietary extensions. FedSQL provides data access technology that brings a scalable, threaded, high-performance way to access, manage, and share relational data in multiple data sources. Beginning in April 2019, it also supports some non-relational data sources. When possible, FedSQL queries are optimized with multithreaded algorithms to resolve large-scale operations.

For applications, FedSQL provides a common SQL syntax across all of the data sources that it supports. FedSQL is a vendor-neutral SQL dialect. Applications can submit the same FedSQL queries to all FedSQL data sources instead of having to submit queries in the SQL dialect that is specific to the data source. In addition, a single FedSQL query can target data in several data sources and return a single result set.

Using the FEDSQL procedure, you can submit FedSQL language statements to SAS and third-party data sources that are accessed with SAS and SAS/ACCESS library engines. Or, if you have SAS Cloud Analytic Services (CAS) configured, you can submit FedSQL language statements to the CAS server.

To execute FedSQL statements in a SAS library, specify the PROC FEDSQL statement followed by FedSQL language statements. Qualify table names in your FedSQL language statements with a libref. If you do not specify a libref, the request is executed in the SAS Work library.

To execute FedSQL statements on the CAS server, specify the SESSREF= (or SESSUUID=) connection option with a CAS session name in the procedure statement. Either load tables into your CAS session using other tools and query the tables with PROC FEDSQL, or set an active caslib for your CAS session and query tables from the caslib by name. When you query unloaded tables from the active caslib, FedSQL passes requests that are eligible for implicit pass-through to the data source for processing or dynamically loads the external data into your CAS session for processing.

Note: Do not use a CAS engine libref with PROC FEDSQL. When SESSREF= (or SESSUUID=) is specified, PROC FEDSQL makes a direct connection to the CAS

server. The procedure does not need the CAS engine. PROC FEDSQL silently passes requests to the fedSQL.execDirect action and the action executes your program on the CAS server.

The FedSQL language supports limited functionality in CAS. For an overview of the FedSQL functionality that is available on the CAS server, see "Using FedSQL in SAS Cloud Analytic Services" on page 1021.

For information about the FedSQL language statements that are supported for data accessed with SAS library engines, see *SAS FedSQL Language Reference*.

Concepts: FEDSQL Procedure

Benefits of FedSQL

FedSQL provides the following features that are not provided in the SAS SQL procedure.

- FedSQL conforms to the SQL 1999 ANSI standard. This conformance allows it to process queries in its own language as well as the native languages of other DBMSs that conform to the ANSI 1999 standard.
- FedSQL supports many more data types than previous SAS SQL implementations. Traditional DBMS access through SAS/ACCESS LIBNAME engines translate target DBMS data types to and from two legacy SAS data types, which are SAS numeric and SAS character. When FedSQL connects to a DBMS with a libref, the language matches or translates the target data source's definition to the FedSQL data types, as appropriate, which allows greater precision. When FedSQL connects to a DBMS with a caslib, the language translates the data source's definition to native CAS data types.
- FedSQL handles federated queries, which access data from multiple data sources and returns a single result set. A federated query is the ability to communicate with more than one data source, access that data, and perform operations against that data. FedSQL also has the ability to break apart a single SQL query that is connected to multiple databases and send the parts down to the individual databases.
- FedSQL supports implicit SQL pass-through. That is, FedSQL statements are translated into data source-specific code internally so that they can be passed directly to the data source for processing. There is no need to submit requests in the native SQL of each data source to get the benefits of native processing. FedSQL implicit pass-through improves query response time and enhances security.

- The volume of data being transferred is reduced by performing the query on the data source. The number of rows that are transferred from the data source to FedSQL can be significantly reduced, thereby decreasing the overall query processing time.
- The security benefit is that any part of a query that can be is processed on the data source side. This eliminates the need to have its associated tables, which might contain sensitive information, transmitted over to the FedSQL side for query processing.

Implicit SQL pass-through is available for SAS libraries and for caslibs, although support in CAS is limited. Support for implicit pass-through in CAS is available starting in SAS Viya 3.3. For more information about FedSQL implicit pass-through in CAS, see *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*.

- When connecting to a SAS library, you can use PROC FEDSQL to create data in any of the supported data sources. This enables you to store data in the data source that most closely meets the needs of your application. (FedSQL output tables in CAS are in-memory tables. You can use other CAS functionality to persist data to caslib data sources.)
- When connecting to a SAS library, FedSQL can perform heterogeneous correlated subqueries. A correlated subquery is when the outer query results affect the results of the subquery. FedSQL has the ability to direct a subquery to be performed by the data source and limit the result set that is transferred from the data source. This is done by using a flexible query textualization technique that allows FedSQL to obtain rows that satisfy only the subquery expression. For an example, see "Example 3: Querying Data Using a Correlated Subquery" on page 1033.

  A unique way that FedSQL can perform a heterogeneous operation is to take advantage of an index in a third-party DBMS when performing a join. The row values from one table involved in the join are copied into FedSQL local space. The specific column values are then used to probe the index. Special textualization techniques return qualified values, thereby allowing FedSQL access to the DBMS index to perform the join. For more information, see "Example 4: Creating and Using a DBMS Index to Perform a Join" on page 1034.

For more information about the FedSQL functionality for SAS libraries, see *SAS FedSQL Language Reference*. For information about FedSQL functionality when you target the CAS server, see *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*.

Data Source Support

When submitting FedSQL statements to a SAS library, PROC FEDSQL can read and write data from the following data sources. Unless otherwise noted, availability starts in SAS 9.4 and SAS Viya 3.3. See SAS/ACCESS documentation for supported operating environments.

Table 27.1 *Data Sources for Which FedSQL Supports SAS Library Access*

Data Source	SAS V9	SAS Viya 3.5	Release Notes
Amazon Redshift	*	*	Added in SAS 9.4M5
Aster	*	*	Added in SAS 9.4M1
DB2	*	*	DB2
Greenplum	*	*	
Google BigQuery	*	*	Added in August 2019, on SAS 9.4M6 and SAS Viya 3.4
Hadoop (Hive)	*	*	Added in SAS 9.4M2
HAWQ	*	*	Added in SAS 9.4M3
Impala	*	*	Added in SAS 9.4M3
databases that are compliant with JDBC	*	*	Added in February 2019, on SAS Viya 3.4 and SAS 9.4M6
Microsoft SQL Server	*	*	Added in SAS 9.4M5
MongoDB	*	*	Read-only support available on SAS 9.4M6, starting in April 2019. Write support available starting in November 2019. Read-and-write support available in SAS Viya 3.5.
MySQL	*	*	
Netezza	*	*	
ODBC-compliant databases	*	*	
Oracle	*	*	

Data Source	SAS V9	SAS Viya 3.5	Release Notes
PostgreSQL	*	*	Added in SAS 9.4M2
Salesforce	*	*	Read-only support available on SAS 9.4M6, starting in April 2019. Write support available starting in November 2019. Read-and-write support available in SAS Viya 3.5.
SAP	*	*	Read-only
SAP HANA	*	*	Added in SAS 9.4M1
SAP IQ	*	*	
SAS data sets	*	*	Added in SAS Viya 3.1
SAS Scalable Performance Data (SPD) Engine data sets	*	*	
SAS Scalable Performance Data (SPD) Server tables	*	*	Added in SAS 9.4M4 SPD Server in UNIX and Windows operating environments only SAS Viya access is client only
Snowflake	*	*	Added in August 2019, on SAS 9.4M6 and SAS Viya 3.4
Spark	*		SAS/ACCESS to Spark is available on Linux only in SAS 9.4M7.
Teradata	*	*	Teradata
Vertica	*	*	Added in SAS 9.4M5

Data Source	SAS V9	SAS Viya 3.5	Release Notes
Yellowbrick	*		SAS/ACCESS to Yellowbrick is limited availability for SAS 9.4 only, starting in SAS 9.4M7.

For information about the statements and data types supported for each data source through a SAS library, see *SAS FedSQL Language Reference*.

When you submit FedSQL language statements to CAS, the procedure reads data from files and in-memory tables and creates CAS session tables. You can preload data into your CAS session with PROC CASUTIL. Or you can use a caslib to dynamically load data into your CAS session. A caslib uses a SAS Viya Data Connector (or SAS Viya Data Connector Accelerator) to access data from a corresponding data source for processing in CAS. For information about available SAS Viya Data Connectors, see *SAS Cloud Analytic Services: User's Guide*.

FedSQL has different functionality on the CAS server than it has in a SAS library. For more information, see "Using FedSQL in SAS Cloud Analytic Services" on page 1021.

For information about how to connect to supported data sources with PROC FEDSQL, see "Data Source Connection" on page 1017.

Syntax: FEDSQL Procedure

PROC FEDSQL <*connection-option*><*processing-options*>;

...FedSQL statements

QUIT;

Statement	Task	Example
PROC FEDSQL	Specify that the subsequent input is FedSQL language statements.	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 8
QUIT	Stop the execution of the FEDSQL procedure.	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 8

PROC FEDSQL Statement

Specifies that the subsequent input is FedSQL language statements.

Requirement: Follow the PROC FEDSQL statement with one or more FedSQL language statements. See *SAS FedSQL Language Reference* for information about FedSQL statements that are supported in a SAS library. See *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services* for information about FedSQL statements that are supported in a CAS session.

Interactions: When creating tables with PROC FEDSQL, note that by default, you cannot overwrite an existing table. You must destroy the table with the DROP TABLE statement first. If you specify the DROP TABLE statement in the same procedure execution as the CREATE TABLE statement, you must specify the FORCE statement option. For more information, see "DROP TABLE Statement" in *SAS FedSQL Language Reference*. In CAS, you can overwrite an existing table by specifying the REPLACE= table option in the CREATE TABLE statement. For more information, see "REPLACE= Table Option" in *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*.

The procedure processes nonexistent values as SAS missing values by default. In a SAS library, you can specify ANSIMODE to request that nonexistent values are processed as ANSI SQL null values.

Note: As of September 2023, Microsoft Azure Active Directory (Azure AD) was renamed to Microsoft Entra ID.

Examples:

"Example 1: Creating a SAS Data Set" on page 1027
"Example 2: Joining Tables from Multiple SAS Libraries" on page 1031
"Example 3: Querying Data Using a Correlated Subquery" on page 1033
"Example 4: Creating and Using a DBMS Index to Perform a Join" on page 1034
"Example 5: Using a DS2 Package in an Expression" on page 1036
"Example 6: Querying Data in CAS" on page 1038
"Example 7: Explicitly Loading and Joining Tables in CAS" on page 1041
"Example 8: Joining Tables from Multiple CAS Libraries" on page 1046

Syntax

PROC FEDSQL <*connection-option*><*processing-options*>;

Summary of Optional Arguments

Connection

LIBS=*libref* | (*libref1libref2 ...librefn*)

restricts the default data source connection to the specified libref(s). All other librefs are ignored.

SESSREF=*session-name*
: specifies to run the FedSQL statements in a CAS session. The CAS session is identified by its session name.

SESSUUID="*session-uuid*"
: specifies to run the FedSQL statements in a CAS session. The CAS session is identified by its universally unique identifier (UUID).

General Processing

_METHOD
: prints a brief text description of the FedSQL query plan.

_POSTOPTPLAN
: prints an XML tree illustrating the FedSQL query plan.

ANSIMODE
: specifies that nonexistent values in CHAR and DOUBLE columns are processed as ANSI SQL null values.

AUTOCOMMIT | NOAUTOCOMMIT
: specifies whether updates are automatically committed (that is, saved to a table) after a default number of rows are updated, and whether rollback is available.

CNTL=(*parameter*)
: specifies optional control parameters for FedSQL query planning and query execution in CAS.

ERRORSTOP | NOERRORSTOP
: specifies whether the procedure stops executing if it encounters an error.

EXEC | NOEXEC
: specifies whether a statement should be executed after its syntax is checked for accuracy.

LABEL | NOLABEL
: specifies whether to use the column label or the column name as the column heading.

MEMSIZE=*n* | *n*M | *n*G
: specifies a limit for the amount of memory that is used for an underlying query (such as a SELECT statement), so that allocated memory is available to support other PROC FEDSQL operations.

NOPRINT
: suppresses the normal display of results.

NUMBER
: specifies to include a column named Row, which is the row (observation) number of the data as the rows are retrieved.

STIMER
: specifies to write a subset of system performance statistics, such as time-elapsed statistics, to the SAS log.

XCODE=ERROR | WARNING | IGNORE
: controls the behavior of the SAS session when an NLS transcoding failure occurs.

Optional Arguments

_METHOD

prints a brief text description of the FedSQL query plan. A FedSQL query is broken into stages. Each stage of execution requires a stand-alone SQL query. This option generates a brief text description of the nodes and stages in the query plan. The information is written to the SAS log.

Notes _METHOD is supported on the CAS server only.

The behavior of this option changed in SAS Viya 3.5. In previous versions of SAS Viya, _METHOD returned the stage query and the number of threads used by a request. Beginning in SAS Viya 3.5, that information and more can be obtained with a new showStages CNTL= option. For more information, see "SHOWSTAGES" on page 1012.

See "FedSQL Query Walk-Through" in *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*

_POSTOPTPLAN

prints an XML tree illustrating the FedSQL query plan. A FedSQL query is broken into stages. Each stage of execution requires a stand-alone SQL query. This option generates an XML tree that illustrates each stage of the FedSQL query plan and the results from each execution stage. The information is written to the SAS log.

Notes _POSTOPTPLAN is supported on the CAS server only.

The XML tree can be very long. You might want to use the _METHOD option instead.

ANSIMODE

specifies that nonexistent values in CHAR and DOUBLE columns are processed as ANSI SQL null values. By default, PROC FEDSQL processes nonexistent values in CHAR and DOUBLE columns as missing values. This is how SAS processes nonexistent values. The ANSIMODE option specifies to process nonexistent values in CHAR and DOUBLE columns as ANSI SQL null values. It is important to understand the differences, or data can be lost. For information about processing differences, see "How FedSQL Processes Nulls and SAS Missing Values" in *SAS FedSQL Language Reference*. All other data types use ANSI NULL semantics all of the time.

Default SAS mode

Restriction ANSIMODE is supported for SAS libraries only.

AUTOCOMMIT | NOAUTOCOMMIT

specifies whether updates are automatically committed (that is, saved to a table) after a default number of rows are updated, and whether rollback is available.

Default All updates are committed immediately after each request is submitted, and no rollback is possible.

Restriction NOAUTOCOMMIT is supported for SAS libraries only.

Requirement For data sources that do not support transactions, specifying NOAUTOCOMMIT returns an error. The data sources that support transactions include Aster, DB2 for UNIX and PC Hosts, Greenplum, Microsoft SQL Server, MySQL, ODBC databases, and SAP IQ.

CNTL=(*parameter*)
specifies optional control parameters for FedSQL query planning and query execution in CAS. Multiple parameters are allowed inside of the parentheses. Separate each parameter with a space. The following parameters are supported:

DISABLEPASSTHROUGH
disables implicit FedSQL pass-through in CAS. FedSQL attempts to use implicit pass-through for all SQL data sources by default. In order for a FedSQL request to be eligible for implicit pass-through in CAS, all tables must exist in the same caslib and the tables cannot have already been loaded into the CAS session. For other requirements, see "FedSQL Implicit Pass-Through Facility in CAS" in *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*. This option can save processing time for FedSQL requests that contain functions that are specific to SAS, or whose tables have already been loaded into the CAS session.

DYNAMICCARDINALITY
instructs the FedSQL query planner to perform cardinality estimations before selecting a query plan.

The FedSQL query planner does not perform cardinality estimations before selecting a query plan by default. Cardinality estimation can improve the accuracy of selectivity estimates for join conditions and WHERE clause predicates, which in turn can lead to better join-order decisions and faster query execution times for some queries. However, dynamic cardinality does not help all queries and adds overhead to the query planning process.

Note The DYNAMICCARDINALITY option is available starting in SAS Viya 3.5.

See "Using the Dynamic Cardinality Instruction" in *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*

OPTIMIZEVARBINARYPRECISION
optimizes VARBINARY precision by using a precision that is appropriate to the actual data, instead of the precision declared for the VARBINARY columns.

The precision is optimized both when reading from a table and when creating a new table from a result set. The greatest benefits from this option are achieved when the declared precision is far larger than the precision of the actual data. Then, this option can improve performance, reduce memory footprint, and create VARBINARY columns in new tables with the needed size rather than propagating the precision from the source table.

Note The OPTIMIZEVARBINARYPRECISION option is available starting in SAS Viya 3.5.

OPTIMIZEVARCHARPRECISION
optimizes VARCHAR precision by using a precision that is appropriate to the actual data, instead of the precision declared for the VARCHAR columns.

The precision is optimized both when reading from a table and when creating a new table from a result set. The greatest benefits from this option are achieved when the declared precision is far larger than the precision of the actual data. Then, this option can improve performance, reduce memory footprint, and create VARCHAR columns in new tables with the needed size rather than propagating the precision from the source table.

Note The OPTIMIZEVARCHARPRECISION option is available starting in SAS Viya 3.5.

PRESERVEJOINORDER
joins tables in the specified order instead of an order chosen by the FedSQL query optimizer.

REQUIREFULLPASSTHROUGH
stops processing the FedSQL request when implicit pass-through of the full query cannot be achieved.

SHOWSTAGES
writes query execution details to the SAS log.

This includes the information returned by the _METHOD option. In addition, showStages prints the stage query, the number of SQL threads used by each stage, and the following execution details:

- Time for each intermediate stage
- Number of output rows from each intermediate stage
- Elapsed time for each stage and for the entire action
- Whether a table was replicated to all workers, or auto-partitioned.

The information is gathered when the query is executed and is written to the client log. Do not specify NOEXEC with showStages. Execution details cannot be printed if the query is not executed.

Note The SHOWSTAGES option is available starting in SAS Viya 3.5.

See "Viewing the FedSQL Query Plan" in *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*

Notes CNTL= is supported on the CAS server only.

CNTL= is available starting in SAS Viya 3.3.

See "Optimizing FedSQL Performance by Modifying the FedSQL Query Plan" in *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*

ERRORSTOP | NOERRORSTOP
specifies whether the procedure stops executing if it encounters an error. In a batch or noninteractive session, ERRORSTOP instructs the procedure to stop executing the statements but to continue checking the syntax after it has encountered an error. NOERRORSTOP instructs the procedure to execute the statements and to continue checking the syntax after an error occurs.

Default NOERRORSTOP in an interactive SAS session; ERRORSTOP in a batch or noninteractive session

Tips ERRORSTOP has an effect only when SAS is running in the batch or noninteractive execution mode.

NOERRORSTOP is useful if you want a batch job to continue executing SQL procedure statements after an error is encountered.

EXEC | NOEXEC
specifies whether a statement should be executed after its syntax is checked for accuracy. EXEC specifies to execute the statement. NOEXEC specifies not to execute the statement.

Default EXEC

Tip NOEXEC is useful if you want to check the syntax of your FedSQL statements without executing the statements.

LABEL | NOLABEL
specifies whether to use the column label or the column name as the column heading.

Default LABEL

Interactions If a column does not have a label, the procedure uses the column's name as the column heading.

A column alias overwrites the label or column name as the column heading.

LIBS=*libref* | (*libref1libref2 ...librefn*)
restricts the default data source connection to the specified libref(s). All other librefs are ignored. When you specify a list of librefs, the order of the list defines the library order.

Alias LIBNAMES=

Restriction LIBS= is supported only for SAS libraries.

Interactions If both LIBS= and SESSREF= (or SESSUUID=) are specified in the procedure statement, SESSREF= is applied and the other option is ignored.

If LIBS= is specified multiple times, the last instance on the procedure statement is applied.

Note LIBS= is available starting in SAS 9.4M3

Tips LIBS= is useful when multiple LIBNAME statements are defined in a SAS session, to limit the scope of the FedSQL request to only the LIBNAME statement(s) to which the request applies. It can also avoid duplicate catalog errors when connecting to data sources that support native catalogs, such as Netezza.

If you are curious about how LIBS= affects library assignments, set the MSGLEVEL=i system option before running a PROC FEDSQL request with LIBS=. The option produces Include and Ignore messages for each of the LIBNAME statements that are processed in the procedure request.

See "Data Source Connection" on page 1017

"About the LIBS= Procedure Option" on page 1019

Example The following PROC FEDSQL procedure statement specifies to create a data source connection that uses only librefs MyLib3 and MyLib4:

```
proc fedsql libs=(mylib3 mylib4);
```

MEMSIZE=*n* | *n*M | *n*G

specifies a limit for the amount of memory that is used for an underlying query (such as a SELECT statement), so that allocated memory is available to support other PROC FEDSQL operations. Specify the memory limit in multiples of 1 (bytes); 1,048,576 (megabytes); or 1,073,741,824 (gigabytes). For example, the value 23M specifies 24,117,248 bytes of memory. The value 16G specifies 17,179,869,184 bytes of memory.

Default The procedure optimizes the setting based on the amount of memory on the host.

Note On the CAS server, MEMSIZE= specifies the memory for a single CAS worker.

Tip Generally, specifying a memory limit is not necessary unless FedSQL reports a memory problem error.

NOPRINT

suppresses the normal display of results.

Interaction NOPRINT affects the value of the SQLOBS automatic macro variable, which contains the number of rows that are executed by a statement.

NUMBER

specifies to include a column named Row, which is the row (observation) number of the data as the rows are retrieved.

Default No row numbers.

SESSREF=*session-name*

specifies to run the FedSQL statements in a CAS session. The CAS session is identified by its session name.

Requirements A CAS server must be configured for your system.

The CAS session must have been previously established by using the CAS statement. If the specified CAS session does not exist, the procedure terminates.

Interactions Use SESSREF= or SESSUUID= to connect to the CAS session. If both options are specified, the last option in the procedure statement is applied.

If both SESSREF= and LIBS= are specified on the procedure statement, SESSREF= is applied and the other option is ignored.

Note This option is supported in SAS Viya 3.1 and later and in SAS 9.4M5 and later.

See "Connecting to the CAS Server" on page 1019

"Using FedSQL in SAS Cloud Analytic Services" on page 1021

"Example 7: Explicitly Loading and Joining Tables in CAS" on page 1041

SESSUUID="*session-uuid*"

specifies to run the FedSQL statements in a CAS session. The CAS session is identified by its universally unique identifier (UUID).

Requirements A CAS server must be configured for your system.

The CAS session must have been previously established by using the CAS statement. The CAS statement generates a UUID value. If the specified CAS session does not exist, the procedure terminates.

Interactions Use SESSREF= or SESSUUID= to connect to the CAS session. If both options are specified, the last option in the procedure statement is applied.

If both SESSUUID= and LIBS= are specified in the procedure statement, SESSUUID= is applied and the other option is ignored.

Note This option is supported in SAS Viya 3.1 and later and in SAS 9.4M5 and later.

See "Connecting to the CAS Server" on page 1019

"Using FedSQL in SAS Cloud Analytic Services" on page 1021

Example Here is a PROC FEDSQL procedure statement that specifies SESSUUID=:

```
proc fedsql sessuuid="76904741-fb09-554d-a8de-6cbce2a0e0e5";
```

The UUID value can be enclosed in single or double quotation marks.

STIMER
specifies to write a subset of system performance statistics, such as time-elapsed statistics, to the SAS log. When STIMER is in effect, the procedure writes to the SAS log a list of computer resources used for each step and the entire SAS session.

Default No performance statistics are written to the SAS log.

Interaction If the SAS system option FULLSTIMER is in effect, the complete list of computer resources is written to the SAS log.

XCODE=ERROR | WARNING | IGNORE
controls the behavior of the SAS session when an NLS transcoding failure occurs. Transcoding failures can occur during row input or output operations, or during string assignment. Transcoding is the process of converting character data from one encoding to another encoding.

ERROR
specifies that a run-time error occurs, which causes row processing to halt. An error message is written to the SAS log. This is the default behavior.

WARNING
specifies that the incompatible character is set to a substitution character. A warning message is written to the SAS log.

IGNORE
specifies that the incompatible character is set to a substitution character. No messages are written to the SAS log.

Default ERROR

Note This option was added in SAS 9.4M2.

QUIT Statement

Stops the execution of the FEDSQL procedure.

Interaction: Unlike other SAS procedures, in SAS 9.4, PROC FEDSQL does not recognize step boundaries. The QUIT statement is required to stop the FEDSQL procedure before you can submit a DATA step or another procedure step.

Syntax

QUIT;

Details

When the FEDSQL procedure reaches the QUIT statement, all resources allocated by the procedure are released. You can no longer execute FedSQL language statements without invoking the procedure again. However, the connection to the data source server is not lost, because that connection was made through the LIBNAME statement. As a result, any subsequent invocation of the procedure that uses the same libref executes almost instantaneously because the LIBNAME engine is already connected to the server.

Usage: FEDSQL Procedure

Data Source Connection

PROC FEDSQL can execute requests in SAS libraries (librefs) or on the CAS server. By default, PROC FEDSQL connects to a data source by using available librefs. You can override this default behavior by specifying connection options. The FEDSQL procedure is not affected by the CASNAME= system option.

Understanding the Default Data Source Connection

PROC FEDSQL connects to a data source by using the attributes of currently assigned librefs. Attributes include the physical location of the data, and for some data sources, access information such as network information used to access the data server, and user identification and password.

1 You first submit the LIBNAME statement for a SAS engine and then submit PROC FEDSQL. For information to define a LIBNAME statement, see:

SAS data sets
SAS Global Statements: Reference

Relational DBMS data sources
SAS/ACCESS for Relational Databases: Reference

MongoDB and Salesforce
SAS/ACCESS for Nonrelational Databases: Reference

SPD Engine data sets
SAS Scalable Performance Data Engine: Reference

SPD Server tables
SAS Scalable Performance Data Server: User's Guide

2 In your FedSQL language statements, use a two-part name in the form *libref.table-name* to refer to tables. The libref tells FedSQL where to create or locate a table.

3 Then, submit the FEDSQL procedure.

This example illustrates how PROC FEDSQL accesses a data source by using the attributes of a previously assigned libref. The LIBNAME statement assigns the libref MyFiles, specifies the BASE engine, and then specifies the physical location for the SAS data set. The FedSQL program then creates a SAS data set named MyFiles.Table1 at the location specified in the LIBNAME statement.

```
libname myfiles base 'C:\myfiles';

proc fedsql;
   create table myfiles.table1 (x double);
   insert into myfiles.table1 values (1.0);
   insert into myfiles.table1 values (2.0);
   insert into myfiles.table1 values (3.0);
quit;
```

The procedure builds a data source connection string that includes all the active librefs in the SAS session and sends it to the FedSQL program. You reference a particular library by specifying its libref in a two-part table name in the form *libref.table-name*. If you do not specify a libref, the table is created in the SAS Work library.

PROC FEDSQL uses libref attributes for connection information only (such as physical location). The procedure generally does not use libref attributes that define behavior. For example, if a previously submitted LIBNAME statement for the BASE engine specifies that SAS data sets are to be compressed, the compression attribute is not used by the procedure. There are exceptions. For example, the MAX_BINARY_LEN= and MAX_CHAR_LEN= for Google BigQuery are included in the internal connection string.

You can determine which LIBNAME options are used by the procedure by setting the MSGLEVEL=i system option before submitting a LIBNAME statement. For many data sources, you can specify a DS2 table option to override a LIBNAME option. For example, the COMPRESS= table option can be used to request compression of SAS data sets. The SCANSTRINGCOLUMNS= table option can be used to override the MAX_BINARY_LEN= and MAX_CHAR_LEN= LIBNAME options. Not all LIBNAME statement options have a corresponding table option.

Note: PROC FEDSQL connects immediately, so an error is generated if the LIBNAME statement includes the DEFER=YES option.

z/OS Specifics: The physical location for the libref must be an HFS path specification.

About the LIBS= Procedure Option

When multiple librefs are active in the SAS session, you might want to include the LIBS= option in the PROC FEDSQL statement. LIBS= restricts the data source connection to the specified libref or librefs and the default library. Work is the default library unless a User library is assigned.

You must continue to qualify table names with a libref, even when LIBS= specifies only one library; otherwise, the default library is used.

The following example illustrates the use of the LIBS= option. In the example, the LIBS= option specifies to use only libref MyFiles.

```
libname allfiles base 'C:\sharedfiles';
libname myfiles base 'C:\myfiles';

proc fedsql libs=myfiles;
   create table myfiles.table1 (x double);
   insert into myfiles.table1 values (1.0);
   insert into myfiles.table1 values (2.0);
   insert into myfiles.table1 values (3.0);
quit;
```

For more information, see "LIBS=*libref* | (*libref1 libref2 ...librefn*)" on page 1013.

For information about the FedSQL statements supported in the connections made with LIBS=, see *SAS FedSQL Language Reference*.

Connecting to the CAS Server

You connect to a CAS session on the CAS server by specifying the SESSREF= (or SESSUUID=) procedure option with a CAS session name in the PROC FEDSQL statement. When SESSREF= (or SESSUUID=) is specified, both the default connection mechanism and the LIBS= option are ignored. Instead, the procedure connects to the specified CAS session.

Note: You must have a CAS server configured. You must first submit the CAS statement to establish the CAS session. To interact with data in a CAS session, you need a caslib. You must first define a caslib (or use a pre-defined caslib). You define a caslib and list the caslibs that are available to your CAS session by using the CASLIB statement. For syntax information, see *SAS Cloud Analytic Services: User's Guide*. A caslib uses a SAS Data Connector (or SAS Data Connector Accelerator) to access data. For information about SAS Data Connectors, see *SAS Cloud Analytic Services: User's Guide*.

Use a two-part name in the form *caslib.table-name* to identify tables in your FedSQL statements. The following example illustrates a PROC FEDSQL request to the CAS server.

```
options cashost="cloud.example.com" casport=5570;
cas mysess;

caslib castera desc='Teradata Caslib'
datasource=(srctype='teradata'
username='myname'
password='mypw'
server='testserver',
db='testdb');

proc fedsql sessref=mysess;
  create table newtable as
  select * from castera.employees;
quit;
```

This example establishes a CAS session named MySess on a CAS server on CAS host cloud.example.com. It then uses the CASLIB statement to assign caslib CASTERA. The PROC FEDSQL statement specifies the SESSREF= procedure option with the CAS session name MySess. The FedSQL CREATE TABLE statement identifies table Employees using the CASTERA caslib.

SAS Viya data connectors support automatic (shown here) and explicit loading of data into CAS. For more examples, see "Example 6: Querying Data in CAS" on page 1038, "Example 7: Explicitly Loading and Joining Tables in CAS" on page 1041, and "Example 8: Joining Tables from Multiple CAS Libraries" on page 1046.

The CAS tables that you create with PROC FEDSQL are in-memory tables. That is, the tables are available for the duration of the CAS session and are accessible only to the current session. PROC FEDSQL does not provide a way to persist a table to a data source or to share the table with other CAS sessions. To persist or share a CAS output table, use the CASUTIL procedure.

Note: Although CAS tables are in-memory tables, PROC FEDSQL will not overwrite an existing table of the same name. Specify the REPLACE= table option to overwrite an existing table with a replacement table. Or, use the DROP TABLE statement to remove the initial table before creating the replacement table.

For more information about SAS Cloud Analytic Services, see *SAS Cloud Analytic Services: Fundamentals*. Also see CAS statement, CASLIB statement, and CASUTIL procedure in *SAS Cloud Analytic Services: User's Guide*.

Using FedSQL in a SAS Library

The FedSQL language includes statements for reading and writing data. For information about the FedSQL statements supported in the default connection and with the LIBS= option, see *SAS FedSQL Language Reference*. When using PROC FEDSQL to read and write data in a SAS library, note that not all FedSQL statements are supported for third-party DBMS. For information about statement support, see "FedSQL Statements" in *SAS FedSQL Language Reference*.

Data type support and table option support is also data source-specific. For more information, see "Data Type Reference" in *SAS FedSQL Language Reference* and "FedSQL Statement Table Options by Data Source" in *SAS FedSQL Language Reference*.

Using FedSQL in SAS Cloud Analytic Services

When you specify the SESSREF= (or SESSUUID=) option, PROC FEDSQL submits your FedSQL query on a CAS server. The request is actually executed with the fedSQL.execDirect action.

The CAS server is an alternative environment for processing FedSQL queries. The CAS server is a multiprocessing server. A FedSQL request executing on the CAS server can perform manipulations on multiple table rows concurrently using multiple threads and worker nodes. These multiple resources can reduce the time required to process large tables.

The FedSQL statements available when you target the CAS server are subset of those that are available for a SAS library. The following FedSQL statements are supported in CAS:

- CREATE TABLE, with the AS query expression
- SELECT
- DROP TABLE

The following SELECT statement features are not supported:

- EXCEPT and INTERSECT SET operations (UNION is supported, starting in SAS Viya 3.5)
- correlated subqueries
- IN, ANY, and ALL subqueries
- dictionary queries
- views
- DS2 user-defined functions (also known as DS2 package expressions).

FedSQL output tables in CAS are in-memory tables. The tables are created in the user session. You must use other CAS actions to promote the output tables for global use in CAS or to store data to caslib data sources. For more information about FedSQL functionality on the CAS server, see *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*.

Applying FedSQL Table Options

When you access a data source with PROC FEDSQL, you can apply FedSQL table options in the subsequent FedSQL statements. A table option specifies actions that enable you to perform operations on a table such as assigning buffer page size

or specifying passwords. A FedSQL table option performs much of the same functionality as a Base SAS data set option.

FedSQL table options are used to apply options when you access a data source within PROC FEDSQL. For example, the following code applies a table option to the SAS data set in order to specify the size of a permanent buffer page for the new table:

```
libname myfiles base 'C:\myfiles';

proc fedsql;
   create table myfiles.table1 {options bufsize=16k}(x double) ;
   insert into myfiles.table1 values (1.0);
   insert into myfiles.table1 values (2.0);
   insert into myfiles.table1 values (3.0);
quit;
```

A CAS library supports different table options than a SAS library. For a list of table options that are supported in SAS libraries, see *SAS FedSQL Language Reference*. For a list of table options that are supported in CAS libraries, see *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*.

Macro Variables

Using Macro Variables in a Literal String

Note: The information in this section applies to PROC FEDSQL use in SAS libraries.

Macro variables enable you to dynamically modify text in a program through symbolic substitution. When you reference a macro variable in a program, the macro processor replaces the reference with the value of the specified macro variable.

With PROC FEDSQL, you can use a macro variable on a subsequent FedSQL statement. However, if a macro variable occurs within a literal string, you cannot enclose the string in double quotation marks. The macro processor uses double quotation marks to resolve macro variable references. FedSQL considers a string enclosed in double quotation marks to be a delimited (case sensitive) identifier such as a table or column name.

To reference a macro variable in a literal string, use the SAS macro function %TSLIT. %TSLIT overrides the need for double quotation marks around the literal string and puts single quotation marks around the input value. For example, the following statement includes the %TSLIT function to specify the &SYSHOSTNAME macro variable, which returns the host name of the computer on which it is executed:

```
select %tslit(&syshostname);
```

The %TSLIT macro function is stored in the default autocall macro library. For more information, see "Referencing a Macro Variable in a Delimited Identifier" in *SAS FedSQL Language Reference* .

Using Macro Variables Set by the Procedure

PROC FEDSQL sets up macro variables with certain values after it executes each statement. These macro variables can be tested inside a macro to determine whether to continue executing the PROC step. After each statement has executed, the following macro variable is updated with these values:

SQLRC
: contains the following status values that indicate the success of the PROC FEDSQL statement:

  0
  : PROC statement completed successfully with no errors.

  4
  : PROC statement encountered a situation for which it issued a warning. The statement continued to execute.

  8
  : PROC statement encountered an error. The statement stopped execution at this point.

  16
  : PROC statement encountered a run-time error. For example, this error code is used when a subquery (that can return only a single value) evaluates more than one row. These errors can be detected only during run time.

Passwords

SAS software enables you to restrict access to SAS data sets and SPD Engine data sets by assigning SAS passwords to the files. When using PROC FEDSQL with SAS libraries, you can assign or specify a password for a data source using the FedSQL table options ALTER=, PW=, READ=, and WRITE=. For example, the following code applies the FedSQL table option PW= in order to assign READ, WRITE, and ALTER passwords to a SAS data set:

```
libname myfiles base 'C:\myfiles';

proc fedsql;
   create table myfiles.table1 {options pw=luke}(x double) ;
   insert into myfiles.table1 values (1.0);
   insert into myfiles.table1 values (2.0);
   insert into myfiles.table1 values (3.0);
quit;
```

This code shows how to specify a table option to read a data set:

```
select * from myfiles.table1 {options pw=luke};
```

A SAS password does not control access to a SAS file beyond SAS. You should use the operating system-supplied utilities and file system security controls to control access to SAS files outside SAS. For more information about SAS passwords, see *SAS FedSQL Language Reference*.

CAS tables do not support SAS passwords. Therefore, you cannot assign a password for a CAS table. When accessing password-protected data from CAS, passwords are specified in the CAS language element used to access the data. For example, passwords are supported in the CASUTIL procedure, which loads data into CAS, as well as in the CASLIB statement and in the Table.addCaslib action. For more information, see the SAS Data Connector documentation in *SAS Cloud Analytic Services: User's Guide*.

Encryption

SAS software enables you to encrypt the contents of a SAS data set, SPD Engine data set, and SPD Server table. SAS supports SAS proprietary encryption and AES encryption.

When using PROC FEDSQL with SAS libraries, you can encrypt output SAS data sets, SPD Engine data sets, and SPD Server tables with SAS proprietary encryption. This is done by specifying the FedSQL ENCRYPT= table option with the PW= or READ= table option. A data set or table encrypted with SAS proprietary encryption must be decrypted by specifying the PW= or READ= table option with the appropriate password.

AES encryption is performed by specifying the ENCRYPT= table option with the ENCRYPTKEY= table option. A data set or table encrypted with AES encryption is later decrypted by specifying the ENCRYPTKEY= table option with the appropriate key value.

SAS supports two levels of AES encryption: AES and AES2. The new AES2 option provides AES encryption to meet newer and more secure encryption standards. AES2 encryption is initially supported for SAS data sets only. For more information, see "ENCRYPT= Table Option" in *SAS FedSQL Language Reference*.

FedSQL currently does not support the encryption attribute for CAS tables. When accessing SAS and AES encrypted data sets from CAS, passwords and encryption keys are specified in the CAS language element that is used to access the data. For example, passwords and encryption keys are supported in the CASUTIL procedure, which loads data into CAS as well as in the CASLIB statement and in the Table.addCaslib action. For more information, see the SAS Data Connector documentation in *SAS Cloud Analytic Services: User's Guide*.

FedSQL Data Type Support for SAS Data Sets

PROC FEDSQL supports the following data types for reading and writing a SAS data set through a SAS library. For a SAS data set, FedSQL data types are translated to and from predetermined legacy SAS data types, which are SAS numeric and SAS character. For example, when you submit the CONTENTS procedure on a table that is created with the FedSQL language, the DATE data type is reported as a SAS numeric. The following table lists the FedSQL data types and describes how they are translated to and from SAS data types.

Table 27.2 *FedSQL Data Type Translation for SAS Data Sets*

FedSQL Data Type	SAS Data Type	Description
BIGINT	SAS numeric	Because a SAS numeric is a DOUBLE, there is potential for loss of precision. DOUBLE is an approximate numeric data type rather than an exact numeric data type.
BINARY(*n*)	SAS character	Applies the SAS format $*n*.
CHAR(*n*)	SAS character	Applies the SAS format $*n*.
DATE	SAS numeric	Applies the SAS format DATE9. Valid SAS date values are in the range from 1582-01-01 to 9999-12-31. Dates outside the SAS date range are not supported and are treated as invalid dates.
DECIMAL| NUMERIC(*p*,*s*)	SAS numeric	
DOUBLE	SAS numeric	
FLOAT(*p*)	SAS numeric	
INTEGER	SAS numeric	
NCHAR(*n*)	SAS character	Applies the SAS format $*n*.
NVARCHAR(*n*)	SAS character	Applies the SAS format $*n*.
REAL	SAS numeric	
SMALLINT	SAS numeric	

FedSQL Data Type	SAS Data Type	Description
TIME(*p*)	SAS numeric	Applies the SAS format TIME8.
TIMESTAMP(*p*)	SAS numeric	Applies the SAS format DATETIME19.2.
TINYINT	SAS numeric	
VARBINARY(*n*)	SAS character	Applies the SAS format $*n*.
VARCHAR(*n*)	SAS character	Applies the SAS format $*n*.

For information about data type support for DBMS data sources through a SAS library, see "Data Type Reference" in *SAS FedSQL Language Reference*.

FedSQL Data Type Support for CAS Tables

FedSQL supports CAS native data types only in CAS. Beginning with SAS Viya 3.5, FedSQL supports the VARBINARY data type in addition to the CHAR(*n*), DOUBLE, INT32, INT64, and VARCHAR(*n*) data types.

Table 27.3 *FedSQL Data Type Translation for CAS Tables*

FedSQL Data Type	CAS Data Type	Description
BIGINT[1]	INT64	Large signed, exact whole number.
CHAR(*n*)	CHAR	Fixed-length character string, where *n* is the maximum number of characters to store. The maximum number of characters is required to store each value regardless of the actual size of the value. If char(10) is specified and the character string is only five characters long, the value is right-padded with spaces.
DOUBLE	DOUBLE	Signed, approximate, double-precision, floating-point number. Allows numbers of large magnitude and permits computations that require many digits of precision to the right of the decimal point. For the CAS server, this is a 64-bit double-precision, floating-point number.
INTEGER[1]	INT32	Regular signed, exact whole number.

FedSQL Data Type	CAS Data Type	Description
VARBINARY[2]	VARBINARY	Varying-length binary opaque data. This data type is used to store image data, audio, documents, and other unstructured data.
VARCHAR(*n*)	VARCHAR	Varying-length character string, where *n* is the maximum number of characters to store.

1 Support for the integer data types starts in SAS Viya 3.3.

2 Support for the VARBINARY data type starts in SAS Viya 3.5. FedSQL can read and write VARBINARY columns in CAS tables (with CREATE TABLE AS). However, the SELECT statement does not display VARBINARY columns in some clients unless you apply the $HEX. format to the VARBINARY column with the PUT function. In earlier SAS Viya releases, FedSQL does not return an error when reading BINARY and VARBINARY columns. However, the data is incorrectly treated as character data. Attempts to read BINARY data now yield an error.

Date, time, and timestamp values in CAS tables are supported as DOUBLEs, with a SAS format applied. FedSQL applies the DATE9. SAS format to date values, the TIME8. SAS format to time values, and the DATETIME25.6 SAS format to datetime values.

CAS tables use the UTF-8 character set by default.

It is important to understand how FedSQL handles missing values in CAS. See "Handling of Nonexistent Data" in *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*.

Examples: FEDSQL Procedure

Example 1: Creating a SAS Data Set

Features:

PROC FEDSQL statement
FedSQL CREATE TABLE statement
FedSQL INSERT statement
QUIT statement
LIBNAME statement
PROC CONTENTS

Details

This example creates a SAS data set in a Base SAS session by submitting the FEDSQL procedure. The example submits the FedSQL CREATE TABLE and INSERT statements. The CONTENTS procedure then is used to describe the contents of the SAS data set.

Program

```
libname mybase base 'C:\My Documents';

proc fedsql;

create table mybase.sales (prodid double not null,
                           custid double not null,
                           totals double having format comma8.,
                           country char(30));

insert into mybase.sales values (3234, 1, 189400, 'United States');
insert into mybase.sales values (1424, 3, 555789, 'Japan');
insert into mybase.sales values (3421, 4, 781183, 'Japan');
insert into mybase.sales values (3422, 2, 2789654, 'United States');
insert into mybase.sales values (3975, 5, 899453, 'Argentina');

quit;

proc contents data=mybase.sales;
run;
```

Program Description

Assign a library reference to the SAS data set to be created. The LIBNAME statement assigns the libref MyFiles, specifies the BASE engine, and specifies the physical location for the SAS data set.

```
libname mybase base 'C:\My Documents';
```

Execute the PROC FEDSQL statement. The PROC FEDSQL statement sets up an environment to submit FedSQL statements. By default, the PROC FEDSQL statement generates a connection string to the data source from the librefs that are active in the SAS session.

```
proc fedsql;
```

Enter the FedSQL CREATE TABLE statement. The statement specifies to create the SAS data set named MyBase.Sales. Note that the two-level name in the FedSQL CREATE TABLE statement specifies the catalog identifier MyBase, which is the assigned libref. The variable declaration defines a NOT NULL integrity constraint on columns ProdId and CustId, and applies the SAS format COMMAw. on column Totals.

```
create table mybase.sales (prodid double not null,
                           custid double not null,
                           totals double having format comma8.,
                           country char(30));
```

Enter INSERT statements to populate the table with data. Note that the table name is qualified with the catalog identifier in each statement. The data values are submitted in a comma-delimited string, preceded by the keyword VALUES.

```
insert into mybase.sales values (3234, 1, 189400, 'United States');
insert into mybase.sales values (1424, 3, 555789, 'Japan');
insert into mybase.sales values (3421, 4, 781183, 'Japan');
insert into mybase.sales values (3422, 2, 2789654, 'United States');
insert into mybase.sales values (3975, 5, 899453, 'Argentina');
```

Stop the procedure. The QUIT statement stops the procedure.

```
quit;
```

List the contents of the SAS data set. The CONTENTS procedure describes the contents of the SAS data set.

```
proc contents data=mybase.sales;
run;
```

Output: Creating a SAS Data Set

Output 27.1 *PROC CONTENTS Output of MyBase.Sales*

Data Set Name	MYBASE.SALES	Observations	5
Member Type	DATA	Variables	4
Engine	BASE	Indexes	0
Created	08/04/2017 09:24:24	Integrity Constraints	2
Last Modified	08/04/2017 09:24:24	Observation Length	56
Protection		Deleted Observations	0
Data Set Type		Compressed	NO
Label		Sorted	NO
Data Representation	WINDOWS_64		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	65536
Number of Data Set Pages	2
First Data Page	1
Max Obs per Page	1167
Obs in First Data Page	5
Number of Data Set Repairs	0
ExtendObsCounter	YES
Filename	C:\mybase\sales.sas7bdat
Release Created	7.1TK
Host Created	X64_1
Owner Name	CARYNT\sassyp
File Size	129KB
File Size (bytes)	132096

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format
4	COUNTRY	Char	30	
2	CUSTID	Num	8	
1	PRODID	Num	8	
3	TOTALS	Num	8	COMMA8.

Alphabetic List of Integrity Constraints

#	Integrity Constraint	Type	Variables
1	_NM0001_	Not Null	PRODID
2	_NM0002_	Not Null	CUSTID

Example 2: Joining Tables from Multiple SAS Libraries

Features: PROC FEDSQL statement
CREATE TABLE statement with AS expression
LIBNAME statements

Details

This example creates a new SAS data set from existing tables by using PROC FEDSQL and the CREATE TABLE statement with the AS query expression syntax. The query expression selects rows from three existing tables — SAS data set Sales, SPD Engine data set Products, and Oracle table Customers — to create the new table: Results.

Program

```
libname mybase v9 'C:\base';
libname myspde spde 'C:\spde';
libname myoracle oracle path=ora11g user=xxxxxx password=xxxxxx
schema=xxxxxx;

proc fedsql;
```

```
   create table mybase.results as
      select products.prodid, products.product, customers.name,
         sales.totals, sales.country
      from myspde.products, mybase.sales, myoracle.customers
      where products.prodid = sales.prodid and
         customers.custid = sales.custid;

   select * from mybase.results;

quit;
```

Program Description

Assign three librefs. The first LIBNAME statement assigns the libref MyBase, specifies the V9 engine, and specifies the physical location for the SAS data set to be created. V9 is an alias for the BASE engine. The second LIBNAME statement assigns the libref MySpde, specifies the SPDE engine, and specifies the physical location for the existing SPD Engine data set. The third LIBNAME statement assigns the libref MyOracle, specifies the ORACLE engine, and specifies the connection information to the Oracle database that contains the existing Oracle tables.

```
libname mybase v9 'C:\base';
libname myspde spde 'C:\spde';
libname myoracle oracle path=ora11g user=xxxxxx password=xxxxxx
schema=xxxxxx;
```

Execute the PROC FEDSQL statement. The PROC FEDSQL statement sets up an environment for submitting FedSQL statements.

```
proc fedsql;
```

Create the new table. The CREATE TABLE statement creates a new SAS data set from three existing SAS data sets by using a query expression to select rows from the existing data sets. The SELECT statement retrieves the qualified columns and rows from the existing data sets to create the new SAS data set.

```
   create table mybase.results as
      select products.prodid, products.product, customers.name,
         sales.totals, sales.country
      from myspde.products, mybase.sales, myoracle.customers
      where products.prodid = sales.prodid and
         customers.custid = sales.custid;
```

Retrieve data in the SAS data set. This second SELECT statement displays the contents of the output data set.

```
   select * from mybase.results;
```

Stop the procedure.

```
quit;
```

Output: Joining Tables from Multiple SAS Libraries

Output 27.2 *Contents of Output Data Set MyBase.Results*

PRODID	PRODUCT	NAME	TOTALS	COUNTRY
3234	Rice	Peter Frank	189,400	United States
3422	Oat	Jim Stew art	2789654	United States
1424	Corn	Janet Chien	555,789	Japan
3421	Wheat	Qing Ziao	781,183	Japan
3975	Barley	Humberto Sertu	899,453	Argentina

Example 3: Querying Data Using a Correlated Subquery

Features: PROC FEDSQL statement
FedSQL SELECT statement
LIBNAME statements

Note: This functionality is available in SAS libraries.

Details

This example illustrates querying data using a correlated subquery. In a correlated subquery, the WHERE clause in the subquery refers to values in a table in the outer query. The correlated subquery is evaluated for each row in the outer query. With correlated subqueries, FedSQL executes the subquery and the outer query together. FedSQL can perform heterogeneous correlated subqueries. FedSQL directs the subquery to be performed by the data source, which limits the result set that is transferred from the data source.

Note: Correlated subqueries are not yet supported on the CAS server.

Program

```
libname myspde spde 'C:\spde';
```

```
libname myoracle oracle path=ora11g user=xxxxxx password=xxxxxx
schema=xxxxxx;

proc fedsql;


   select * from myspde.product
      where exists (select * from myoracle.sales
      where product.prodid=sales.prodid);

quit;
```

Program Description

Assign two library references. The first LIBNAME statement assigns the libref MySpde, specifies the SPDE engine, and specifies the physical location for the SPD Engine data set. The second LIBNAME statement assigns the libref MyOracle, specifies the Oracle engine, and specifies the connection information to the Oracle database.

```
libname myspde spde 'C:\spde';
libname myoracle oracle path=ora11g user=xxxxxx password=xxxxxx
schema=xxxxxx;
```

Execute the PROC FEDSQL statement. The PROC FEDSQL statement creates an environment for submitting FedSQL statements.

```
proc fedsql;
```

Submit a correlated query. FedSQL directs the subquery WHERE expression to be evaluated by the Oracle database.

```
   select * from myspde.product
      where exists (select * from myoracle.sales
      where product.prodid=sales.prodid);
```

Stop the procedure. Specify the QUIT statement to complete the procedure request.

```
quit;
```

Example 4: Creating and Using a DBMS Index to Perform a Join

Features:	PROC FEDSQL statement FedSQL language statements LIBNAME statements
Note:	This functionality is available in SAS libraries.

Details

This example illustrates how to create an index for an Oracle table. It then illustrates how to use the index to perform a join of the Oracle table and an SPD Engine data set.

Note: The CREATE INDEX statement is not supported on the CAS server.

Program

```
libname myspde spde 'C:\spde';
libname myoracle oracle path=ora11g user=xxxxxx password=xxxxxx
schema=xxxxxx;

proc fedsql;

   create index prodid on myoracle.sales (prodid);

   select * from myspde.product, myoracle.sales
      where product.prodid=sales.prodid;

quit;
```

Program Description

Assign two library references. The first LIBNAME statement assigns the libref MySpde, specifies the SPDE engine, and specifies the physical location for the SPD Engine data set. The second LIBNAME statement assigns the libref MyOracle, specifies the ORACLE engine, and specifies the connection information to the Oracle database.

```
libname myspde spde 'C:\spde';
libname myoracle oracle path=ora11g user=xxxxxx password=xxxxxx
schema=xxxxxx;
```

Execute the PROC FEDSQL statement. The PROC FEDSQL statement creates an environment for submitting FedSQL statements.

```
proc fedsql;
```

Create an index for the Oracle table. The CREATE INDEX statement creates an index named ProdId in the Oracle table named Sales for the column ProdId.

```
   create index prodid on myoracle.sales (prodid);
```

Retrieve columns and rows. The SELECT statement retrieves data from the SPD Engine data set named Product and the Oracle table named Sales. Even though the index is in the Oracle database, FedSQL can take advantage of the index to perform the join.

```
   select * from myspde.product, myoracle.sales
      where product.prodid=sales.prodid;
```

Stop the procedure. Specify the QUIT statement to complete the procedure request.

```
quit;
```

Example 5: Using a DS2 Package in an Expression

Features: FedSQL SELECT statement
Package method declaration
DS2 PACKAGE statement
DS2 METHOD statement
DS2 DATA statement

Note: This functionality is available in SAS libraries.

Details

The FedSQL language supports the ability to invoke user-defined DS2 package methods as functions in the SELECT statement. This example creates and submits a DS2 package method named Add on a table named Numbers from PROC FEDSQL. The package method and table are created in the Work library.

Note: Package methods that are run from PROC FEDSQL can have only input arguments in the method. For more information, see "Using DS2 Packages in Expressions" in *SAS FedSQL Language Reference*.

Note: User-defined package methods are not supported on the CAS server.

Program

```
proc ds2;
   package adder / overwrite =yes;

   method add( double x, double y ) returns double;
   return x + y;
  end;
endpackage;

data numbers / overwrite = yes;
   dcl double x y;
   method init();
```

```
   dcl int i;
   do i = 1 to 10;
   x = i; y = i * i;
   output;
 end;
end;
enddata;

run;

quit;

proc fedsql;

   select x, y, work.adder.add( x, y ) as z from work.numbers;

quit;
```

Program Description

Invoke the DS2 procedure with the PROC DS2 statement and define a package. This PACKAGE statement specifies to create a package named Adder.

```
proc ds2;
   package adder / overwrite =yes;
```

Define a method. This METHOD statement specifies to create a method named Add. The method Add has two input variables, X and Y, both of type DOUBLE, and it returns an output of type DOUBLE. The output variable contains the sum from adding the value of variable X to variable Y. The END and ENDPACKAGE statements signal the completion of the METHOD and PACKAGE declarations.

```
   method add( double x, double y ) returns double;
   return x + y;
  end;
endpackage;
```

Create a table. This DATA statement specifies to create a table named Numbers. A library is not specified, so the Work library will be used. The table has two columns, X and Y, of type DOUBLE. The system INIT method is called to populate the table with values. A variable, I, is defined to hold input values. A DO statement uses variable I to insert rows containing the values 1 through 10 into column X. Then, it multiplies each instance of I with itself and inserts the result into column Y. The END and ENDDATA statements signal the completion of the DO statement, INIT method, and DATA statement declarations.

```
data numbers / overwrite = yes;
   dcl double x y;
   method init();
   dcl int i;
   do i = 1 to 10;
   x = i; y = i * i;
   output;
 end;
end;
enddata;
```

Submit the DS2 statements. Like in the DATA step, the RUN statement executes DS2 language statements.

```
run;
```

Stop the DS2 procedure. The QUIT statement completes the procedure request.

```
quit;
```

Invoke the FEDSQL procedure. The PROC FEDSQL statement invokes the FEDSQL procedure.

```
proc fedsql;
```

Submit a SELECT statement that invokes the package method on the table. The statement specifies to select columns X and Y, and the result of the package method expression is column Z from table Numbers. The package method is referenced using a three-part name in the form [catalog.][schema.]package.method.

```
select x, y, work.adder.add( x, y ) as z from work.numbers;
```

Stop the FEDSQL procedure. The QUIT statement completes the PROC FEDSQL request.

```
quit;
```

Here is the output from the SELECT statement:

x	y	z
1	1	2
2	4	6
3	9	12
4	16	20
5	25	30
6	36	42
7	49	56
8	64	72
9	81	90
10	100	110

Example 6: Querying Data in CAS

Features:

PROC FEDSQL statement
SESSREF= procedure option
FedSQL language statements
CAS system options
CAS statement
CASLIB statement

Details

This example illustrates the steps necessary to query a database table named Employees from CAS.

Program

```
options cashost="cloud.example.com" casport=5570;

cas mysess;

caslib castera desc='Teradata Caslib'
   datasource=(srctype='teradata',
      dataTransferMode='serial',
      username='myname',
      password='mypw',
      server='testserver',
      db='test');

proc fedsql sessref=mysess;

select Pos, count(Pos) as Count_Pos
    from castera.employees
    group by Pos
    having count(Pos) >= 2;

quit;
```

Program Description

Invoke the CAS server. The CASHOST= and CASPORT= system options specify the name and port number of the CAS server.

```
options cashost="cloud.example.com" casport=5570;
```

Establish a session on the CAS server. The CAS statement specifies to create a session named MySess on the CAS server.

```
cas mysess;
```

Add a caslib for the Teradata database. When submitting a request to the CAS server, you must identify your data source with a caslib instead of a libref. The CASLIB statement specifies to create caslib CasTera. The caslib specifies the SrcType=Teradata, dataTransferMode='serial', and connection details for the Teradata database. A data connect accelerator that loads data in parallel is available for Teradata, but it is not used here. CasTera becomes the active caslib in your CAS session.

```
caslib castera desc='Teradata Caslib'
   datasource=(srctype='teradata',
      dataTransferMode='serial',
      username='myname',
      password='mypw',
      server='testserver',
      db='test');
```

Specify the PROC FEDSQL statement with the SESSREF= procedure option. In the SESSREF= procedure option, specify the name CAS session name MySess. The SESSREF= option establishes the connection to the CAS session and it instructs the procedure to pass FedSQL language statements that follow to the fedSQL.execDirect action.

```
proc fedsql sessref=mysess;
```

Specify FEDSQL statements and identify the data source with caslib CASTERA. The SELECT statement specifies to list all of the job titles in database table Employees that have at least two employees. The table is identified by the two-part name CasTera.Employees. When you identify tables using a two-part name, the execDirect action responds as follows. The FedSQL language supports single-source, full-query implicit SQL pass-through in CAS. If the target tables have not yet been loaded into the CAS session, the tables are evaluated for implicit pass-through. Implicit pass-through passes eligible requests to the data source for processing and loads the result set into CAS. SQL implicit pass-through is possible only for tables that have not yet been loaded into the CAS session. There are other important requirements. For information about these requirements, see "FedSQL Implicit Pass-Through Facility in CAS" in *SAS Viya: FedSQL Programming for SAS Cloud Analytic Services*.. Unloaded tables that are not eligible for pass-through are automatically loaded into the CAS session for processing by the CAS server. Tables already existing in the CAS session are processed by the CAS server.

```
select Pos, count(Pos) as Count_Pos
    from castera.employees
    group by Pos
    having count(Pos) >= 2;
```

Stop the procedure.

```
quit;
```

Output: Result of Database Query from CAS

Output 27.3 *Output of CAS Database Query*

Pos	COUNT_POS
Manager	4.000000
Developer	2.000000
Sales Associate	2.000000

```
1          OPTIONS NONOTES NOSTIMER NOSOURCE NOSYNTAXCHECK
72
73              proc fedsql sessref=mysess;
74              select Pos, count(Pos) as Count_Pos
75                  from castera.employees
76                  groupby Pos
77                  having count(Pos) >=2;
NOTE: The SQL statement was fully offloaded to the underlying data source via
full pass-through
78               quit;
```

Example 7: Explicitly Loading and Joining Tables in CAS

Features:
- PROC FEDSQL statement
- SESSREF= procedure option
- CAS system options
- CAS statement
- CASLIB statement
- CAS LIBNAME statement
- DATA step
- CASUTIL procedure

Details

In some cases, some formatting is required before data can be processed successfully. This example explicitly loads three files that contain comma-delimited data into CAS. The CAS LIBNAME engine and the DATA step are used to format and load the tables. Then, after the tables are in CAS, PROC FEDSQL is used to join them and to create a new CAS table that contains the result set. The input files are named Supplier, Nation, and Customer. The output CAS table is named CASDATA.NewTable. All of the CAS tables are in-memory tables. They disappear at the end of the CAS session, unless you save or promote them using PROC CASUTIL.

The example assigns a caslib and a libref. The libref is mapped to the caslib in the CAS LIBNAME statement. The DATA step executes in the libref. When the SESSREF= option is specified in the PROC FEDSQL procedure statement, FedSQL statements are executed in a caslib.

Note: When formatting your FEDSQL requests, be aware that leading spaces before statements and clauses are important. Do not begin statements and clauses flush with the left margin. If you put a line break in a quoted string, always follow the line break with at least one blank.

Program

```
options cashost="cloud.example.com" casport=5570;

cas mysess;
```

```
caslib casdata path='/r/ge.unx.company.com/vol/vol210/u21/myID/hold';

libname mycas cas host="cloud.example.com" port=5570 sessref=mysess
caslib=casdata;

data mycas.supplier;
  infile "/r/ge.unx.company.com/vol/vol210/u21/myID/hold/supplier.tbl"
delimiter='|';
  length S_SUPPKEY 8. S_NAME VARCHAR(25) S_ADDRESS VARCHAR(40)
S_NATIONKEY 8.
S_PHONE VARCHAR(15) S_ACCTBAL 8. S_COMMENT VARCHAR(101);
  input  S_SUPPKEY S_NAME S_ADDRESS S_NATIONKEY S_PHONE S_ACCTBAL
S_COMMENT;
run;

data mycas.nation;
  infile "/r/ge.unx.company.com/vol/vol210/u21/myID/hold/nation.tbl"
delimiter='|';
  length N_NATIONKEY 8. N_NAME VARCHAR(25) N_REGIONKEY 8. N_COMMENT
VARCHAR(152);
  input  N_NATIONKEY N_NAME N_REGIONKEY N_COMMENT;
run;

data mycas.customer;
  infile "/r/ge.unx.company.com/vol/vol210/u21/myID/hold/customer.tbl"
delimiter='|';
  length C_CUSTKEY 8. C_NAME VARCHAR(25) C_ADDRESS VARCHAR(40)
C_NATIONKEY 8.
 C_PHONE VARCHAR(15) C_ACCTBAL 8. C_MKTSEGMENT VARCHAR(10) C_COMMENT
VARCHAR(117);
  input  C_CUSTKEY C_NAME C_ADDRESS C_NATIONKEY C_PHONE C_ACCTBAL
C_MKTSEGMENT
  C_COMMENT;
run;

proc casutil;
  list tables incaslib="casdata";
run;

proc fedsql sessref=mysess;

  create table newtable {options replace=true} as
  select
    s_name, s_acctbal, n_name, sum_c_acctbal
  from
    supplier,
    nation,
    (select c_nationkey, sum(c_acctbal) as sum_c_acctbal from customer
group by
 c_nationkey) C
   where
    s_nationkey = n_nationkey and
    s_nationkey = c_nationkey
  ;

select * from newtable;

quit;
```

Program Description

Invoke the CAS server. The CASHOST= and CASPORT= system options specify the name and port number of the CAS server.

```
options cashost="cloud.example.com" casport=5570;
```

Establish a session on the CAS server. The CAS statement specifies to create a CAS session named MySess.

```
cas mysess;
```

Assign a caslib that points to your input files. The CASLIB statement assigns the caslib CASDATA to the location specified in the PATH= parameter. The path specification must use an absolute pathname.

```
caslib casdata path='/r/ge.unx.company.com/vol/vol210/u21/myID/hold';
```

Assign a CAS engine libref. The LIBNAME statement specifies the libref MyCas, the CAS engine, connection parameters for the CAS server, and the CASDATA caslib. The LIBNAME statement invokes the CAS engine and maps libref to the caslib.

```
libname mycas cas host="cloud.example.com" port=5570 sessref=mysess
caslib=casdata;
```

Use the DATA step to format and load the first file into CAS. The DATA statement specifies to create a table named MyCas.Supplier. The CAS engine creates the output table as a CAS table. In the SAS session, the table is known as MyCas.Supplier. In CAS session MySess, the table is known as CASDATA.Supplier. The INFILE= statement specifies to read the contents of the file using a | (pipe symbol) as a column delimiter. The LENGTH statement specifies column names and lengths for the output table. (Note that the INFILE specification can be relative to the path that is specified in the CASLIB statement.) The CAS engine creates table Supplier in caslib CASDATA.

```
data mycas.supplier;
  infile "/r/ge.unx.company.com/vol/vol210/u21/myID/hold/supplier.tbl"
delimiter='|';
  length S_SUPPKEY 8. S_NAME VARCHAR(25) S_ADDRESS VARCHAR(40)
S_NATIONKEY 8.
S_PHONE VARCHAR(15) S_ACCTBAL 8. S_COMMENT VARCHAR(101);
  input  S_SUPPKEY S_NAME S_ADDRESS S_NATIONKEY S_PHONE S_ACCTBAL
S_COMMENT;
run;
```

Format and load the second file into CAS. This DATA statement specifies to create a CAS table named MyCas.Nation. The INFILE= statement reads the contents of the file using a pipe symbol as a delimiter. The LENGTH statement specifies column names and lengths for the output table. The CAS engine creates table Nation in caslib CASDATA.

```
data mycas.nation;
  infile "/r/ge.unx.company.com/vol/vol210/u21/myID/hold/nation.tbl"
delimiter='|';
  length N_NATIONKEY 8. N_NAME VARCHAR(25) N_REGIONKEY 8. N_COMMENT
VARCHAR(152);
  input  N_NATIONKEY N_NAME N_REGIONKEY N_COMMENT;
run;
```

Format and load the third file into CAS. The DATA step specifies to create a CAS table named MyCas.Customer. The INFILE= statement reads the contents of the file. The LENGTH statement specifies column names and lengths for the output table. The CAS engine creates table Customer in caslib CASDATA.

```
data mycas.customer;
  infile "/r/ge.unx.company.com/vol/vol210/u21/myID/hold/customer.tbl"
delimiter='|';
  length C_CUSTKEY 8. C_NAME VARCHAR(25) C_ADDRESS VARCHAR(40)
C_NATIONKEY 8.
 C_PHONE VARCHAR(15) C_ACCTBAL 8. C_MKTSEGMENT VARCHAR(10) C_COMMENT
VARCHAR(117);
  input  C_CUSTKEY C_NAME C_ADDRESS C_NATIONKEY C_PHONE C_ACCTBAL
C_MKTSEGMENT
  C_COMMENT;
run;
```

Verify that the files were created in CAS. Submit the CASUTIL procedure to list the tables that are available in caslib CASDATA.

```
proc casutil;
  list tables incaslib="casdata";
run;
```

Specify the PROC FEDSQL statement. In the PROC FEDSQL statement, specify the SESSREF= procedure option with the name MySess to connect to the CAS session and direct the FedSQL statements that follow to the fedSQL.execDirect action. Because of earlier activity in the CAS session, CASDATA is the active caslib.

```
proc fedsql sessref=mysess;
```

Submit the FedSQL statements. The fedSql.execDirect action enables you to identify tables in the active caslib using either a one-part or a two-part name. Because the tables already exist in the session, the one-part form is used here. The CREATE TABLE statement specifies to create a table named NewTable using columns from the Supplier, Nation, and Customer tables. The SELECT statement retrieves the columns S_NAME, S_ACCTBAL, N_NAME from the tables and creates a new column SUM_C_ACCTBAL by issuing a subquery. The tables are joined based on the values in the S_NATIONKEY, N_NATIONKEY, and C_NATIONKEY columns. FedSQL combines the data and returns the results in the new CAS table.

```
  create table newtable {options replace=true} as
  select
    s_name, s_acctbal, n_name, sum_c_acctbal
  from
    supplier,
    nation,
    (select c_nationkey, sum(c_acctbal) as sum_c_acctbal from customer
group by
 c_nationkey) C
   where
    s_nationkey = n_nationkey and
    s_nationkey = c_nationkey
  ;
```

Display the contents of table NewTable. The SELECT statement specifies to display the content of CAS table NewTable. NewTable is an in-memory table. To persist or promote it, you must use PROC CASUTIL.

```
select * from newtable;
```

Stop the procedure.

```
quit;
```

Output: Joining Tables That Were Explicitly Loaded into CAS

Output 27.4 *Output of the CASUTIL Procedure LIST Statement*

The CASUTIL Procedure

Table Information for Caslib CASDATA

Table Name	Number of Rows	Number of Columns	NLS encoding	Created	Last Modified	Promoted Table	Repeated Table	View	Compressed
SUPPLIER	10000	7	utf-8	08Jul2016:13:57:25	08Jul2016:13:57:25	No	No	No	No
NATION	25	4	utf-8	08Jul2016:13:57:43	08Jul2016:13:57:43	No	No	No	No
CUSTOMER	150000	8	utf-8	08Jul2016:13:58:14	08Jul2016:13:58:14	No	No	No	No

Output 27.5 *A Portion of the SELECT Results for Table NewTable*

S_NAME	S_ACCTBAL	N_NAME	SUM_C_ACCTBAL
Supplier#000000014	9189.820000	MOROCCO	26625512
Supplier#000000153	850.550000	INDONESIA	27930482
Supplier#000000292	9598.620000	VIETNAM	27081998
Supplier#000000431	9477.340000	CANADA	27025344
Supplier#000000570	922.720000	PERU	26556292
Supplier#000000709	8638.350000	SAUDI ARABIA	26455693
Supplier#000000848	4404.290000	CANADA	27025344
Supplier#000000987	-40.300000	CHINA	26740212
Supplier#000001126	7243.050000	JAPAN	26898469
Supplier#000001265	3986.630000	IRAQ	26919597
Supplier#000001404	5223.720000	ALGERIA	26322970
Supplier#000001543	2107.210000	EGYPT	27100354
Supplier#000001682	9413.980000	CANADA	27025344
Supplier#000001821	7431.290000	VIETNAM	27081998
Supplier#000001960	443.600000	SAUDI ARABIA	26455693
Supplier#000002099	7043.940000	ALGERIA	26322970
Supplier#000002238	5244.930000	JORDAN	26891366
Supplier#000002377	7455.660000	MOZAMBIQUE	27022906
Supplier#000002516	2819.790000	EGYPT	27100354
Supplier#000002655	4856.740000	VIETNAM	27081998
Supplier#000002794	4271.280000	KENYA	27406567
Supplier#000002933	3557.950000	BRAZIL	26821676
Supplier#000003072	7279.730000	INDIA	27293627
Supplier#000003211	8315.050000	UNITED STATES	27316299

Example 8: Joining Tables from Multiple CAS Libraries

Features:
PROC FEDSQL statement
SESSREF= procedure option
FedSQL language statements
CAS system options
CAS statement
CASUTIL procedure
CASLIB statements

Details

This example shows how to perform the join in "Example 2: Joining Tables from Multiple SAS Libraries" on page 1031 on the CAS server. A difference is that this example joins a SAS data set and an SPD Engine data set with a Teradata table instead of an Oracle table.

Invoke the CAS server and start a CAS session. These steps are necessary only if a CAS server connection and a CAS session do not already exist.

```
options cashost="cloud.example.com" casport=5570;
cas mysess;
```

Load the SAS data set Customers into your CAS session. PROC CASUTIL loads the data set into default caslib CASUSERHDFS.

```
proc casutil;
  load data="path-to-customers-data-set" outcaslib="casuserhdfs";
quit;
```

Add an SPD Engine caslib. The CASLIB statement specifies to create caslib spdeCasLib. The caslib specifies SrcType=SPDE and it specifies the path to the directory that contains the metadata file for SPD Engine data set Products.

```
caslib spdecaslib Desc="SPD Engine caslib"
datasource=(srctype="spde", username="",
mdfpath="path-to-metafile",
dataTransferMode="serial");
run;
```

Add a Teradata caslib. This step is necessary only if the caslib has not already been assigned in the CAS session.

```
caslib TDcaslib desc='Teradata Caslib'
   datasource=(srctype='teradata'
      username='myname'
```

```
      password='mypw'
      server='testserver',
      db='test')
      notactive;
```

Submit the join request. The PROC FEDSQL statement specifies the SESSREF= procedure option. The SESSREF= option specifies CAS session MySess. Each table name in the CREATE TABLE statement is identified using a two-part table name. A SELECT statement requests to print the contents of table Results.

```
proc fedsql sessref=mysess;
create table results as
      select products.prodid, products.product, customers.name,
         sales.totals, sales.country
      from spdecaslib.products, TDcaslib.sales, casuserhdfs.customers
      where products.prodid = sales.prodid and
         customers.custid = sales.custid;

select * from results;
quit;
```

Output: Joining Tables from Multiple CAS Libraries

Output 27.6 *Contents of CAS Table Results*

PRODID	PRODUCT	NAME	TOTALS	COUNTRY
3421.000000	Wheat	Qing Ziao	781183	Japan
1424.000000	Corn	Janet Chien	555789	Japan
3975.000000	Barley	Humberto Sertu	899453	Argentina
3421.000000	Wheat	Jim Stewart	2789654	United States
3234.000000	Rice	Peter Frank	189400	United States

28

FMTC2ITM Procedure

Overview: FMTC2ITM Procedure

What Does the FMTC2ITM Procedure Do?

The FMTC2ITM procedure converts one or more format catalogs into a single item store that can be made available to CAS. PROC FMTC2ITM enables you to create an item store that has the following contents:

- all of the formats from one catalog
- a subset of the formats from one catalog
- all of the formats from multiple catalogs
- a subset of the formats from each of multiple catalogs.

After you create an item store with PROC FMTC2ITM, you can use the CAS statement with the addFmtLib action to make the item store available to CAS. For more information, see "CAS Statement" in *SAS Cloud Analytic Services: User's Guide* and addFmtLib Action.

Syntax: FMTC2ITM Procedure

PROC FMTC2ITM <*options*>;
<SELECT *member-list*>;

Statement	Task
PROC FMTC2ITM	Converts one or more format catalogs into a single item store.
SELECT	Lists the formats to be placed in the item store.

PROC FMTC2ITM Statement

Converts one or more format catalogs into a single item store.

Note: The item store is written as a new file. If you specify the name of an existing item store with the ITEMSTORE option, it overwrites the contents of the existing item store.

Syntax

PROC FMTC2ITM <*options*>;

Required Arguments

CATALOG= memname | libname.memname(| list)
specifies a catalog that is to be converted to an item store. If you do not specify the CATALOG option, the default catalog is WORK.FORMATS.

You can specify the following values for the CATALOG option:

- A single-level name that SAS interprets as a catalog name in the WORK library.
- A two-level name that SAS interprets as a libname.memname for a catalog.
- A list enclosed in parentheses that SAS interprets as a list of catalog names.

SAS opens each catalog in the list in the listed order and writes the members of the catalogs to the item store. Only the first occurrence of the member is written. For example, if CATALOG A has members X and Y, and CATALOG B has members X and Z as specified in this code example:

```
proc fmtc2itm catalog=(a b) itemstore='itemstoreA'; run;
```

The resulting item store contains members X and Y from CATALOG A, and member Z from CATALOG B.

ITEMSTORE= fileref | 'filename'
specifies the name of the item store. You can specify a fileref, or you can specify a pathname in quotation marks.

Note: You can specify only one item store with each invocation of PROC FMTC2ITM.

ENCODING=*encoding-name*
specifies an encoding for a catalog or for all of the catalogs in a list.

To specify an encoding for one catalog, specify the ENCODING= option after the catalog name as shown in this example code.

```
proc fmtc2itm cat=(abc.fmtlib1/encoding=utf8 abc.fmtlib2);
```

SAS applies the UTF8 encoding to only the Abc.Fmtlib1 catalog. The Abc.Fmtlib2 catalog uses the session encoding.

To specify an encoding for a list of format catalogs, specify the ENCODING= option at the end of a list of catalogs.

```
proc fmtc2itm cat=(abc.fmtlib1 abc.fmtlib2) encoding=utf8;
```

SAS applies the UTF8 encoding to all of the catalogs in the list.

If you do not specify the ENCODING= option for a catalog, then SAS assigns the session encoding option to the catalog.

PROC FMTC2ITM validates all of the character data (all labels and character range values) in a catalog to ensure that they are valid for the specified encoding. SAS issues an error if any of the characters do not transcode successfully.

Optional Arguments

PRINT
displays information about each catalog member that is written.

LOCALE
adds locale-sensitive prefixes to the names of members of an item store.

If you specify the LOCALE option, then the processing of the parenthetical list of member names is different from the usual processing of member names in a list. If any catalog has a locale suffix (of the form _xx or _xx_yy), then the members from the catalog are written to the item store with that suffix as a prefix. For example, if catalog X_EN_US has members ABC, DEF, and GHI, and catalog X_FR_FR also has members ABC, DEF and JKL as specified in this code example

```
proc fmtc2itm catalog=(x_en_us x_fr_fr) itemstore locale; run;
```

The resulting item store contains the members EN_US-ABC, EN_US-DEF, EN_US-GHI, FR_FR-ABC, FR_FR-DEF, and FR_FR-JKL. A subsequent usage of

the item store in CAS allows for ABC or DEF to be loaded properly based on an EN_US or FR_FR locale. If the LOCALE option is not provided, the item store contains the members ABC, DEF, and GHI from X_EN_US, and member JKL from X_FR_FR.

Note: When you specify PROC FMTC2ITM, your SAS session must use the same encoding that was used when the format catalogs were created. For example, if the EN_US locale was used when the catalogs were created, then the session where you specify PROC FMTC2ITM must also use the EN_US locale.

SELECT Statement

Lists the formats to place in the item store.

Tip: If you do not specify the members of the format catalog with a SELECT statement, then all formats in the catalog are written to the item store.

Syntax

SELECT <*member-list*>;

Optional Argument

member-list
Contains the names of the formats to place in the item store.

Details

The SELECT statement enables you to select only the formats from a format library that you want to add to an item store. For example, if you had a format library that contained the formats CHOICE, SINGLE2, TESTFMTA, WHEN, and WHERE, you could specify the WHEN and WHERE formats with the SELECT statement. The WHEN and WHERE formats are then added to the item store, but the CHOICE, SINGLE2, and TESTFMTA, formats are not added.

Example: Migrate Formats to a CAS Session

Features:

PROC FMTC2ITM statement options
- CATALOG
- ITEMSTORE

CAS statement options
- LOADFORMATS
- LISTFORMAT
- SAVEFMTLIB

Details

This example uses the FMTC2ITM procedure to migrate user-defined formats that are stored in one or more SAS format catalogs to a format library in a CAS session.

Program

```
libname orion "path-to-library";

proc format;
   value $codes
      "A" = "Alpha"
      "B" = "Beta"
      "C" = "Charlie"
      "D" = "Delta";
   value response
      1 = "Yes"
      2 = "No"
      3 = "Undecided"
      4 = "No response";
   value MPGrating
      34  - HIGH = "Excellent"
      24  -< 34  = "Good"
      19  -< 24  = "Fair"
      LOW -< 19  = "Poor";
run;

proc format library=orion.mailfmts;
   value $officeCodes
      "CHI" = "Chicago"
```

```
      "NYC" = "New York"
      "ATL" = "Atlanta"
      "CUP" = "Cupertino";
   value $regionCodes
      "E" = "East"
      "W" = "West"
      "N" = "North"
      "S" = "South";
run;

cas casauto;

proc fmtc2itm
   catalog=(work.formats orion.mailfmts)
   itemstore="path-to-item-store-file";
run;

cas casauto addfmtlib fmtlibname="myfmtlib"
   path=path-to-item-store-file
   replacefmtlib;

cas casauto listformat fmtlibname="myfmtlib"
   members;

cas casauto savefmtlib fmtlibname=myfmtlib
   caslib=casuser table=myfmtlib replace;
```

Program Description

Create the Orion library and add the formats.

```
libname orion "path-to-library";

proc format;
   value $codes
      "A" = "Alpha"
      "B" = "Beta"
      "C" = "Charlie"
      "D" = "Delta";
   value response
      1 = "Yes"
      2 = "No"
      3 = "Undecided"
      4 = "No response";
   value MPGrating
      34  - HIGH = "Excellent"
      24  -< 34  = "Good"
      19  -< 24  = "Fair"
      LOW -< 19  = "Poor";
run;

proc format library=orion.mailfmts;
   value $officeCodes
      "CHI" = "Chicago"
      "NYC" = "New York"
      "ATL" = "Atlanta"
      "CUP" = "Cupertino";
```

```
   value $regionCodes
      "E" = "East"
      "W" = "West"
      "N" = "North"
      "S" = "South";
run;
```

Start a CAS session.

```
cas casauto;
```

Create the item store with the formats. The FMTC2ITM procedure writes the formats in format catalogs Work.Formats and Orion.Mailfmts to an item store file. The CATALOG option specifies to search the format catalogs Work.Formats and Orion.Mailfmts. The ITEMSTORE option specifies the path where the item store is to be written. To select a subset of the formats in the specified format catalogs, specify a SELECT statement in the FMTC2ITM procedure step.

```
proc fmtc2itm
   catalog=(work.formats orion.mailfmts)
   itemstore="path-to-item-store-file";
run;
```

Load the Formats The CAS statement ADDFMTLIB option uses the item store file that you created with the FMTC2ITM procedure to add the format library Myfmtlib.

```
cas casauto addfmtlib fmtlibname="myfmtlib"
   path=path-to-item-store-file
   replacefmtlib;
```

List the formats. The CAS statement LISTFORMAT option lists the formats in format library Myfmtlib to the SAS log for verification.

```
cas casauto listformat fmtlibname="myfmtlib"
   members;
```

Save the format library. The CAS statement SAVEFMTLIB option saves the format library to a SASHDAT file. This step is optional.

For format libraries that you use repeatedly, saving to a caslib is a best practice. Use the CAS statement ADDFMTLIB option with parameters CASLIB= and TABLE= when adding a format library from a caslib.

```
cas casauto savefmtlib fmtlibname=myfmtlib
   caslib=casuser table=myfmtlib replace;
```

29

FONTREG Procedure

Overview: FONTREG Procedure

What Does the FONTREG Procedure Do?

The FONTREG procedure enables you to update the SAS registry to include system fonts, which can then be used in SAS output. PROC FONTREG uses FreeType font-

rendering to recognize and incorporate various types of font definitions. Fonts of any type that can be incorporated and used by SAS are known collectively in this documentation as fonts in the FreeType library.

Note: Including a system font in the SAS registry means that SAS knows where to find the font file. The font file is not actually used until the font is called for in a SAS program. Therefore, do not move or delete font files after you have included the fonts in the SAS registry.

For more information, see the following sources:

- "Specifying Fonts in SAS/GRAPH Programs" in *SAS/GRAPH: Reference*
- "GDEVICE Procedure" in *SAS/GRAPH: Reference*
- "FONTSLOC= System Option" in *SAS System Options: Reference* and "SYSPRINTFONT= System Option" in *SAS System Options: Reference*
- gitlab.freedesktop.org/freetype for information about the FreeType project

Concepts: FONTREG Procedure

Supported Font Types and Font Naming Conventions

When a font is added to the SAS registry, the font name is prefixed with a three-character tag, enclosed in angle brackets (< >). This prefix indicates the font type. For example, if you add the TrueType font **Arial** to the SAS registry, then the name in the registry is **<ttf> Arial**. This naming convention enables you to add and distinguish between fonts that have the same name but are of different types.

When you specify a font in a SAS program, use the three-character tag to distinguish between fonts that have the same name:

```
proc report data=sashelp.class nowd
            style(header)=[font_face='<ttf> Palatino Linotype'];
run;
```

Examples of when you can specify a font in a SAS program are in the TEMPLATE procedure or in the STYLE= option in the PROC REPORT.

If you do not include a tag in your font specification, SAS searches the registry for fonts with that name. If more than one font with that name is found, SAS uses the font that has the highest rank in the following table.

Table 29.1 *Supported Font Types*

Rank	Type	Tag	File Extension
1	TrueType	`<ttf>`	`.ttf`
2	Type1	`<at1>`	`.pfa` `.pfb`
3	OpenType	`<cff>`	`.otf`

Note: OpenType font is an extension of TrueType font and is supported by SAS. OpenType contains the family values for serif, sans-serif, monospace, and symbol fonts. OpenType registers .otf font files.

Note: PDF and PostScript do not support double-byte Type1 fonts.

SAS does not support any type of nonscalable fonts that require FreeType font-rendering. Even if they are recognized as valid fonts, they will not be added to the SAS registry.

Font files that are not produced by major vendors can be unreliable, and in some cases SAS might not be able to use them.

The following SAS output methods and device drivers can use FreeType font-rendering:

- SAS/GRAPH GIF, GIFANIM
- SAS/GRAPH JPEG
- SAS/GRAPH PCL
- SAS/GRAPH PNG
- SAS/GRAPH SASEMF
- SAS/GRAPH SASWMF
- SAS/GRAPH TIFFP, TIFFB
- Universal EMF
- Universal PNG
- Universal Printing GIF
- Universal Printing TIFF
- Universal Printing PCL
- Universal Printing PDF
- Universal PS
- Universal SVG

Registering Fonts with PROC FONTREG

PROC FONTREG is used to register fonts in the SAS Registry. For example, if you have a Type1 or OpenType font in your Windows font directory, you can register the font by submitting the following code:

```
proc fontreg mode=add;
fontpath '!SYSTEMROOT\fonts';
run;
```

This code will register all of the other font files in the Windows font directory.

Removing Fonts from the SAS Registry

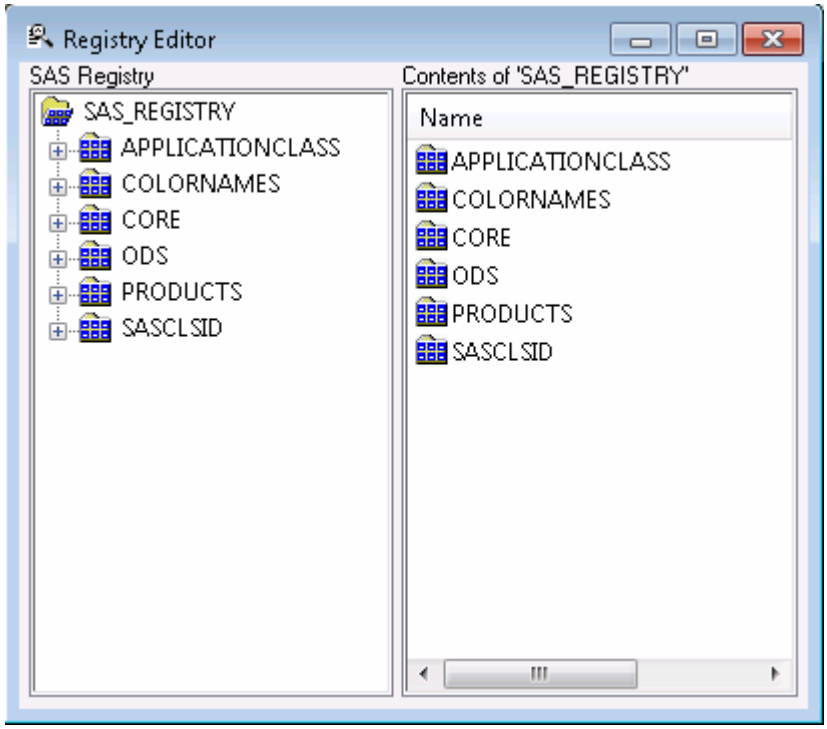
You can remove a font from the SAS registry in the following ways:

- by using the SAS Registry Editor
- by using PROC REGISTRY
- by using the REMOVE statement in PROC FONTREG

To remove a font by using the SAS Registry Editor, select **Solutions** ⇨ **Accessories** ⇨ **Registry Editor**. Alternatively, you can enter `regedit` in the command window or `Command ===>` prompt.

The following display shows the SAS Registry Editor window.

Figure 29.1 *SAS Registry Editor Window*



In the left pane of the Registry Editor window, navigate to the [CORE\PRINTING \FREETYPE\FONTS] key. Select the font that you want to delete, and use one of these methods to delete it:

- Right-click the font name and select **Delete** from the menu.
- Select the **Delete** button  .
- Select **Edit** ⇨ **Delete** ⇨ **Key**.

To delete a font by using PROC REGISTRY, submit a program similar to the following example. This example removes the **<ttf> Arial** font.

```
   /* Write the key name for the font to an external file */
proc registry export='external-filename'
              startat='core\printing\freetype\fonts\<ttf> Arial';
run;

   /* Remove the "<ttf> Arial" font from the SAS registry */
proc registry
uninstall='external-filename' fullstatus;
run;
```

To delete a font by using the REMOVE statement in PROC FONTREG, see "REMOVE Statement" on page 1067.

For more information about PROC REGISTRY, see Chapter 57, "REGISTRY Procedure," on page 2027.

Using a Fileref with PROC FONTREG

You can use a fileref with the FONTPATH, TRUETYPE, TYPE1, and OPENTYPE statements in PROC FONTREG, if you first define a filename. The following examples show how a fileref is used:

```
filename fonts1 'c:\windows\fonts';
proc fontreg mode=all;
   fontpath fonts1;
run;

proc fontreg mode=all;
   truetype fonts1;
run;
```

The ability to use a fileref enables you to directly use the FILENAME statement and its features. For example, you can register available fonts by using a URL. With fileref support, you would use a FILENAME statement and a PROC FONTREG step.

Font Aliases and Locales

The FONTFILE, FONTPATH, TRUETYPE, and OPENTYPE statements support aliases and locales. If the font that is being processed contains a localized name in the same locale as the current SAS session, then an alias of that localized name will be added to the SAS registry to reference the font family.

Syntax: FONTREG Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Interaction: If no statements are specified, then PROC FONTREG searches for TrueType font files in the directory that is indicated in the FONTSLOC= SAS system option.

Note: For z/OS sites that do not use the hierarchical file system (HFS), only the FONTFILE statement is supported. For more information, see "FONTREG Procedure Statement: z/OS" in *SAS Companion for z/OS*.

Tip: If you specify more than one statement, then the statements are executed in the order in which they appear, except for REMOVE statements, which are always executed first. You can use the same statement more than once in a single PROC FONTREG step.

See: "FONTREG Procedure Statement: z/OS" in *SAS Companion for z/OS*

PROC FONTREG <*options*>;

FONTFILE '*file*' <...'*file*'> | '*file-1*, *pfm-file-1*, *afm-file-1*' <...'*file-n*'> ||;

FONTPATH <*fileref*> '*directory*' <...'*directory*'>;

OPENTYPE <*fileref*> '*directory*' <...'*directory*'>

REMOVE '*family-name*' | '*alias*' | *family-type* | _ALL_;

TRUETYPE <*fileref*> '*directory*' <...'*directory*'>;

TYPE1 <*fileref*> '*directory*' <...'*directory*'>;

Statement	Task
PROC FONTREG	Specify how to handle new and existing fonts
FONTFILE	Identify which font files to process
FONTPATH	Search directories to identify valid font files to process
REMOVE	Remove a font family, all fonts of a particular type, or all fonts from the Core\Printing\Freetype\Fonts location of the SAS registry
TRUETYPE	Search directories to identify TrueType font files
TYPE1	Search directories to identify valid Type 1 font files
OPENTYPE	Search directories to identify valid OpenType font files

PROC FONTREG Statement

Enables you to update the SAS registry to include system fonts, which can then be used in SAS output.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Syntax

PROC FONTREG <*options*>;

Summary of Optional Arguments

MODE=ADD | REPLACE | ALL
: specifies how to handle new and existing fonts.

MSGLEVEL=VERBOSE | NORMAL | TERSE | NONE
: specifies the level of detail to include in the SAS log.

NOUPDATE
: specifies that the procedure should run without updating the SAS registry.

USESASHELP
: specifies that the SAS registry in the Sashelp library be updated.

Optional Arguments

MODE=ADD | REPLACE | ALL
specifies how to handle new and existing fonts in the SAS registry:

ADD
specifies to add fonts that do not already exist in the SAS registry. Do not modify existing fonts.

REPLACE
specifies to replace fonts that already exist in the SAS registry. Do not add new fonts.

ALL
specifies to add new fonts that do not already exist in the SAS registry and replace fonts that already exist in the SAS registry.

Default ADD

Example "Example 3: Replacing Existing TrueType Font Files from a Directory" on page 1073

MSGLEVEL=VERBOSE | NORMAL | TERSE | NONE
specifies the level of detail to include in the SAS log.

Here are the levels:

VERBOSE
SAS log messages include which fonts were added, which fonts were not added, and which fonts were not understood. The log also contains a summary that indicates the number of fonts that were added, not added, and not understood.

NORMAL
SAS log messages include which fonts were added, and a summary that indicates the number of fonts that were added, not added, and not understood.

TERSE
SAS log messages include only the summary that indicates the number of fonts that were added, not added, and not understood.

NONE
No messages are written to the SAS log, except for errors (if encountered).

Default TERSE

Example "Example 2: Adding All Font Files from Multiple Directories" on page 1071

NOUPDATE
specifies that the procedure should run without actually updating the SAS registry. This option enables you to test the procedure on the specified fonts before modifying the SAS registry.

USESASHELP
specifies that the SAS registry in the Sashelp library should be updated. You must have Write access to the Sashelp library in order to use this option. If the USESASHELP option is not specified, then the SAS registry in the Sasuser library is updated.

FONTFILE Statement

Specifies one or more font files to be processed.

See: "Example 1: Adding a Single Font File" on page 1070

Syntax

FONTFILE '*file*' <...'*file*'> | '*file-1*, *pfm-file-1*, *afm-file-1*' <...'*file-n*'>;

Required Arguments

file
is the complete pathname to a font file. If the file is recognized as a valid font file, then the file is processed. Each pathname must be enclosed in quotation marks. If you specify more than one pathname, then you must separate the pathnames with a space.

pfm-file
specifies a file specific to Windows that contains font metrics as well as the value of the Windows font name.

afm-file
specifies a file that contains font metrics.

Details

Processing a Type1 Font

When a valid Type1 font is processed by the TYPE1 statement or the FONTPATH statement, SAS attempts to find a corresponding PFM or AFM font metric file in the same directory that contains the font file. The font filename prefix is used with the .PFM and .AFM extensions to generate metric filenames. If these files are opened successfully and are determined to be valid metric files, then they will be associated with the font in the font family when they are added to the SAS registry.

If you specify a Type1 font in the FONTFILE statement, and you do not specify a PFM or AFM file, then SAS does not search for the PFM or AFM files.

Specifying a PFM or AFM File

If the font file contains a Type1 font, then you can also specify its corresponding PFM or AFM file as well. You must specify the full host name (directory and filename) for each file, and all files must be grouped together and enclosed in quotation marks, as in this example:

```
fontfile 'c:\winnt\fonts\alpinerg.pfb,
          c:\winnt\fonts\alpinerg.pfm,
          c:\winnt\fonts\alpinerg.afm';
```

If you specify an AFM file but do not specify a PFM file, then you must use a comma as a placeholder for the missing PFM file, as in this example:

```
fontfile 'c:\winnt\fonts\alpinerg.pfb, ,
c:\winnt\fonts\alpinerg.afm';
```

If you specify a PFM file but do not specify an AFM file, then you do not need a comma as a placeholder for the missing AFM file, as in this example:

```
fontfile 'c:\winnt\fonts\alpinerg.pfb,
c:\winnt\fonts\alpinerg.pfm';
```

When you specify a PFM or AFM file, SAS attempts to open the file and determine whether the file is of the specified type. If it is not, then SAS writes a message to the log and the file is not used.

The PFM file is a file that is specific to Windows, and contains font metrics as well as a value for the Windows Font Name field. If you specify a valid PFM file, then SAS opens the file, retrieves the value in Windows Font Name, and saves it with the font in the SAS registry. SAS uses this field when it creates a file (such as an EMF formatted file) to export into a Windows application.

Not Specifying a PFM or AFM File

You do not need to specify a PFM or AFM file along with a Type1 font file in a FONTFILE statement. In this case, no metric file information is added to the font in the font family in the SAS registry. If an existing font family that contains multiple styles and weights already exists in the SAS registry, and the FONTFILE statement is used to replace one of the fonts in that family, then all of the information for that font will be updated. The replacement also updates the Host Filename, PFM Name, AFM Name, and Windows Font Name.

Note: If you replace a font in a family and the font contains values for the PFM Name or AFM Name, specifying a missing or invalid value for the metric in the FONTFILE statement causes the corresponding metric value to be deleted from the font in the registry.

Note: You cannot use a PFM or AFM file specification if you specify a TrueType font.

FONTPATH Statement

Specifies one or more directories to be searched for valid font files to process.

See: "Example 2: Adding All Font Files from Multiple Directories" on page 1071

Syntax

FONTPATH <*fileref*> '*directory*' <...'*directory*'>;

Required Argument

directory
specifies a directory to search. All files that are recognized as valid font files are processed. Each directory must be enclosed in quotation marks. If you specify more than one directory, then you must separate the directories with a space.

Operating Environment Information: In the Windows operating environment only, you can locate the fonts folder if you do not know where the folder resides.

In addition, you can register system fonts without having to know where the fonts are located. To find this information, submit the following program:

```
proc fontreg;
    fontpath "%sysget(systemroot)\fonts";
run;
```

The %SYSGET macro retrieves the value of the Windowing environment variable SYSTEMROOT, and resolves to the location of your system directory. The fonts subdirectory is located one level below the system directory.

Optional Argument

fileref
specifies a fileref to use with the FONTPATH statement.

REMOVE Statement

Removes a font family, all fonts of a particular type (such as TrueType or Type1), or all fonts from the Core\Printing\Freetype\Fonts location of the SAS registry.

Syntax

REMOVE '*family-name*' | '*alias*' | *family-type* | _ALL_;

Required Arguments

family-name
specifies the family name of the font that you want to remove from the Core\Printing\Freetype\Fonts key in the SAS registry. Enclose *family-name* in quotation marks if the value contains one or more spaces.

alias
specifies an alternative name, usually in a shortened form, for *family-name*. Enclose the alias name in quotation marks if the value contains one or more spaces.

Note The valid values that can be specified as an alias are listed in the Core\Printing\Alias\Fonts\Freetype key in the SAS registry.

family-type
specifies the name of a font type (such as TrueType or Type1) that SAS supports and that you want removed from the SAS registry.

Note: The font type is not removed from the operating system location in which they reside. The registration of the font type from the SAS registry is removed so that SAS does not recognize the fonts.

ALL
specifies that all font families in the Core\Printing\Freetype\Fonts key in the SAS registry will be deleted.

Details

Removing Fonts from the Registry

The REMOVE statement removes a font family, all fonts of a particular type, or all fonts from the **Core\Printing\Freetype\Fonts** location in the SAS registry. If you specify the USESASHELP procedure option, then fonts are removed from the Sashelp portion of the registry. If you do not specify USESASHELP, then fonts are removed from the Sasuser portion of the registry. Removal from the Sasuser portion of the registry is the default.

Note that when you specify the *family-name* argument in the REMOVE statement, SAS removes font families rather than individual fonts within the family. For example, you might register several fonts within the **Arial** family. When you use the `REMOVE Arial;` statement, all fonts in the **Arial** family are removed from the registry. Similarly, when you specify the *family-type* argument and use the `REMOVE Type1;` statement, all Type1 font families are removed from the registry.

The Order in Which Fonts Are Added or Removed

Fonts are removed from the SAS registry before any fonts are added or replaced in the registry using other procedure statements. The REMOVE statement removes a font family from the registry as soon as the statement is processed. Other font statements, such as FONTFILE, FONTPATH, TRUETYPE, and TYPE1, are processed in the order in which they are received. The font information is stored until all of the statements are processed. SAS then updates the registry.

Searching for a Font That Is Specified in the REMOVE Statement

If the name that you specify in a REMOVE statement does not exist, then SAS adds a font tag prefix (for example, <ttf>) to the specified name to determine whether it exists in the SAS registry. For example, if you specify **Arial**, SAS uses the <ttf> prefix tag and first searches for a TrueType font type so that it can be removed from the registry. If the search is not successful, then SAS uses the <at1> prefix tag and searches for a Type1 font type so that it can be removed from the registry.

When SAS Is Unable to Remove a Font Family

If SAS is unable to remove a font family after processing the information in the _ALL_, *family-type*, or *family-name* arguments, then SAS looks in the Core\Printing\Alias\Fonts\Freetype key in the SAS registry to determine whether the specified value is an alias. If the specified value exists as an alias in this key, then SAS deletes the font family that corresponds to the alias and deletes the alias as well. For example, if an alias of Test refers to the **Arial** font family, and you specify the `REMOVE test;` statement with PROC FONTREG, then SAS determines

that Test is an alias for **Arial**. SAS removes the **Arial** font family from the **Core\Printing\Freetype\Fonts** key and the Test alias from the **Core\Printing\Alias\Fonts\Freetype** key in the SAS registry.

If SAS is unable to remove a font family at this point, then SAS writes a message to the log indicating that the specified value in the REMOVE statement is invalid.

TRUETYPE Statement

Specifies one or more directories to be searched for TrueType font files.

See: "Example 3: Replacing Existing TrueType Font Files from a Directory" on page 1073

Syntax

TRUETYPE <*fileref*> '*directory*' <...'*directory*'>;

Required Argument

directory
specifies a directory to search. Only files that are recognized as valid TrueType font files are processed. Each directory must be enclosed in quotation marks. If you specify more than one directory, then you must separate the directories with a space.

Optional Argument

fileref
specifies a fileref to use with the TRUETYPE statement.

TYPE1 Statement

Specifies one or more directories to be searched for valid Type1 font files.

Syntax

TYPE1 <*fileref*> '*directory*' <...'*directory*'>;

Required Argument

directory
specifies a directory to search. Only files that are recognized as valid Type1 font files are processed. Each directory must be enclosed in quotation marks. If you

specify more than one directory, then you must separate the directories with a space.

Optional Argument

fileref
specifies a fileref to use with the TYPE1 statement.

OPENTYPE Statement

Specifies one or more directories to be searched for valid OpenType font files.

Syntax

OPENTYPE <*fileref*> '*directory*' <...'*directory*'>;

Required Argument

directory
specifies a directory to search. Only files that are recognized as valid OpenType font files are processed. Each directory must be enclosed in quotation marks. If you specify more than one directory, then you must separate the directories with a space.

Optional Argument

fileref
specifies a fileref to use with the OPENTYPE statement.

Examples: FONTREG Procedure

Example 1: Adding a Single Font File

Features: FONTFILE statement

Details

This example shows how to add a single font file to the SAS registry. The FONTFILE statement specifies the complete path to a single font file.

Program

```
proc fontreg;
   fontfile '<ttf> Arial';
run;
```

Log

Example Code 29.1 *Adding a Single Font File to the SAS Registry*

```
SUMMARY:
  Files processed: 1
  Unusable files: 0
  Files identified as fonts: 1
  Fonts that were processed: 1
  Fonts replaced in the SAS registry: 0
  Fonts added to the SAS registry: 1
  Fonts that could not be used: 0
  Font Families removed from SAS registry: 0
```

Example 2: Adding All Font Files from Multiple Directories

Features: MSGLEVEL= option
FONTPATH statement

Details

This example shows how to add all valid font files from two different directories and how to write detailed information to the SAS log.

Program

```
proc fontreg msglevel=verbose;

fontpath 'your-font-directory-1' 'your-font-directory-2';
run;
```

Program Description

Write complete details to the SAS log. The MSGLEVEL=VERBOSE option writes complete details about what fonts were added, what fonts were not added, and what font files were not understood.

```
proc fontreg msglevel=verbose;
```

Specify the directories to search for valid fonts. You can specify more than one directory in the FONTPATH statement. Each directory must be enclosed in quotation marks. If you specify more than one directory, then you must separate the directories with a space.

```
fontpath 'your-font-directory-1' 'your-font-directory-2';
run;
```

Log

Example Code 29.2 *Messages from Adding All Font Files from Multiple Directories*

```
1    proc fontreg msglevel=verbose;
2    fontpath 'your-font-directory-1'
3             'your-font-directory-2';
4    run;

ERROR: FreeType base module FT_New_Face -- unknown file format.
ERROR: A problem was encountered with file
"your-font-directory-2\MODERN.FON".

. . .  more log entries . . .

WARNING: The "Sasfont" font in file
         "your-font-directory-2\SAS1252.FON" is non-scalable.     Only scalable
fonts are supported.

. . .  more log entries . . .

NOTE: The font "Albertus Medium" (Style: Regular, Weight: Normal) has been
      added to the SAS Registry at
      [CORE\PRINTING\FREETYPE\FONTS\<ttf>Albertus Medium]. Because it is a
      TRUETYPE font, it can be referenced as "Albertus Medium" or
      "<ttf>Albertus Medium" in SAS. The font resides in file
      "your-font-directory-1\albr55w.ttf".

. . .  more log entries . . .

WARNING: The font "Georgia" (Style: Regular, Weight: Normal) will not be added
because it already exists in the "<ttf>Georgia" font family of the SAS Registry.

. . .  more log entries . . .

SUMMARY:
  Files processed: 138
  Unusable files: 3
  Files identified as fonts: 135
  Fonts that were processed: 135
  Fonts replaced in the SAS registry: 0
  Fonts added to the SAS registry: 91
  Fonts that could not be used: 44
  Font Families removed from SAS registry: 0

NOTE: PROCEDURE FONTREG used (Total process time):
      real time           27.81 seconds
      cpu time            1.18 seconds
```

Example 3: Replacing Existing TrueType Font Files from a Directory

Features: MODE= option
TRUETYPE statement

Details

This example reads all the TrueType fonts in the specified directory and replaces the ones that already exist in the SAS registry.

Program

```
proc fontreg mode=replace;
   truetype 'your-font-directory';
run;
```

Program Description

Replace existing fonts only. The MODE=REPLACE option limits the action of the procedure to replacing fonts that are already defined in the SAS registry. New fonts will not be added.

```
proc fontreg mode=replace;
```

Specify a directory that contains TrueType font files. Files in the directory that are not recognized as being TrueType font files are ignored.

```
   truetype 'your-font-directory';
run;
```

Log

Example Code 29.3 *Replacing Existing TrueType Font Files from a Directory*

```
SUMMARY:
  Files processed: 49
  Unusable files: 3
  Files identified as fonts: 46
  Fonts that were processed: 40
  Fonts replaced in the SAS registry: 40
  Fonts added to the SAS registry: 0
  Fonts that could not be used: 0
  Font Families removed from SAS registry: 0
```

30

FORMAT Procedure

Overview: FORMAT Procedure

What Does the FORMAT Procedure Do?

The FORMAT procedure enables you to define your own informats and formats for variables. In addition, you can perform these actions:

- print the parts of a catalog that contain informats or formats
- store descriptions of informats or formats in a SAS data set
- use a SAS data set to create informats or formats.

Format Encodings in SAS Viya

SAS Viya supports only UTF-8 encoding.

When you store formats in a library, SAS uses the session encoding in which the formats were created. If the original encoding is not UTF-8, then truncation of characters might occur if you convert the format library to an encoding that requires more bytes to represent the characters.

Note: Moving format libraries between previous versions of SAS and CAS might have some risk. SAS recommends that you use CNTLOUT data sets to reduce this risk.

For more information about using format libraries in SAS Viya, see *Migrating Data to UTF-8 for SAS Viya* and *SAS Viya FAQ for Processing UTF-8 Data*.

What Are Formats and Informats?

Informats determine how raw data values are read and stored. Formats determine how variable values are printed. For simplicity, this section uses the terminology the informat converts and the format prints.

Informats and formats tell SAS the data's type (character or numeric) and form (such as how many bytes it occupies; decimal placement for numbers; how to handle leading, trailing, or embedded blanks and zeros; and so on). SAS provides informats and formats for reading and writing variables. For a thorough description of informats and formats that SAS provides, see *SAS Formats and Informats: Reference*.

With informats, you can do the following:

- Convert a number to a character string (for example, convert 1 to **YES**).
- Convert a character string to a different character string (for example, convert **'YES'** to **'OUI'**).
- Convert a character string to a number (for example, convert **YES** to 1).
- Convert a number to another number (for example, convert 0–9 to 1, 10–100 to 2, and so on).

Note: User-defined informats read-only character data. They can convert character values into real numeric values, but they cannot convert real numbers into characters.

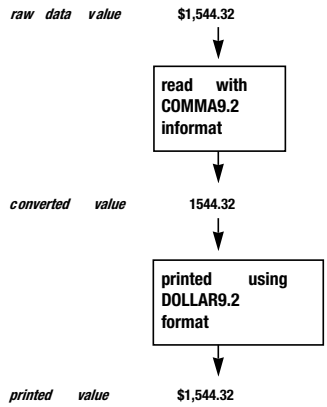
With formats, you can do the following:

- Print numeric values as character values (for example, print 1 as **MALE** and 2 as **FEMALE**).
- Print one character string as a different character string (for example, print **YES** as **OUI**).
- Print numeric values using a template (for example, print 9458763450 as **945-876-3450**).

How Are Formats and Informats Associated with a Variable?

The following figure summarizes what occurs when you associate an informat and format with a variable. The COMMA*w.d* informat and the DOLLAR*w.d* format are provided by SAS.

Figure 30.1 Associating an Informat and a Format with a Variable



In the figure, SAS reads the raw data value that contains the dollar sign and comma. The COMMA9.2 informat ignores the dollar sign and comma and converts the value to 1544.32. The DOLLAR9.2 format prints the value, adding the dollar sign and comma. For more information about associating informats and formats with variables, see "Associating Informats and Formats with Variables " on page 1078.

Concepts: FORMAT Procedure

Associating Informats and Formats with Variables

Methods of Associating Informats and Formats with Variables

The following table summarizes the different methods for associating informats and formats with variables.

Table 30.1 *Associating Informats and Formats with Variables*

Step	Informats	Formats
In a DATA step	Use the ATTRIB or INFORMAT statement to permanently associate an informat with a variable. Use the INPUT function or INPUT statement to associate the informat with the variable only for the duration of the DATA step.	Use the ATTRIB or FORMAT statement to permanently associate a format with a variable. Use the PUT function or PUT statement to associate the format with the variable only for the duration of the DATA step.
In a PROC step	The ATTRIB and INFORMAT statements are valid in Base SAS procedures. However, in Base SAS software, typically you do not assign informats in PROC steps because the data has already been read into SAS variables.	Use the ATTRIB statement or the FORMAT statement to associate formats with variables. If you use either statement in a procedure that produces an output data set, then the format is permanently associated with the variable in the output data set. If you use either statement in a procedure that does not produce an output data set or modify an existing data set, the statement associates the format with the variable only for the duration of the PROC step.

Differences between the FORMAT Statement and PROC FORMAT

Do not confuse the FORMAT statement with the FORMAT procedure. The FORMAT and INFORMAT statements associate an existing format or informat (either standard SAS or user-defined) with one or more variables. PROC FORMAT creates user-defined formats or informats.

Assigning Formats and Informats to a Variable

Assigning your own format or informat to a variable is a two-step process:

1. creating the format or informat with the FORMAT procedure
2. assigning the format or informat with the ATTRIB, FORMAT,or INFORMAT statements, or the INPUT or PUT functions

For complete documentation on the ATTRIB, INFORMAT, and FORMAT statements, see *SAS DATA Step Statements: Reference*. For complete documentation on the

INPUT and PUT functions, see *SAS Functions and CALL Routines: Reference*. For more information and example of using formats in Base SAS procedures, see "Formatted Values" on page 63 .

Storing Informats and Formats

Format Catalogs

PROC FORMAT stores user-defined informats and formats as entries in SAS catalogs.[1] You use the LIBRARY= option in the PROC FORMAT statement to specify the catalog. If you omit the LIBRARY= option, then formats and informats are stored in the Work.Formats catalog. If you specify LIBRARY=*libref* but do not specify a catalog name, then formats and informats are stored in the *libref*.FORMATS catalog. Note that this use of a one-level name differs from the use of a one-level name elsewhere in SAS. With the LIBRARY= option, a one-level name indicates a library; elsewhere in SAS, a one-level name indicates a file in the WORK library.

The name of the catalog entry is the name of the format or informat. The entry types are as follows:

- FORMAT for numeric formats
- FORMATC for character formats
- INFMT for numeric informats
- INFMTC for character informats

Temporary Informats and Formats

Informats and formats are temporary when they are stored in a catalog in the WORK library. If you omit the LIBRARY= option, then PROC FORMAT stores the informats and formats in the temporary catalog Work.Formats. You can retrieve temporary informats and formats only in the same SAS session or job in which they are created. To retrieve a temporary format or informat, simply include the name of the format or informat in the appropriate SAS statement. SAS automatically looks for the format or informat in the Work.Formats catalog.

1. Catalogs are a type of SAS file and reside in a SAS library. If you are unfamiliar with the types of SAS files or the SAS library structure, then see the section on SAS files in *SAS Language Reference: Concepts*.

Permanent Informats and Formats

If you want to use a format or informat that is created in one SAS job or session in a subsequent job or session, then you must permanently store the format or informat in a SAS catalog.

You permanently store informats and formats by using the LIBRARY= option in the PROC FORMAT statement. See the discussion of the LIBRARY= option in the PROC FORMAT Statement on page 1085.

Accessing Permanent Informats and Formats

After you have permanently stored an informat or format, you can use it in later SAS sessions or jobs. If you associate permanent informats or formats with variables in a later SAS session or job, then SAS must be able to access the informats and formats. Thus, you must use a LIBNAME statement to assign a libref to the library that stores the catalog that stores the informats or formats.

SAS uses one of two methods when searching for user-defined formats and informats:

- By default, SAS always searches a library that is referenced by the Library libref for a FORMATS catalog. If you have only one format catalog, then do the following:
  1. Assign the Library libref to a SAS library in the SAS session in which you are running the PROC FORMAT step.
  2. Specify the option `library=library` in the PROC FORMAT statement. PROC FORMAT stores the informats and formats that are defined in that step in the Library.Formats catalog.
  3. In the SAS program that uses your user-defined formats and informats, include a LIBNAME statement to assign the Library libref to the library that contains the permanent format catalog.
- If you have more than one format catalog, or if the format catalog is named something other than Formats, then do the following:
  1. Assign a libref to a SAS library in the SAS session in which you are running the PROC FORMAT step.
  2. Specify the option `library=`*`libref`* or `library=`*`libref.catalog`* in the PROC FORMAT step, where *libref* is the libref that you assigned in step 1.
  3. In the SAS program that uses your user-defined formats and informats, use the FMTSEARCH= option in an OPTIONS statement, and include *libref* or *libref.catalog* in the list of format catalogs.

The syntax for specifying a list of format catalogs to search is

OPTIONS FMTSEARCH=(*catalog-specification-1*<*catalog-specification-2* ... >);

Each *catalog-specification* can be *libref* or *libref.catalog*. If only *libref* is specified, then SAS assumes that the catalog name is Formats.

When searching for a format or informat, SAS always searches in Work.Formats first, and then Library.Formats, unless one of them appears in the FMTSEARCH= list. SAS searches the catalogs in the FMTSEARCH= list in the order in which they are listed until the format or informat is found.

For more information, see "FMTSEARCH= System Option" in *SAS System Options: Reference*. For an example that uses the LIBRARY= and FMTSEARCH= options together, see "Example 17: Writing Ranges for Character Strings" on page 1187.

Missing Informats and Formats

If you reference an informat or format that SAS cannot find, then you receive an error message and processing stops unless the SAS system option NOFMTERR is in effect. When NOFMTERR is in effect, SAS uses the *w.* or $*w.* default format to print values for variables with formats that it cannot find. For example, to use NOFMTERR, use this OPTIONS statement:

```
options nofmterr;
```

For more information, see "FMTERR System Option" in *SAS System Options: Reference*.

If SAS encounters a missing variable to format using a user-defined format and the MISSING= system option defines a character to be printed for missing values, the missing value is determined as follows:

- If the user-defined format or informat has a value-range-set for missing values, the missing value is defined by the user-defined format.
- If the user-defined format does not have a value-range-set defined for missing values, the missing value is defined by the MISSING= system option. The default value for the MISSING= system option is . (period).

Printing Informats and Formats

The output that is provided when you use the FMTLIB option in the PROC FORMAT statement is intended to present a brief view of the informat and format values.

Instead of using the FMTLIB option, you can use the CNTLOUT= option to create an output data set that stores information about informats and formats. You can then use PROC PRINT or PROC REPORT to print the data set. In this case, labels are not truncated.

Note: You can use data set options to keep or drop references to additional variables that were added by using the CNTLOUT= option.

Using Formats in a CAS Session

PROC FORMAT supports creating format libraries in catalogs in a SAS client session and loading format libraries to a SAS Cloud Analytic Services (CAS) session. When you use the SESSREF system option to specify a CAS session, and you also specify the CASFMTLIB option, then PROC FORMAT loads the format libraries to the specified CAS session. Otherwise, PROC FORMAT stores the format libraries where the SAS client session is running. For more information, see "CASFMTLIB='*name*'" on page 1086.

The SAS client session and the CAS session can interact through the session reference that you establish with the SESSREF system option or the SESSREF argument in the CASLIB statement. When you use a SAS language element that can take advantage of processing in CAS, the session reference identifies where that processing should occur. If you do not specify a session reference, then processing occurs in the client session. If the language element is not supported in CAS, then processing occurs in the client session.

For more information about SESSREF, see:

- "SESSREF= System Option" in *SAS Cloud Analytic Services: User's Guide*
- "CASLIB Statement" in *SAS Cloud Analytic Services: User's Guide*

For more information about using formats in a CAS session, see:

- "Example 1: Create a Format Library in a CAS Session" on page 1143
- "Using User-Defined Formats In SAS Cloud Analytic Services" in *SAS Cloud Analytic Services: User-Defined Formats*

A Binary Search Determines the User-Defined Format or Informat for a Value

PROC FORMAT uses a binary search to determine the correct user-defined format or informat to use for a value. In comparison, using IF-THEN/ELSE statements is essentially a sequential search for a value. Because of the search method that the binary search uses, PROC FORMAT can provide a more efficient search for making a large number of comparisons.

Here are some user-defined format values that could be written using PROC FORMAT:

```
1='Yes'
2='No'
3='Possibly'
```

If you use these IF-THEN/ELSE statements, SAS begins searching with the first value in the range, `x=1`, and steps through the values until it finds a matching value.

This type of search can be more efficient if the value that you want is near the beginning of the range of values.

```
if x=1 then label='Yes';
else if x=2 then label='No';
else if x=3 then label='Possibly';
```

If you are searching for the value 3, there will be 3 comparisons before a match is found. If you are searching for the value 1, there will be only one comparison made.

If you use the VALUE statement of PROC FORMAT, SAS begins searching at the middle value in the range. In this example, SAS begins by comparing the value to the middle range value, `2='No'`. It then compares the value to the higher range, value `3="Possibly"`, and then compares the value to the lower range value, `1="Yes"`.

```
value
    1="Yes"
    2="No"
    3="Possibly";
```

A binary search like PROC FORMAT uses is more efficient when the range has a large number of values to search.

Syntax: FORMAT Procedure

Restrictions:

You cannot use a SELECT statement and an EXCLUDE statement within the same PROC FORMAT step.

When the CASFMTLIB option is specified, the SELECT and EXCLUDE statements ignore format libraries in SAS Cloud Analytics Services (CAS) sessions and refer only to catalogs.

Formats that are not enabled for threaded-kernel processing are not written to CAS.

Informats cannot be written to a CAS session. Informats included in your SAS code are ignored.

Formats that use functions-as-labels or formats-as-labels cannot be written to CAS.

Tips:

User–defined format names cannot end in a number. For more information, see "User-Defined Formats" in *SAS Formats and Informats: Reference* and "Names in the SAS Language" in *SAS Language Reference: Concepts*.

You can use appropriate global statements with this procedure. See "Global Statements" on page 25 for a list.

For information about generating a list of user-defined formats that are related to a SAS library, see the documentation for the %UDFSEL macro in *SAS Cloud Analytic Services: User-Defined Formats*.

See:

"Using Formats in a CAS Session" on page 1083

"FORMAT Procedure Statement: z/OS" in *SAS Companion for z/OS*

PROC FORMAT <*options*>;

EXCLUDE *entry(s)*;

INVALUE <$>*name* <(*informat-options*)> <*value-range-set(s)*>;

PICTURE *name* <(*format-options*)>
<*value-range-set-1* <(*picture-1-options*)>
<*value-range-set-2* <(*picture-2-options*)>> ...>;

SELECT *entry(s)*;

VALUE <$>*name* <(*format-options*)> <*value-range-set(s)*>;

Statement	Task	Example
PROC FORMAT	Define formats and informats for variables	Ex. 3, Ex. 13, Ex. 15, Ex. 16
EXCLUDE	Exclude catalog entries from processing by the FMTLIB and CNTLOUT= options	
INVALUE	Create an informat for reading and converting raw data values	Ex. 12
PICTURE	Create a template for printing numbers	Ex. 3, Ex. 5, Ex. 18
SELECT	Select catalog entries for processing by the FMTLIB and CNTLOUT= options	Ex. 15
VALUE	Create a format that specifies character strings to use to print variable values	Ex. 8, Ex. 11, Ex. 17

PROC FORMAT Statement

Creates user-specified formats and informats for variables.

Tips:

User–defined format names cannot end in a number. For more information, see "User-Defined Formats" in *SAS Formats and Informats: Reference* and "Names in the SAS Language" in *SAS Language Reference: Concepts*.

You can use data set options with the CNTLIN= and CNTLOUT= data set options. See "Data Set Options" on page 23 for a list.

Moving catalogs between previous versions of SAS and CAS might have some risk. SAS recommends that you use CNTLOUT data sets to reduce this risk.

Examples:

"Example 3: Creating a Picture Format" on page 1150

"Example 13: Creating a Format from a CNTLIN= Data Set" on page 1173

"Example 15: Printing the Description of Informats and Formats" on page 1183

"Example 16: Retrieving a Permanent Format" on page 1185

Syntax

PROC FORMAT <*options*>;

Summary of Optional Arguments

CASFMTLIB='*name*'
: adds a format library to a CAS session.

CNTLIN=*input-control-SAS-data-set*
: specifies a SAS data set from which PROC FORMAT builds informats or formats.

CNTLOUT=*output-control-SAS-data-set*
: creates a SAS data set that stores information about informats or formats that are contained in the catalog specified in the LIBRARY= option.

FMTLIB
: prints information about informats or formats in the catalog that is specified in the LIBRARY= option.

LIBRARY=*libref<.catalog>*
: specifies a SAS library or catalog that contains the informats or formats that you are creating in the PROC FORMAT step.

LOCALE
: specifies to create a format catalog that corresponds to the current SAS locale.

MAXLABLEN=*number-of-characters*
: specifies the number of characters of the informatted or formatted value that appear in PROC FORMAT output.

MAXSELEN=*number-of-characters*
: specifies the number of characters of the start and end values that appear in the PROC FORMAT output.

NOREPLACE
: prevents a new informat or format from replacing an existing one of the same name.

PAGE
: prints information about each format and informat in the catalog.

Optional Arguments

CASFMTLIB='*name*'
adds a format library to a CAS session.

You can specify the CASFMTLIB option only in an active SAS Cloud Analytic Services (CAS) session. PROC FORMAT connects to the CAS session and loads a format library. If the format library already exists in the CAS session, then SAS updates it. SAS also appends the format library to the search list for any subsequent referencing by procedures that are operating in CAS in that session. That is, if a format library already exists and you create a new library with

CASFMTLIB, then the new library is appended to the search order. The library name should be a one-level name that does not contain any slashes.

Note: A CAS session can have more than one format library. The libraries are available only to that CAS session. For information about using a CAS action to promote a format library to a global scope, see "Promote format library" in *SAS Viya: System Programming Guide*.

You can specify additional CAS sessions with the SESSREF= option. For information about the SESSREF= option and other CAS language elements, see *SAS Cloud Analytic Services: User's Guide*.

SAS formats are available in the local SAS client regardless of whether you add them to a format library in CAS. When the CASFMTLIB option is specified, the EXCLUDE and SELECT statements are applied to the local SAS session format catalogs, not to the CAS session format library. Informats cannot be loaded into a CAS session. If you specify an INVALUE statement with CASFMTLIB, then a note is written to the log and nothing is written to the CAS format library.

Restriction The format library name that you specify with the CASFMTLIB option cannot have a length of more than 63 characters.

Notes The specified value of the CASFMTLIB option must be enclosed in single or double quotation marks.

The library name that you specify is case-sensitive. It has to be a valid SAS name, and cannot contain blank spaces.

Formats defined in the VALUE or PICTURE statements are also written to the format catalog that is specified by the LIBRARY= option. If you do not specify a library, then SAS uses the WORK.FORMATS library.

Tip You can use the CAS action `addFmtLib=fmtsearch` to control the order in which SAS searches for format libraries. For more information, see "Manage User-Defined Formats with CAS Actions" in *SAS Cloud Analytic Services: User's Guide*

See "Using Formats in a CAS Session" on page 1083

CNTLIN=*input-control-SAS-data-set*

specifies a SAS data set from which PROC FORMAT builds informats or formats.

CNTLIN= builds formats and informats without using a VALUE, PICTURE, or INVALUE statement. If you specify a one-level name, then the procedure searches only the default library (either the WORK library or USER library) for the data set, regardless of whether you specify the LIBRARY= option.

Notes When using PROC FORMAT with a CNTLIN data set the START and END columns must have the same length. If the lengths are different, an error might occur.

LIBRARY= can point to either a library or a catalog. If only a libref is specified, a catalog name of FORMATS is assumed.

Tip A common source for an input control data set is the output from the CNTLOUT= option of another PROC FORMAT step.

See "Input Control Data Set" on page 1139

Example "Example 13: Creating a Format from a CNTLIN= Data Set" on page 1173

CNTLOUT=*output-control-SAS-data-set*

creates a SAS data set that stores information about informats or formats that are contained in the catalog specified in the LIBRARY= option. If you are creating an informat or format in the same step that the CNTLOUT= option appears, then the informat or format that you are creating is included in the CNTLOUT= data set.

If you specify a one-level name, then the procedure stores the data set in the default library (either the WORK library or the USER library), regardless of whether you specify the LIBRARY= option.

If you issue CNTLOUT= with an ENCODING option to create an output data set that has a different encoding, Cross Environment Data Access (CEDA) might issue a truncation error, SAS stops processing, and the CNTLOUT= data set is created with 0 observations. SAS writes an error to the log such as the following about the truncation of data:

```
ERROR: Some character data was lost during transcoding in the dataset
       WORK.TEST. Either the data contains characters that are not
       representable in the new encoding or truncation occurred during
       transcoding.
```

Suppose you are using a data set that contains monetary values in Euros. You are using the Wlatin1 session encoding, and you specify UTF-8 encoding for the CNTLOUT= data set. In Wlatin1 the LABEL variable is predetermined to be 5 bytes long and have a value of €1234 (in hexadecimal representation, '803132334'x). When you attempt to store the variable in the CNTLOUT= data set with UTF-8 encoding, the length of that string must be 7 bytes (in hexadecimal representation, 'E282AC3132334'x). The two additional bytes are needed in UTF-8 encoding for the Euro sign. Without the additional two bytes, the string is truncated. You can use the %COPY_TO_NEW_ENCODING macro to prevent this error. For information about the %COPY_TO_NEW_ENCODING macro, see "Avoiding Character Truncation Using the %COPY_TO_NEW_ENCODING Macro" in *SAS National Language Support (NLS): Reference Guide*.

The macro examines the CNTLOUT data set and re-creates it in the new encoding with the necessary lengths. If a width is stored as part of the associated format, the value is not expanded by the CVP engine. The format can cause truncation when the formatted value is displayed.

The DEFAULT value for the format width in the CNTLOUT data set is the default width (in bytes) for the format. The user can specify DEFAULT=, MIN=, and MAX= when they create the format, or the default is computed based on the largest label. If the START, MIN, MAX, or LABEL variable, in characters, is

larger in UTF-8 encoding, then these widths are not expanded by the CVP engine. Use the %COPY_TO_NEW_ENCODING macro instead. For more information about using CNTLOUT= with PROC FORMAT to convert catalogs to UTF-8, see "Converting Format Catalogs to UTF-8 Encoding" in *Moving and Accessing SAS Files*.

Note LIBRARY= can point to either library or a catalog. If only a libref is specified, SAS uses the catalog name FORMATS.

Tip You can use an output control data set as an input control data set in subsequent PROC FORMAT steps.

See "Output Control Data Set" on page 1135

SAS Viya supports only UTF-8 encoding. For information about the encoding of your format catalogs in SAS Viya, see *Migrating Data to UTF-8 for SAS Viya* and *SAS Viya FAQ for Processing UTF-8 Data*.

FMTLIB

prints information about informats or formats in the catalog that is specified in the LIBRARY= option. To get information about specific informats or formats, subset the catalog using the SELECT or EXCLUDE statement.

Note: FMTLIB is not supported for CASFMTLIB.

Interaction The PAGE option invokes FMTLIB.

Tips If your output from FMTLIB is not formatted correctly in the ODS LISTING destination, then try increasing the value of the LINESIZE= system option.

If you use a SELECT or EXCLUDE statement in your code without including a CNTLOUT= option, the FMTLIB option is automatically invoked and the FMTLIB report is generated. If necessary, this report can be suppressed by placing the following ODS EXCLUDE statement immediately before the PROC FORMAT statement:

```
ods exclude FORMAT;
```

Example "Example 15: Printing the Description of Informats and Formats" on page 1183

LIBRARY=*libref<.catalog>*

specifies a SAS library or catalog that contains the informats or formats that you are creating in the PROC FORMAT step. The procedure stores these informats and formats in the catalog that you specify so that you can use them in subsequent SAS sessions or jobs.

Alias LIB=

Default If you omit the LIBRARY= option, then formats and informats are stored in the Work.Formats catalog. If you specify the LIBRARY= option but do not specify a name for *catalog*, then formats and informats are stored in the *libref*.FORMATS catalog.

Note LIBRARY= can point to either a library or a catalog. If only a libref is specified, then SAS uses the catalog name FORMATS.

Tips SAS automatically searches Library.Formats. You might want to define and use the LIBRARY libref for your format catalog.

You can control the order in which SAS searches for format catalogs with the FMTSEARCH= system option. For more information, see "FMTSEARCH= System Option" in *SAS System Options: Reference*.

See "Storing Informats and Formats " on page 1080

Example "Example 3: Creating a Picture Format" on page 1150

LOCALE
specifies to create a format catalog that corresponds to the current SAS locale. The name of the catalog that SAS creates is the SAS library or catalog that is specified in the LIBRARY= option appended with the five-character POSIX locale value for the current SAS locale.

See For a list of POSIX locale values, see "LOCALE= Values for PAPERSIZE and DFLANG, Options" in *SAS National Language Support (NLS): Reference Guide*.

Example If the SAS locale is German_Germany, the POSIX locale value is de_DE. Using the following PROC FORMAT statement, SAS creates the catalog mylib.formats_de_DE to store formats and informats created by this procedure:

```
proc format locale lib=mylib.formats;
```

MAXLABLEN=*number-of-characters*
specifies the number of characters in the informatted or formatted value that you want to appear in the CNTLOUT= data set or in the output of the FMTLIB option. The FMTLIB option prints a maximum of 40 characters for the informatted or formatted value.

MAXSELEN=*number-of-characters*
specifies the number of characters in the start and end values that you want to appear in the CNTLOUT= data set or in the output of the FMTLIB option. The FMTLIB option prints a maximum of 16 characters for start and end values.

NOREPLACE
prevents a new informat or format from replacing an existing one of the same name. If you omit NOREPLACE, then the procedure warns you that the informat or format already exists and replaces it.

Note You can have a format and an informat of the same name.

PAGE
prints information about each format and informat in the catalog.

Interaction The PAGE option activates the FMTLIB option.

Tip In the ODS LISTING destination, the information about each format and informat appears on separate pages in the Output window.

EXCLUDE Statement

Excludes entries from processing by the FMTLIB and CNTLOUT= options.

Restrictions:

Only one EXCLUDE statement can appear in a PROC FORMAT step.

You cannot use a SELECT statement and an EXCLUDE statement within the same PROC FORMAT step.

When the CASFMTLIB option is specified, the EXCLUDE statement ignores format libraries in CAS sessions and refers only to catalogs in the SAS session.

Syntax

EXCLUDE *entry(s)*;

Required Argument

entry(s)
specifies one or more catalog entries to exclude from processing. Catalog entry names are the same as the name of the informat or format that they store. Because informats and formats can have the same name, and because character and numeric informats or formats can have the same name, you must use certain prefixes when specifying informats and formats in the EXCLUDE statement. Follow these rules when specifying entries in the EXCLUDE statement:

- Precede names of entries that contain character formats with a dollar sign ($).
- Precede names of entries that contain character informats with an at sign and a dollar sign (for example, @$*entry-name*).
- Precede names of entries that contain numeric informats with an at sign (@).
- Specify names of entries that contain numeric formats without a prefix.

Details

Shortcuts to Specifying Names

You can use the colon (:) and hyphen (-) wildcard characters to exclude entries. For example, the following EXCLUDE statement excludes all formats or informats that begin with the letter **a**.

```
exclude a:;
```

In addition, the following EXCLUDE statement excludes all formats or informats that occur alphabetically between **apple** and **pear**, inclusive:

```
exclude apple-pear;
```

FMTLIB Output

If you use the EXCLUDE statement without either FMTLIB or CNTLOUT= in the PROC FORMAT statement, then the procedure invokes the FMTLIB option and you receive FMTLIB option output.

INVALUE Statement

Creates an informat for reading and converting raw data values.

See: *SAS Formats and Informats: Reference* for documentation on informats supplied by SAS.

Example: "Example 12: Converting Raw Character Data to Numeric Values" on page 1170

Syntax

INVALUE <$>*name* <(*informat-options*)> <*value-range-set(s)*>;

Summary of Optional Arguments

DEFAULT=*length*
: specifies the default length of the informat.

FUZZ=*fuzz-factor*
: specifies a fuzz factor for matching values to a range.

JUST
: left-justifies all input strings before they are compared to ranges.

MAX=*length*
: specifies a maximum length for the informat.

MIN=*length*
: specifies a minimum length for the informat.

NOTSORTED
: stores values or ranges in the order in which you define them.

REGEXP

REGEXPE
: specifies that the preceding range is to be treated as a Perl regular expression.

UPCASE
: upper cases all input strings before they are compared to ranges.

Control the input template.

value-range-set(s)

specifies the variable template for reading data.

Required Argument

name

names the informat that you are creating.

Restriction
A user-defined informat name cannot be the same as an informat name that is supplied by SAS.

Requirement
The name must be a valid SAS name. A numeric informat name can be up to 31 characters in length; a character informat name can be up to 30 characters in length and cannot end in a number. If you are creating a character informat, then use a dollar sign ($) as the first character. Adding the dollar sign to the name is why a character informat is limited to 30 characters.

Interaction
The maximum length of an informat name is controlled by the VALIDFMTNAME= system option. See *SAS System Options: Reference* for details.

Tips
Refer to the informat later by using the name followed by a period. However, do not use a period after the informat name in the INVALUE statement.

When SAS prints messages that refer to a user-written informat, the name is prefixed by an at sign (@). When the informat is stored, the at sign is prefixed to the name that you specify for the informat. The addition of the at sign to the name is why the name is limited to 31 or 30 characters. You need to use the at sign *only* when you are using the name in an EXCLUDE or SELECT statement; do not prefix the name with an at sign when you are associating the informat with a variable.

Optional Arguments

DEFAULT=*length*

specifies the default length of the informat. The value for DEFAULT= becomes the length of the informat if you do not give a specific length when you associate the informat with a variable.

Defaults
For character informats, the length of the longest label

For numeric informats, 12 if you have numeric data to the left of the equal sign

For quoted strings, the length of the longest string

Note
If you specify an invalid value for DEFAULT=, SAS ignores the value and writes an error to the log.

Tip
As a best practice, if you specify an existing informat in a value-range set, always specify the DEFAULT= option.

FUZZ=*fuzz-factor*
specifies a fuzz factor for matching values to a range. If a number does not match or fall in a range exactly but comes within *fuzz-factor*, then the informat considers it a match. For example, the following INVALUE statement creates the LEVELS. informat, which uses a fuzz factor of .2:

```
invalue levels (fuzz=.2) 1='A'
                         2='B'
                         3='C';
```

FUZZ=.2 means that if a variable value falls within .2 of a value on either end of the range, then the informat uses the corresponding formatted value to store the variable value. So the LEVELS. informat saves the value 2.1 as **B**.

Tips Specify FUZZ=0 to save storage space when you use the INVALUE statement to create numeric informats.

Use a nonzero fuzz factor only with numbers that are very close but not an exact match. Ranges are stored internally in sorted order (unless the NOTSORTED option is used), in order to perform a binary search. When a fuzz-factor is added to the end of one range and subtracted from the beginning of the next range, and the ranges overlap, the results can be unpredictable. A value is placed in the first range that is a match in the binary search. The exclusion operator is insufficient to override this binary search algorithm. As a best practice, when you use the exclusion operator, set FUZZ=0 or the NOTSORTED option.

A best practice is to use FUZZ=0 when you use the < exclusion operator with numeric informats.

JUST
left-justifies all input strings before they are compared to ranges.

MAX=*length*
specifies a maximum length for the informat. When you associate the informat with a variable, you cannot specify a width greater than the MAX= value.

Default 40

Range 1–32767

Note If you specify an invalid value for MAX=, SAS ignores the value and writes an error to the log.

MIN=*length*
specifies a minimum length for the informat. If a CNTLIN= data set contains a value for MIN that rounds to 0 or less, SAS ignores the invalid value and substitutes 1 for it. When you specify the CNTLIN= data set in SAS code, SAS continues processing the code step and does not write an error to the log.

The following example specifies a data set that has a MIN value of -1 and uses CNTLIN= to call the data set on the subsequent PROC FORMAT statement.

```
data temp;
   fmtname='abc';
   start=1;
   label='xyz';
```

```
   min=-1;
run;

proc format cntlin=temp;
run;
```

If you specify an invalid value for MIN in code, SAS does not ignore the invalid value or substitute another value for it. SAS stops processing the code step and writes an error to the log.

The following example specifies `min=-1` for the NEWABC data set, which causes SAS to stop processing and issue an error.

```
proc format;
    value newabc (min=-1) 1='yes';
run;
```

Default 1

Range 1–32767

NOTSORTED

stores values or ranges in the order in which you define them.

If you do not specify NOTSORTED, then values or ranges are stored in sorted order by default, and SAS uses a binary searching algorithm to locate the range that a particular value falls into. If you specify NOTSORTED, then SAS searches each range in the order in which you define them until a match is found.

Use NOTSORTED if one of the following is true:

- You know the likelihood of certain ranges occurring, and you want your informat to search those ranges first to save processing time.
- You want to preserve the order that you define ranges when you print a description of the informat using the FMTLIB option.
- You want to preserve the order that you define ranges when you use the ORDER=DATA option and the PRELOADFMT option to analyze class variables in PROC MEANS, PROC SUMMARY, or PROC TABULATE.

Do not use NOTSORTED if the distribution of values is uniform or unknown, or if the number of values is relatively small. The binary searching algorithm that SAS uses when NOTSORTED is not specified optimizes the performance of the search under these conditions.

SAS automatically sets the NOTSORTED option when you use the CPORT and CIMPORT procedures to transport informats or formats between operating environments with different standard collating sequences. This automatic setting of NOTSORTED can occur when you transport informats or formats between ASCII and EBCDIC operating environments. If this situation is undesirable, then do the following:

- Use the CNTLOUT= option in the PROC FORMAT statement to create an output control data set.
- Use the CPORT procedure to create a transport file for the control data set.
- Use the CIMPORT procedure in the target operating environment to import the transport file.

- In the target operating environment, use PROC FORMAT with the CNTLIN= option to build the formats and informats from the imported control data set.

REGEXP
REGEXPE
specifies that the preceding range is to be treated as a Perl regular expression. If you specify REGEXPE, the regular expression is expected to produce a modified result, as in using the substitute action.

During execution, all regular expressions are compiled and the input data is passed to the first expression to confirm a match. If there is a match, the corresponding label is used. If there is no match, the next range is compared. Ranges are not sorted and are processed in the order in which they were defined in the INVALUE statement or in the order in which they appear in the CNTLIN= data set.

The rules for regular expressions using the REGEXP option are the same as they are for the PRXPARSE function in the DATA step. The rules for the REGEXPE option are the same as they are for the PRXCHANGE function.

Interaction If you are using a CNTLIN= data set, the HLO variable contains P for REGEXP and E for REGEXPE.

See "Example 10: Creating an Informat Using Perl Regular Expressions" on page 1165

UPCASE
converts all raw data values to uppercase before they are compared to the possible ranges. If you use UPCASE, then make sure the values or ranges that you specify are in uppercase.

value-range-set(s)
specifies raw data and values that the raw data becomes. The *value-range-set(s)* can be one or more of the following:

value-or-range-1<, *value-or-range-2* ...>=*informatted-value* | [*existing-informat*]

The informat converts the raw data to the values of *informatted-value* on the right side of the equal sign.

value-or-range
See "Specifying Values or Ranges" on page 1129.

informatted-value
is the value that you want the raw data in *value-or-range* to become. Use one of the following forms for *informatted-value*:

'character-string'
is a character string up to 32,767 characters long. Typically, *character-string* becomes the value of a character variable when you use the informat to convert raw data. Use *character-string* for *informatted-value* only when you are creating a character informat. If you omit the single or double quotation marks around *character-string*, then the INVALUE statement assumes that the quotation marks are there.

For hexadecimal literals, you can use up to 32,767 typed characters, or up to 16,382 represented characters at two hexadecimal characters per represented character.

number
is a number that becomes the informatted value. Typically, *number* becomes the value of a numeric variable when you use the informat to convert raw data. Use *number* for *informatted-value* when you are creating a numeric informat. The maximum for *number* depends on the host operating environment.

ERROR
treats data values in the designated range as invalid data. SAS assigns a missing value to the variable, prints the data line in the SAS log, and issues a warning message.

SAME
prevents the informat from converting the raw data as any other value. For example, the following GROUP informat converts values 01 through 20 and assigns the numbers 1 through 20 as the result. All other values are assigned a missing value.

```
invalue group 01-20= _same_
              other= .;
```

existing-informat
is an informat that is supplied by SAS or an existing user-defined informat. The informat that you are creating uses the existing informat to convert the raw data that match *value-or-range* on the left side of the equal sign. If you use an existing informat, then enclose the informat name in square brackets (for example, [date9.]) or with parentheses and vertical bars (for example, (|date9.|)). Do not enclose the name of the existing informat in single quotation marks.

Tip As a best practice, if you specify an existing informat in a value-range-set, always specify a default value by using the DEFAULT= option.

Examples

Example 1: Create a Character Informat for Raw Data Values

The $GENDER. character informat converts the raw data values **F** and **M** to character values **'1'** and **'2'**:

```
invalue $gender 'F'='1'
                'M'='2';
```

The dollar sign prefix indicates that the informat converts character data.

Example 2: Create Character and Numeric Values or a Range of Values

When you create numeric informats, you can specify character strings or numbers for *value-or-range*. For example, the TRIAL. informat converts any character string that sorts between **A** and **M** to the number 1 and any character string that sorts between **N** and **Z** to the number 2. The informat treats the unquoted range 1–3000 as a numeric range, which includes all numeric values between 1 and 3000:

```
invalue trial 'A'-'M'=1
              'N'-'Z'=2
               1-3000=3;
```

Example 3: Convert Input Strings to Uppercase and Left-justify

The EVALUATION. informat uses the UPCASE and JUST options to uppercase and left-justify all input strings before they are converted to numbers.

```
invalue evaluation (upcase just) 'O'=4
                                 'S'=3
                                 'E'=2
                                 'C'=1
                                 'N'=0;
```

Note: Options in the INVALUE statement must be specified in parentheses.

Example 4: Create an Informat Using _ERROR_ and _SAME_

The CHECK. informat uses _ERROR_ and _SAME_ to convert values of 1 through 4 and 99. All other values are invalid:

```
invalue check 1-4=_same_
               99=.
           other=_error_;
```

If you use a numeric informat to convert character strings that do not correspond to any values or ranges, then you receive an error message.

PICTURE Statement

Creates a template for printing numbers.

Tips:

As a best practice, if you specify an existing format in a value-range-set, always specify a default value by using the DEFAULT= option on page 1123.

If you are using the DATATYPE= option, use the DEFAULT= option to set the default format width to be large enough to format these characters. Without setting the DEFAULT= option, the default width of a format is the width of the largest value to the right of the equation symbol.

The DEFAULT, FUZZ, MAX, MIN, MULTILABEL, NOTSORTED, and ROUND options are valid before the value range specification.

The DATATYPE, DECSEP, DIG3SEP, FILL, LANGUAGE, MULT, NOEDIT, and PREFIX options are valid in parentheses after the user-supplied value label.

The DATATYPE, DECSEP, DIG3SEP, FILL, LANGUAGE, MULT, NOEDIT, PREFIX, and ROUND options are valid only with the PICTURE statement.

See: *SAS Formats and Informats: Reference* and *SAS National Language Support (NLS): Reference Guide* for documentation about formats that are supplied by SAS.

Examples: "Example 3: Creating a Picture Format" on page 1150

"Example 5: Filling a Picture Format" on page 1155

"Example 18: Creating a Format in a non-English Language" on page 1190

Syntax

PICTURE *name* <(*format-options*)>
<*value-range-set-1* <(*picture-1-options*)>
<*value-range-set-2* <(*picture-2-options*)>> ...>;

Summary of Optional Arguments

Control the attributes of each picture in the format

FILL='*character*'
: specifies a character that completes the formatted value.

MULTIPLIER=*n*
: specifies a number to multiply the variable's value by before it is formatted.

NOEDIT
: specifies that numbers are message characters rather than digit selectors.

PREFIX='*prefix*'
: specifies a character prefix to place in front of the formatted value.

Control the attributes of the format

DATATYPE=DATE | TIME | DATETIME | DATETIME_UTIL
: enables the use of directives in the picture as a template to format date, time, or datetime values.

DECSEP='*character*'
: specifies the separator character for the fractional part of a number.

DEFAULT=*length*
: specifies the default length of the picture.

DIG3SEP='*character*'
: specifies the three-digit separator character for a number.

FUZZ=*fuzz-factor*
: specifies a fuzz factor for matching values to a range.

LANGUAGE=

specifies the language that is used for weekdays and months that you can substitute in a date, time, or datetime picture.

MAX=*length*
specifies a maximum length for the format.

MIN=*length*
specifies a minimum length for the format.

MULTILABEL
enables the assignment of labels to multiple *values-or-range* values that might have the same or overlapping values.

NOTSORTED
stores values or ranges in the order in which you define them.

ROUND
rounds the value to the nearest integer before formatting.

Control the template for printing

value-range-set
specifies one or more variable values and a template for printing those values.

Required Argument

name
names the format that you are creating.

Restriction: A user-defined format cannot be the name of a format supplied by SAS.

Requirement: The name must be a valid SAS name. A numeric format name can be up to 32 characters in length; a character format name can be up to 31 characters in length, not ending in a number. If you are creating a character format, you use a dollar sign ($) as the first character, which is why a character informat is limited to 31 characters. For information about SAS names, see "Rules for Words and Names in the SAS Language" in *SAS Language Reference: Concepts*.

Interaction: The maximum length of a format name is controlled by the VALIDFMTNAME= system option. See *SAS System Options: Reference* for details.

Tip: Refer to the format later by using the name followed by a period. However, do not put a period after the format name in the VALUE statement.

Optional Arguments

DATATYPE=DATE | TIME | DATETIME | DATETIME_UTIL
enables the use of directives in the picture as a template to format date, time, or datetime values. Specify either DATE, TIME, DATETIME, or DATETIME_UTIL based on the directive that you use in the picture format. See the definition and list of directives on page 1107 in the description of *picture*.

Interaction DATATYPE=DATETIME results in datetime hours 00:00:00–23:59:59. DATATYPE=DATETIME_UTIL results in datetime hours between 00:00:01–24:00:00.

Tip If you format a numeric missing value, then the resulting label is ERROR. Adding a clause to your program that checks for missing values can eliminate the ERROR label.

DEFAULT=*length*
specifies the default length of the picture. The value for DEFAULT= becomes the length of *picture* if you do not give a specific length when you associate the format with a variable.

Default The length of the longest picture value

Range 1–32767

Tip If you are using the DATATYPE= option, use the DEFAULT= option to set the default format width large enough to format these characters.

DECSEP='*character*'
specifies the separator character for the fractional part of a number.

Default . (a decimal point)

DIG3SEP='*character*'
specifies the three-digit separator character for a number.

Default , (a comma)

FILL='*character*'
specifies a character that completes the formatted value.

If the number of significant digits is less than the length of the format, then the format must complete, or fill, the formatted value:

- The format uses *character* to fill the formatted value if you specify zeros as digit selectors.
- The format uses zeros to fill the formatted value if you specify nonzero-digit selectors. The FILL= option has no effect.

If the picture includes other characters, such as a comma, which appear to the left of the digit selector that maps to the last significant digit placed, then the characters are replaced by the fill character or leading zeros.

Default ' ' (a blank)

Restriction The FILL= option is not valid when you use a function to format a value.

Interaction If you use the FILL= and PREFIX= options in the same picture, then the format places the prefix and then the fill characters.

Example "Example 5: Filling a Picture Format" on page 1155

FUZZ=*fuzz-factor*

specifies a fuzz factor for matching values to a range. If a number does not match or fall in a range exactly but comes within *fuzz-factor*, on either end of the range, then the format considers it a match. For example, the following VALUE statement creates the LEVELS. format, which uses a fuzz factor of .2:

```
value levels (fuzz=.2) 1='A'
                       2='B'
                       3='C';
```

FUZZ=.2 means that if a variable value falls within .2 of a value on either end of the range, then the format uses the corresponding formatted value to print the variable value. The LEVELS format formats the value 2.1 as B.

Default 1E−12 for numeric formats.

Tips Specify FUZZ=0 to save storage space when you use the VALUE statement to create numeric formats.

Use a nonzero fuzz factor only with numbers that are very close but not an exact match. If *fuzz-factor* is added to the end of one range and subtracted from the beginning of the next range, and the ranges overlap, the results can be unpredictable. A value is placed in the first range that is a match in a binary search.

A best practice is to use FUZZ=0 when you use the < exclusion operator with numeric formats.

LANGUAGE=

specifies the language that is used for weekdays and months that you can substitute in a date, time, or datetime picture. If you specify a language that is not supported or is invalid, English is used.

These are the valid values for the LANGUAGE= option:

Afrikaans	English	Macedonian	Spanish
Catalan	Finnish	Norwegian	Swedish
Croatian	French	Polish	Swiss_French
Czech	German	Portuguese	Swiss_German
Danish	Hungarian	Russian	
Dutch	Italian	Slovenian	

Defaults For single-byte character sets, the language that is specified by DFLANG= system option

For double-byte and UTF-8 character sets, the language that is specified by the LOCALE= system option

Tip To use a user-defined format in languages other than those that are supported by the LANGUAGE= option, set the LOCALE= system option to the locale for the language. In PROC FORMAT, do not specify the LANGUAGE= option. The language of a picture format is determined by the locale setting. For a list of locales, see “LOCALE=

Values for PAPERSIZE and DFLANG, Options" in *SAS National Language Support (NLS): Reference Guide*.

See "DFLANG= System Option: UNIX, Windows, and z/OS" in *SAS National Language Support (NLS): Reference Guide*

MAX=*length*

specifies a maximum length for the format. When you associate the format with a variable, you cannot specify a width greater than the MAX= value.

Default 40

Range 1–32767

MIN=*length*

specifies a minimum length for the format.

Default 1

Range 1–32767

MULTILABEL

enables the assignment of labels to multiple *values-or-range* values that might have the same or overlapping values. The label is the formatted value that is determined by the picture definition on the right of the equal sign in a value-range-set. Here is an example of how MULTILABEL is used:

The following PICTURE statements show the two uses of the MULTILABEL option. In each case, number formats are assigned as labels. The first PICTURE statement assigns multiple labels to a single value. Multiple labels can also be assigned to a single range of values. The second PICTURE statement assigns labels to overlapping ranges of values. The MULTILABEL option enables the assignment of multiple labels to the overlapped values.

```
picture abc (multilabel)
    1000='9,999'
    1000='9999';

  picture overlap (multilabel)
    /* without decimals */
    0-999='999'
    1000-9999='9,999'

     /* with decimals */
    0-9='9.999'
    10-99='99.99'
    100-999='999.9';
```

Only multilabel-enabled procedures such as PROC MEANS, PROC SUMMARY, and PROC TABULATE can use multiple labels. All other procedures and the DATA step recognize only the primary label.

The *primary label* for a given entry is the formatted value (based on the picture) that is assigned to the first value or range-of-values (left side of the equal sign) that matches or contains the entry when all values (on the left side of the equal sign) are ordered sequentially. Here is an example:

- In the first PICTURE statement, the primary label for 1000 is 1,000 because the picture 9,999 is the first value that is assigned to 1000. The secondary label for 1000 is 1000, based on the 9999 picture.
- In the second PICTURE statement, the primary label for 5 is 5.000 based on the 9.999 picture that is assigned to the range 0–9 because 0–9 is sequentially the first range of values that contain 5. The secondary label for 5 is 005 because the range 0–999 occurs in sequence after the range 0–9.

Consider carefully when you assign multiple labels to a value.

Unless you use the NOTSORTED option when you assign value-range-sets, SAS stores the value-range-sets in sorted order. This order can produce unexpected results when value-range-sets with the MULTILABEL format are processed. Here is an example:

In the second PICTURE statement, the primary label for 15 is 015, and the secondary label for 15 is 15.00 because the range 0–999 occurs in sequence before the range 10–99. If you want the primary label for 15 to use the 99.99 format, then you might want to change the range 10–99 to 0–99 in the PICTURE statement. The range 0–99 occurs in sequence before the range 0–999 and produces the desired result.

Restriction The maximum number of labels that can be created for a single format or informat is 255.

MULTIPLIER=*n*

specifies a number to multiply the variable's value by before it is formatted. The value of the MULTIPLIER= option depends both on the result of the multiplication and on the digit selectors in the *picture* portion of the *value-range-set*. For example, the following PICTURE statement creates the MILLION. format, which formats the variable value 1600000 as `$1.6M`:

```
picture million low-high='09.9M'
        (prefix='$' mult=.00001);
```

1600000 is first multiplied by .00001, which equals 16. Note that there is a digit selector after the decimal. The value 16 is placed into the picture beginning on the right. The value 16 overlays 09.9, and results in 01.6. Leading zeros are dropped, and the final result is 1.6M.

If the value of low-high is equal to '000M', then the result would be 16M.

Alias MULT=

Default 10^n, where *n* is the number of digits after the first decimal point in the picture. For example, suppose your data contains a value 123.456 and you want to print it using a picture of '999.999'. The format multiplies 123.456 by 10^3 to obtain a value of 123456, which results in a formatted value of 123.456.

Restrictions The MULT= option is not valid when you use a function to format a value.

The MULT= option is ignored when you specify the DATATYPE= option.

Examples "Example 3: Creating a Picture Format" on page 1150

"Example 4: Creating a Picture Format for Large Dollar Amounts" on page 1152

NOEDIT

specifies that numbers are message characters rather than digit selectors. That is, the format prints the numbers as they appear in the picture. For example, the following PICTURE statement creates the MILES. format, which formats any variable value greater than 1000 as **>1000 miles**:

```
picture miles 1-1000='0000'
          1000<-high='>1000 miles'(noedit);
```

Restriction The NOEDIT= option is not valid when you use a function to format a value.

NOTSORTED

stores values or ranges in the order in which you define them. If you do not specify NOTSORTED, then values or ranges are stored in sorted order by default, and SAS uses a binary searching algorithm to locate the range that a particular value falls into. If you specify NOTSORTED, then SAS searches each range in the order in which you define them until a match is found.

Use NOTSORTED if one of the following is true:

- You know the likelihood of certain ranges occurring, and you want your format to search those ranges first to save processing time.
- You want to preserve the order that you define ranges when you print a description of the format using the FMTLIB option.
- You want to preserve the order that you define ranges when you use the ORDER=DATA option and the PRELOADFMT option to analyze class variables in PROC MEANS, PROC SUMMARY, or PROC TABULATE.

Do not use NOTSORTED if the distribution of values is uniform or unknown, or if the number of values is relatively small. The binary searching algorithm that SAS uses when NOTSORTED is not specified optimizes the performance of the search under these conditions.

SAS automatically sets the NOTSORTED option when you use the CPORT and CIMPORT procedures to transport informats or formats between operating environments with different standard collating sequences. This automatic setting of NOTSORTED can occur when you transport informats or formats between ASCII and EBCDIC operating environments. If this situation is undesirable, then do the following:

- Use the CNTLOUT= option in the PROC FORMAT statement to create an output control data set.
- Use the CPORT procedure to create a transport file for the control data set.
- Use the CIMPORT procedure in the target operating environment to import the transport file.

- In the target operating environment, use PROC FORMAT with the CNTLIN= option to build the formats and informats from the imported control data set.

PREFIX='*prefix*'
specifies a character prefix to place in front of the formatted value. The prefix is placed in front of the value's first significant digit. You must use zero-digit selectors or the prefix is not used.

Typical uses for PREFIX= are printing leading currency symbols and minus signs. For example, the PAY format prints the variable value 25500 as **$25,500.00**:

```
picture pay
   low-high='000,009.99' (prefix='$');
```

Default no prefix

Restriction The PREFIX= option is not valid when you use a function to format a value.

Interaction If you use the FILL= and PREFIX= options in the same picture, then the format places the prefix and then the fill characters.

Examples "Example 3: Creating a Picture Format" on page 1150

"Example 5: Filling a Picture Format" on page 1155

CAUTION **If the picture is not wide enough to contain both the value and the prefix, then the format truncates or omits the prefix, which results in inaccurate data.**

ROUND
rounds the value to the nearest integer before formatting. Without the ROUND option, the format multiplies the variable value by the multiplier, truncates the decimal portion (if any), and prints the result according to the template that you define. With the ROUND option, the format multiplies the variable value by the multiplier, rounds that result to the nearest integer, and then formats the value according to the template. Note that if the FUZZ= option is also specified, the rounding takes place after SAS has used the fuzz factor to determine which range the value belongs to.

Tip The ROUND option rounds a value of .5 to the next highest integer.

CAUTION **The picture must be wide enough for an additional digit if rounding a number adds a digit to the number.** For example, the picture for the number .996 could be '99' (prefix '.' mult=100). After rounding the number and multiplying it by 100, the resulting number is 100. When the picture is applied, the result is .00, an inaccurate number. In order to ensure accuracy of numbers when you round numbers, make the picture wide enough to accommodate larger numbers.

value-range-set
specifies one or more variable values and a template for printing those values. *value-range-set* has the following form:

value-or-range-1 <, *value-or-range-2*, ...>='*picture*'

value-or-range
See "Specifying Values or Ranges" on page 1129.

picture
specifies a template for formatting values of numeric variables. The picture is a sequence of characters in single quotation marks. The maximum length for a picture is 40 characters. Pictures are specified with three types of characters: digit selectors, message characters, and directives. You can have a maximum of 16 digit selectors in a picture.

digit selectors
are numeric characters (0 through 9) that define positions for numeric values. A picture format with nonzero-digit selectors prints any leading zeros in variable values; picture digit selectors of 0 do not print leading zeros in variable values. If the picture format contains digit selectors, then a digit selector must be the first character in the picture.

Note This section uses 9s as nonzero-digit selectors.

message characters
are nonnumeric characters that are printed as specified in the picture. The following PICTURE statement contains both digit selectors (99) and message characters (**`illegal day value`**). Because the DAYS. format has nonzero-digit selectors, values are printed with leading zeros. The special range OTHER prints the message characters for any values that do not fall into the specified range (1 through 31).

```
picture days
          01-31='99'
          other='99-illegal day value';
```

Example The values 02 and 67 are printed as

```
                                02
      67-illegal day value
```

directives
are special characters that you can use in the picture to format date, time, or datetime values.

Note: You can use directives only when you specify the DATATYPE= option on page 1100 in the PICTURE statement. Ensure that the value of the DATATYPE= option is appropriate for the type of directive that you want to use. If you use an inappropriate value, the data does not format. For example, for the %a directive, use DATATYPE=DATE.

The DFLANG datetime handler and the National Language (NL) datetime handler are the two methods to control character casing in user format handling. The DFLANG datetime handler is the default method under non–UTF8 and non–DBCS sessions. The NL datetime handler is the default method under UTF8 and DBCS sessions.

Note: The DFLANG datetime handler is used if you specify it for UTF8 and DBCS sessions. Otherwise, the NL datetime handler is used.

Note: The following are handled by the DFLANG datetime handler: a A b B d H I j m M p q S w U y Y.

If you specify the DFLANG datetime handler, then month names are in all uppercase if you specify English (for example, JAN), they are in all lowercase if you specify French (for example, jan), and they are in mixed case if you specify German (for example, Jan).

If you specify the NL datetime handler, then month names are in mixed case if you specify English or German (Jan), and they are in lowercase if you specify French (for example, jan).

The DFLANG datetime handler is used only if a supported language is specified with the DFLANG= system option and all of the specified datetime elements are supported by the DFLANG format handler. Otherwise, the NL datetime handler is used.

The casing of the month names is determined by the DFLANG= system option and the LANGUAGE= argument of the PICTURE statement. Otherwise, the casing is determined by the language elements in the locale data. For example, if the language specified by the LOCALE= option is English, then only the first character is in uppercase because it is defined as mixed–case strings in the locale data. For more information, see "DFLANG= System Option: UNIX, Windows, and z/OS" in *SAS National Language Support (NLS): Reference Guide*.

Note: The DFLANG option supports only 22 languages. Use the DFLANG= option only for compatibility purposes. When you specify the DFLANG= option, support for the datetime directive is limited and some elements such as %I are not supported.

Specify the LANGUAGE= argument if you need to use it in the FORMAT procedure, or you need month names in all uppercase for a locale such as English.

If you mainly use the EUR* datetime formats and you need support for European languages only for compatibility, then you can use the DFLANG= option to specify the language.

Use the LOCALE= system option to set the locale for double-byte and UTF-8 character sets. The %b directive formats month names with only the first letter in uppercase when the locale is set with LOCALE=. For more information, see "LOCALE System Option" in *SAS National Language Support (NLS): Reference Guide*.

If you specify a format element that is supported by only the NL datetime handler, then the NL format handler is used regardless of whether the DFLANG= option is used. %b also produces abbreviated month names in mixed case for English if there is an unsupported directive such as %I.

The permitted directives are as follows:

%a
abbreviated weekday name (for example, Wed).

%A
full weekday name (for example, Wednesday).

%b
abbreviated month name (for example, JAN or Jan).

The default value for the LANGUAGE= argument in UTF-8 sessions is LOCALE. To format month names in all upper–case characters in UTF-8 sessions, specify the locale on the LANGUAGE= argument. For more information, see "LANGUAGE=" on page 1102.

Tip For the English language, use the directive %3B to create an abbreviated month with only an uppercase initial letter (for example, Jan).

%<*n*>B
the full month name (for example, January) if *n* is not included in the directive. *n* specifies the number of characters that appear for the month name. In comparison, the %b directive writes a three-character month abbreviation in uppercase letters for some locales.

Restriction *n* is not supported in DBCS and Unicode SAS sessions.

Example %3B would write Oct for the month of October

%C
long month name with blank padding (January through December) (for example, December).

%d
day of the month.

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0d).

%e
day of the month as a two-character decimal number with leading spaces (" 1"- "31") (for example, " 2").

%F
full weekday name with blank padding.

%G
year as a four-digit decimal number (for example, 2008). If the week that contains January 1 has four or more days in the new year, then it is considered week 1 in the new year. Otherwise, it is the last week of the previous year and the year is considered the previous year.

%H
hour (24-hour clock).

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0H).

Tip When DATETYPE=DATETIME, SAS uses datetime hours 00:00–23:59. When DATETYPE=DATETIME_UTIL, SAS uses datetime hours 00:00:01–24:00:00 and 24:00:00 is

midnight at the end of the day. The hour 00:00:00 is not in the hour range and if used, converts to 24:00:00 of the previous day. When you specify DATETIME, 00:00:00 is midnight of a new day and the value 24:00:00 is midnight of the next day.

Example "Example 7: Change the 24–Hour Clock to 00:00:01–24:00:00" on page 1159

%l
hour (12-hour clock).

Alias %i

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0l).

%j
day of the year as a decimal number (1–366), with leading zero.

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0j).

%m
month (1–12).

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0m).

%M
minute (0–59).

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0M).

%n
number of days in a duration as a decimal number (maximum of 10 digits) (for example, 25).

Restriction This directive is not valid for DBCS and Unicode SAS sessions.

%o
month (1-12) with blank padding (for example, " 2").

%p
equivalent to either a.m. or p.m.

%q
abbreviated quarter of the year string such as 1, 2, 3, or 4.

%Q
quarter of the year string, such as Quarter1, Quarter2, Quarter3, or Quarter4.

%s

fractional seconds as decimal digits (for example, .39555). The number of digits formatted is the number of digits to the right of the decimal point that is specified when you use the format. SAS rounds fractional seconds to accommodate the number of digits specified for fractional seconds.

Restriction This directive is not valid for DBCS and Unicode SAS sessions.

Interaction The %s and %S directives cannot be used together.

Tips The %s directive displays both whole and fractional seconds.

To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0s).

%S

seconds (0–59), allowing for possible leap seconds.

Interaction The %s and %S directives cannot be used together.

Tips The %S directive displays whole seconds. It does not display fractional seconds.

To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0S).

Example 58 and 59.07

%u

weekday as a one-digit decimal number (1–7 (Monday - Sunday)) (for example, Sunday=7).

%U

week number of the year as a decimal number (0–53). Sunday is considered the first day of the week.

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0U).

%V

week number (01–53) with the first Monday as the start day of the first week. Minimum days of the first week is 4.

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0SV).

%w

weekday as a one-digit decimal number (0–6 (Sunday through Saturday)) (for example, Sunday=0).

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0w).

%W
week number (0–53) with the first Monday as the start day of the first week.

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0W).

%y
year without century (0–99) (for example, 93).

Note To add a leading zero before a single-digit number, insert a 0 before the directive (for example, %0y).

%Y
year with century as a four-digit decimal number (1970–2069) (for example, 1994).

%z
UTC time-zone offset.

%Z
time-zone name.

%%
the % character.

Tip Add code to your program to direct how you want missing values to be displayed.

Interaction If you specify LANGUAGE= and PICTURE= in the format definition, the format supports only English and the European languages. To use a user-defined format in languages other than those that are supported by the LANGUAGE= option, use the PICTURE= statement. Do not specify the LANGUAGE= option. The language of a picture format is determined by the locale setting.

Details

Building a Picture Format: Step by Step

This section shows how to write a picture format that eliminates leading zeros. In the SAMPLE data set, the default printing of the variable Amount has leading zeros on numbers between 1 and –1. The PICTURE statement defines two similar formats that eliminate leading zeros on numbers between 1 and –1. The difference between the two formats is that the NOZEROSR. format specifies the ROUND option to round numbers and the NOZEROS. format does not round numbers.

This program creates, sorts, and prints the sample data set:

```
data sample;
   input Amount;
   datalines;
-2.051
```

```
-.05
-.017
  0
.093
.54
.556
6.6
14.63
0.996
-0.999
-45.00
;
run;


proc sort data=sample;
   by amount;
run;

proc print data=sample;
   title 'Default Printing of the Variable Amount';
run;
```

Default Printing of the Variable Amount

Obs	Amount
1	-45.000
2	-2.051
3	-0.999
4	-0.050
5	-0.017
6	0.000
7	0.093
8	0.540
9	0.556
10	0.996
11	6.600
12	14.630

Here is the PROC FORMAT step that creates the NOZEROSR. and NOZEROS. formats. Both formats eliminate leading zeros in the formatted values. The NOZEROSR. format specifies the ROUND option to round numbers. The NOZEROS. format does not perform rounding.

```
libname library 'SAS-library';

proc format;
```

```
  picture nozerosR (round fuzz=0)
    low -  -1      =  '000.00' (prefix='-')
    -1 < - < -.99  =  '0.99'  (prefix='-' mult=100)
    -0.99 <-<  0   =  '99'    (prefix='-.' mult=100)
               0   =  '9.99'
     0 <  -< .99   =  '99'    (prefix='.' mult=100)
     0.99 - < 1    =  '0.99'  (mult=100)
     1  - high     =  '09.99';

  picture nozeros (fuzz=0)
    low -  -1      =  '000.00' (prefix='-')
    -1 < - < -.99  =  '0.99'  (prefix='-.' mult=100)
    -0.99 <-<  0   =  '99'    (prefix='-.' mult=100)
               0   =  '9.99'
     0 <  -< .99   =  '99'    (prefix='.' mult=100)
     0.99 - < 1    =  '0.99'  (prefix='.' mult=100)
     1  - high     =  '09.99';

run;
```

The following table explains how one value from each range is formatted. For an illustration of each step, see Table 30.74 on page 1117.

Table 30.2 *Building a Picture Format*

Step	Rules for Processing the PICTURE Statement	In This Example
1	Determine into which range the value falls and use that picture.	In the second range, the exclusion operator < appears on both sides of the hyphen and excludes −1 and -.99 from the range. The third range excludes 0 and .99. The fourth range excludes 1. Because exclusion operators are used, the FUZZ=0 option is specified.
2	Take the absolute value of the numeric value.	Because the absolute value is used, you need a separate range and picture for the negative numbers in order to prefix the minus sign.
3	Multiply the number by the MULT= value. If you do not specify the MULT= option, then the PICTURE statement uses the default. The default is 10^n, where *n* is the number of digit selectors to the right of the decimal in the picture. (Step 6 discusses digit selectors further.) [1]	Specifying a MULT= value is necessary for numbers between 0 and 1 and numbers between 0 and −1 because no decimal appears in the pictures for those ranges. Because MULT= defaults to 1, truncation of the significant digits results without a MULT= value specified. (Truncation is explained in the next step.) For the three ranges that do not have MULT= values specified, the MULT= value defaults to 100 because the corresponding picture has two digit selectors to the right of the decimal. After the

Step	Rules for Processing the PICTURE Statement	In This Example
		MULT= value is applied, all significant digits are moved to the left of the decimal.
4	If the number is within 10^{-8} of a higher integer, round the number up. This operation is performed before the ROUND option is performed. The ROUND option is in effect. The format rounds the number after the decimal to the next highest integer if the number after the decimal is greater than or equal to .5.	Because the example uses MULT= values that ensured that all of the significant digits were moved to the left of the decimal, no significant digits are lost. The zeros are truncated. 205.1 is rounded to 205. 55.6 is rounded up to 56. 99.6 is rounded up to 100. Rounding is not performed on 5 and 660.
4a	When the ROUND option is not performed, the numbers after the decimal are truncated.	205.1 is truncated to 205. 55.6 is truncated to 55. 99.6 is truncated to 99.
5	Turn the number into a character string. If the number is shorter than the picture, then the length of the character string is equal to the number of digit selectors in the picture. Pad the character string with leading zeros. (The results are equivalent to using the Z*w.* format. Z*w.* is explained in the section on SAS formats in *SAS Formats and Informats: Reference*.	205 becomes the character string 00205. 5 becomes the character string 05. 56 becomes the character string 56. 100 becomes the character string 100. 660 becomes the character string 0660. When the picture is longer than the numbers, the format adds a leading zero to the value. The format does not add leading zeros to the character string 56 and 100 because the corresponding picture has the same number of selectors.
5a		205 becomes the character string 00205. 5 becomes the character string 05. 55 becomes the character string 55. 99 becomes the character string 099. 660 becomes the character string 0660. When the picture is longer than the numbers, the format adds a leading zero to the value. The format does not add leading zeros to the character string 55 because the corresponding picture has the same number of selectors.

Step	Rules for Processing the PICTURE Statement	In This Example
6	Apply the character string to the picture. The format maps only the rightmost *n* characters in the character string, where *n* is the number of digit selectors in the picture. Thus, it is important to make sure that the picture has enough digit selectors to accommodate the characters in the string. After the format takes the right-most *n* characters, it then maps those characters to the picture from left to right. Choosing a zero or nonzero-digit selector is important if the character string contains leading zeros. If one of the leading zeros in the character string maps to a nonzero-digit selector, then it and all subsequent leading zeros and message characters become part of the formatted value. If all of the leading zeros map to zero-digit selectors, then none of the leading zeros or message characters become part of the formatted value. The format replaces the leading zeros in the character string with blanks. [2]	00205 is mapped to 2.05. 05 is mapped to 05. 56 is mapped to 56. 100 is mapped to 1.00. 0660 is mapped to 6.60. The leading zero is dropped from the character strings `00205` and `0660` because the leading zero maps to a zero-digit selector in the picture.
6a		00205 is mapped to 2.05. 05 is mapped to 05. 55 is mapped to 55. 099 is mapped to 99. 0660 is mapped to 6.60. The leading zero is dropped from the character strings `00205`, `099`, and `0660`, because the leading zero maps to a zero-digit selector in the picture.

Step	Rules for Processing the PICTURE Statement	In This Example
		The period (.) message character in the 0.99 picture is dropped because the leading zero maps to a zero-digit selector. Because the period message character is dropped, the format definition for the range 0.99 – < 1 requires a prefix of '.' in the NOZEROS. format to format a decimal number.
7	Prefix any characters that are specified in the PREFIX= option. You need the PREFIX= option because when a picture contains any digit selectors, the picture must begin with a digit selector. Thus, you cannot begin your picture with a decimal point, minus sign, or any other character that is not a digit selector.	The PREFIX= option reclaims the decimal point and the negative sign, as shown with the formatted values `-2.05`, `-.05` and `.56`.
7a		The PREFIX= option reclaims the decimal point and the negative sign, as shown with the formatted values `-2.05`, `-.05`, `.55`, and `.99`.

1 A decimal in a PREFIX= option is not part of the picture.
2 You can use the FILL= option to specify a character other than a blank to become part of the formatted value.

Table 30.3 *Steps to Format Various Values*

Step	Action	-2.051	-.05	.556	.996	6.6
1	Range	low – –1	–0.99 < – < 0	0 < – < .99	0.99 – < 1	1 – high
	Picture	000.00	99	99	0.99	09.99
2	Absolute value	2.051	.05	.556	.996	6.6
3	MULT=	$2.051\times10^{2}=205.1$	.05×100=5	.556×100=55.6	.996×100=99.6	$6.6\times10^{2}=660$
4	Round	205	5	56	100	660
4a	No Rounding	205	5	55	99	660

Step	Action	-2.051	-.05	.556	.996	6.6
5	Character string, rounding	00205	05	56	100	0660
5a	Character string, no rounding	00205	05	55	099	0660
6	Template, rounding	2.05	05	56	1.00	6.60
6a	Template, no rounding	2.05	05	55	99	6.60
7	Prefix, rounding	prefix='–'	prefix='–.'	prefix='.'	none	none
7a	Prefix, no rounding	prefix='–'	prefix='–.'	prefix='.'	prefix='.'	none
	Formatted result, rounding	–2.05	–.05	.56	1.00	6.60
	Formatted results, no rounding	–2.05	–.05	.55	.99	6.60

The following PROC PRINT steps associates the NOZEROSR. format and the NOZEROS. format with the AMOUNT variable in SAMPLE. The first output shows the result of rounding.

```
proc print data=sample;
   format amount nozerosr.;
   title 'Formatting the Variable Amount';
   title2 'with the NOZEROSR. Format Using Rounding';
run;

proc print data=sample;
   format amount nozeros.;
   title 'Formatting the Variable Amount';
   title2 'with the NOZEROS. Format, No Rounding';
run;
```

Formatting the Variable Amount with the NOZEROSR. Format Using Rounding

Obs	Amount
1	-45.00
2	-2.05
3	-1.00
4	-.05
5	-.02
6	00
7	.09
8	.54
9	.56
10	1.00
11	6.60
12	14.63

Formatting the Variable Amount with the NOZEROS. Format, No Rounding

Obs	Amount
1	-45.00
2	-2.05
3	-.99
4	-.05
5	-.01
6	00
7	.09
8	.54
9	.55
10	.99
11	6.60
12	14.63

CAUTION
The picture must be wide enough for the prefix and the numbers. In this example, if the value –45.00 were formatted with NOZEROS., then the result would be 45.00 because it falls into the first range, low – –1, and the picture for that range is not wide enough to accommodate the prefixed minus sign and the number.

CAUTION
The picture must be wide enough for an additional digit if rounding a number adds a digit to the number. For example, the picture for the number .996 could be '99' (prefix '.' mult=100). After rounding the number and multiplying it by 100, the resulting number is 100. When the picture is applied, the result is .00, an inaccurate number. In order to ensure accuracy of numbers when you round numbers, make the picture wide enough to accommodate larger numbers.

Specifying No Picture

This PICTURE statement creates a *picture-name* format that has no picture:

```
picture picture-name;
```

Using this format has the effect of applying the default SAS format to the values.

SELECT Statement

Selects entries for processing by the FMTLIB and CNTLOUT= options.

Restrictions: Only one SELECT statement can appear in a PROC FORMAT step.

You cannot use a SELECT statement and an EXCLUDE statement within the same PROC FORMAT step.

Example: "Example 15: Printing the Description of Informats and Formats" on page 1183

Syntax

SELECT *entry(s)*;

Required Argument

entry(s)
specifies one or more catalog entries for processing. Catalog entry names are the same as the name of the informat or format that they store. Because informats and formats can have the same name, and because character and numeric informats or formats can have the same name, you must use certain prefixes when specifying informats and formats in the SELECT statement. Follow these rules when specifying entries in the SELECT statement:

- Precede names of entries that contain character formats with a dollar sign ($).

- Precede names of entries that contain character informats with an at sign and a dollar sign (for example, @$*entry-name*).
- Precede names of entries that contain numeric informats with an at sign (@).
- Specify names of entries that contain numeric formats without a prefix.

Details

Shortcuts to Specifying Names

You can use the colon (:) and hyphen (-) wildcard characters to select entries. For example, the following SELECT statement selects all formats or informats that begin with the letter **a**.

```
select a:;
```

In addition, the following SELECT statement selects all formats or informats that occur alphabetically between **apple** and **pear**, inclusive:

```
select apple-pear;
```

How the FMTLIB and CNTLOUT= Options Affect Whether a Catalog Is Opened in Read or Update Mode

Using the FMTLIB and CNTLOUT= options in the SELECT statement indicates whether a catalog is opened for Read or Update mode. The following rules apply:

- If you use the SELECT statement and do not specify the FMTLIB option or the CNTLOUT= option, PROC FORMAT assumes that the catalog is opened in Update mode.
- If you use the SELECT statement and specify the FMTLIB option or the CNTLOUT= option, the catalog is opened for Read access.
- If you use the SELECT statement without the FMTLIB option or the CNTLOUT= option, and the SAS program does not have Write access to the catalog, the following error is written to the SAS log:

```
ERROR: User does not have appropriate authorization level
       for file libref.FORMATS.CATALOG.
```

VALUE Statement

Creates a format that specifies character strings to use to print variable values.

See: *SAS Formats and Informats: Reference* for documentation about SAS formats.

Examples: "Example 8: Creating a Format for Character Values" on page 1160

"Example 11: Writing a Format for Dates Using a Standard SAS Format and a Color Background" on page 1167

"Example 17: Writing Ranges for Character Strings" on page 1187

Syntax

VALUE <$>*name* <(*format-options*)> <*value-range-set(s)*>;

Summary of Optional Arguments

DEFAULT=*length*
: specifies the default length of the format.

FUZZ=*fuzz-factor*
: specifies a fuzz factor for matching values to a range.

MAX=*length*
: specifies a maximum length for the format.

MIN=*length*
: specifies a minimum length for the format.

MULTILABEL
: enables the assignment of multiple labels or external values to internal values.

NOTSORTED
: stores values or ranges in the order in which you define them.

value-range-set(s)
: specifies the assignment of a value or a range of values to a formatted value.

Required Argument

name
names the format that you are creating. If you created a function using the FCMP procedure to use as a format, *name* is the function name without parenthesis.

Restrictions
: The name of a user-defined format cannot be the same as the name of a format that is supplied by SAS.

  Format names cannot end in a number. For more information, see "User-Defined Formats" in *SAS Formats and Informats: Reference* and "Names in the SAS Language" in *SAS Language Reference: Concepts*.

Requirement
: The name must be a valid SAS name. A numeric format name can be up to 32 characters in length. A character format name can be up to 31 characters in length. If you are creating a character format, then use a dollar sign ($) as the first character.

Interaction
: The maximum length of a format name is controlled by the VALIDFMTNAME= system option. See *SAS System Options: Reference* for details.

Tip Refer to the format later by using the name followed by a period. However, do not use a period after the format name in the VALUE statement.

See "Using a Function to Format Values" on page 1132

Optional Arguments

DEFAULT=*length*

specifies the default length of the format. The value for DEFAULT= becomes the length of the format if you do not give a specific length when you associate the format with a variable.

Default The length of the longest label that is assigned to the right of the equal sign

Range 1–32767

Tip As a best practice, always specify the DEFAULT= option if you specify a format as a label.

FUZZ=*fuzz-factor*

specifies a fuzz factor for matching values to a range. If a number does not match or fall in a range exactly but comes within *fuzz-factor*, then the format considers it a match. For example, the following VALUE statement creates the LEVELS. format, which uses a fuzz factor of .2:

```
value levels (fuzz=.2) 1='A'
                       2='B'
                       3='C';
```

FUZZ=.2 means that if a variable value falls within .2 of a value on either end of the range, then the format uses the corresponding formatted value to print the variable value. So the LEVELS. format formats the value 2.1 as `B`.

Default 1E−12 for numeric formats and 0 for character formats.

Tips Specify FUZZ=0 to save storage space when you use the VALUE statement to create numeric formats.

Use a nonzero fuzz factor only with numbers that are very close but not an exact match. Ranges are stored internally in sorted order (unless the NOTSORTED option is used), in order to perform a binary search. When a fuzz-factor is added to the end of one range and subtracted from the beginning of the next range, and the ranges overlap, the results can be unpredictable. A value is placed in the first range that is a match in the binary search. The exclusion operator is insufficient to override this binary search algorithm. As a best practice, when you use the exclusion operator, set FUZZ=0 or the NOTSORTED option

A best practice is to use FUZZ=0 when you use the < exclusion operator with numeric formats.

MAX=*length*
specifies a maximum length for the format. When you associate the format with a variable, you cannot specify a width greater than the MAX= value.

Default 40

Range 1–32767

MIN=*length*
specifies a minimum length for the format.

Default 1

Range 1–32767

MULTILABEL
enables the assignment of multiple labels or external values to internal values. The following VALUE statements show the two uses of the MULTILABEL option. The first VALUE statement assigns multiple labels to a single internal value. Multiple labels can also be assigned to a single range of internal values. The second VALUE statement assigns labels to overlapping ranges of internal values. The MULTILABEL option allows the assignment of multiple labels to the overlapped internal values.

```
value one (multilabel)
    1='ONE'
    1='UNO'
    1='UN';

  value agefmt (multilabel)
    15-29='below 30 years'
    30-50='between 30 and 50'
    51-high='over 50 years'
    15-19='15 to 19'
    20-25='20 to 25'
    25-39='25 to 39'
    40-55='40 to 55'
    56-high='56 and above';
```

Only multilabel-enabled procedures such as PROC MEANS, PROC SUMMARY, and PROC TABULATE can use multiple labels. All other procedures and the DATA step recognize only the primary label.

The primary label for a given entry is the external value that is assigned to the first internal value or range of internal values that matches or contains the entry when all internal values are ordered sequentially. Here is an example:

- In the first VALUE statement, the primary label for 1 is ONE because ONE is the first external value that is assigned to 1. The secondary labels for 1 are UNO and UN.
- In the second VALUE statement, the primary label for 33 is **`25 to 39`** because the range 25–39 is sequentially the first range of internal values that contains 33. The secondary label for 33 is **`between 30 and 50`** because the range 30–50 occurs in sequence after the range 25–39.

Restriction The maximum number of labels that can be created for a single format is 255.

NOTSORTED
stores values or ranges in the order in which you define them. If you do not specify NOTSORTED, then values or ranges are stored in sorted order by default, and SAS uses a binary searching algorithm to locate the range that a particular value falls into. If you specify NOTSORTED, then SAS searches each range in the order in which you define them until a match is found.

Use NOTSORTED if one of the following is true:

- You know the likelihood of certain ranges occurring, and you want your format to search those ranges first to save processing time.
- You want to preserve the order that you define ranges when you print a description of the format using the FMTLIB option.
- You want to preserve the order that you define ranges when you use the ORDER=DATA option and the PRELOADFMT option to analyze class variables in PROC MEANS, PROC SUMMARY, or PROC TABULATE.

Do not use NOTSORTED if the distribution of values is uniform or unknown, or if the number of values is relatively small. The binary searching algorithm that SAS uses when NOTSORTED is not specified optimizes the performance of the search under these conditions.

SAS automatically sets the NOTSORTED option when you use the CPORT and CIMPORT procedures to transport formats between operating environments with different standard collating sequences. This automatic setting of NOTSORTED can occur when you transport formats between ASCII and EBCDIC operating environments. If this situation is undesirable, then do the following:

- Use the CNTLOUT= option in the PROC FORMAT statement to create an output control data set.
- Use the CPORT procedure to create a transport file for the control data set.
- Use the CIMPORT procedure in the target operating environment to import the transport file.
- In the target operating environment, use PROC FORMAT with the CNTLIN= option to build the formats from the imported control data set.

value-range-set(s)
specifies the assignment of a value or a range of values to a formatted value. The *value-range-set(s)* have the following form:

value-or-range-1 <, *value-or-range-2*, ...>=*formatted-value* | [*existing-format*] | [*functionname*]

The variable values on the left side of the equal sign prints as the character string on the right side of the equal sign. The maximum length of each *value-or-range* to the left of the equal sign is 32,767 characters.

value-or-range
For details about how to specify *value-or-range*, see "Specifying Values or Ranges" on page 1129.

formatted-value

specifies a character string that becomes the printed value of the variable value that appears on the left side of the equal sign. Formatted values are always character strings, regardless of whether you are creating a character or numeric format.

Formatted values can be up to 32,767 characters. For hexadecimal literals, you can use up to 32,767 typed characters, or up to 16,382 represented characters at 2 hexadecimal characters per represented character. Some procedures, however, use only the first 8 or 16 characters of a formatted value.

Requirements You must enclose a formatted value in single or double quotation marks. The following example shows a formatted value that is enclosed in double quotation marks:

```
value $ score
   'M'="Male"
   'F'="Female";
```

If a formatted value contains a single quotation mark, then enclose the value in double quotation marks:

```
value sect
   1="Smith's class"
   2="Leung's class";
```

Tip Formatting numeric variables does not preclude the use of those variables in arithmetic operations. SAS uses stored values for arithmetic operations.

existing-format

specifies a format that is supplied by SAS or an existing user-defined format. The format that you are creating uses the existing format to convert the raw data that is a match for *value-or-range* on the left side of the equal sign.

Using an existing format can be thought of as nesting formats. A nested level of one means that if you are creating the format A with the format B as a formatted value, then the procedure has to use only one existing format to create A.

Requirement If you use an existing format, then enclose the format name in square brackets (for example, [date9.]) or with parentheses and vertical bars (for example, (|date9.|)). Do not enclose the name of the existing format in single quotation marks.

Tips Avoid nesting formats more than one level. The resource requirements can increase dramatically with each additional level.

As a best practice, if you specify an existing format in *value-range-set*, always specify a default value by using the DEFAULT= option on page 1123.

functionname
specifies a function that is supplied by SAS or an existing user-defined function.

Tips As a best practice, you should define the default length.

If you create a function using the FCMP procedure to use as a format, *name* is the function name without parenthesis.

See "Using a Function to Format Values"

Examples

Example 1: Create a Format to Print Postal Codes for Selected States

The $STATE. character format prints the postal code for selected states:

```
value $state 'Delaware'='DE'
             'Florida'='FL'
             'Ohio'='OH';
```

The variable value **Delaware** prints as **DE**, the variable value **Florida** prints as **FL**, and the variable value **Ohio** prints as **OH**. Note that the $STATE. format begins with a dollar sign.

Note: Range specifications are case sensitive. In the $STATE. format above, the value **OHIO** would not match any of the specified ranges. If you are not certain what case the data values are in, then one solution is to use the UPCASE function on the data values and specify all uppercase characters for the ranges.

Example 2: Write Numeric Values as Character Values

The numeric format ANSWER. writes the values 1 and 2 as yes and no:

```
value answer 1='yes'
             2='no';
```

Example 3: Specifying No Ranges

This VALUE statement creates a *format-name* format that has no ranges:

```
value format-name;
```

Using this format has the effect of applying the default SAS format to the values.

Example 4: Create a Format Using Existing SAS Formats as Labels

This program creates the MYfmt. format to format dates based on the year.

Note: If the format-as-label or function-as-label is within square brackets, then it is referred to as nested. A format specification in square brackets is followed by at least a period, for example, `[year.]`. A function specification in square brackets is followed by parentheses, for example, `[year()]`. SAS uses the nested format to format the values in the range. For example, see `low-'31DEC2011'd=[year4.]` in the following example. For another example that uses nested formats, see "Example 5: Create a Format for Missing and Nonmissing Values Using an Existing SAS Format as a Label" on page 1128.

```
data test;
  do Date='01jan2006'd to '31dec2013'd;
    do j=1 to rannor(0)*100;
       output;
    end;
  end;
run;
proc format;
   value MYfmt
        /* Format dates prior to 31DEC2011 using only a year. */
        low-'31DEC2011'd=[year4.]

        /* Format 2012 dates using the month and year. */
        '01jan2012'd-'31DEC12'd=[monyy7.]

        /* Format dates 01JAN2013 and beyond using the day, month, and
year. */
        '01JAN2013'd-high=[date9.]

        /* Catch missing values. */
        other='n/a';
run;

proc freq data=test;
      table date /missing;
      format date myfmt.;
run;
```

Example 5: Create a Format for Missing and Nonmissing Values Using an Existing SAS Format as a Label

This program formats missing numeric values with the label N/A, and formats nonmissing values with the existing SAS format 12.1.

```
proc format;
      value myfmt .='N/A' other=[12.1];
run;
```

Usage: FORMAT Procedure

Specifying Values or Ranges

As the syntax of the INVALUE, PICTURE, and VALUE statements indicates, you must specify values as *value-range-sets*. On the left side of the equal sign, you specify the values that you want to convert to other values. On the right side of the equal sign, you specify the values that you want the values on the left side to become. This section discusses the different forms that you can use for *value-or-range*, which represents the values on the left side of the equal sign. For details about how to specify values for the right side of the equal sign, see the "Required Arguments" section for the appropriate statement.

The INVALUE, PICTURE, and VALUE statements accept numeric values on the left side of the equal sign. In character informats, numeric ranges are treated as character strings. INVALUE and VALUE also accept character strings on the left side of the equal sign.

As the syntax shows, you can have multiple occurrences of *value-or-range* in each *value-range-set*, using a comma to separate the occurrences. Each occurrence of *value-or-range* is either one of the following:

value
a single value, such as 12 or **'CA'**. For character formats and informats, enclose the character values in single quotation marks.

You can use the keyword OTHER= as a single value. OTHER= matches all values that do not match any other value or range. OTHER= includes missing values for both numeric and character user-defined formats. You cannot nest a user-defined format by using the format as the value of OTHER=, unless the format is a function that formats values.

If you specify a format that is too narrow to represent a value, then SAS tries to fit the longer label into the available space. SAS truncates character values on the right, and it sometimes reverts numeric values to the BEST*w.d* format. If you do not specify an adequate width for a format, then SAS prints asterisks in the output. In this example, the specified value is two characters, DK. The width of DK is not adequate for the five-character 99999 value, and SAS prints two asterisks in the output.

```
proc format;
   value fmtzip 99999="DK";

data testzip;
   zip=27609;
   output;
```

```
   zip=99999;
   output;
run;

proc print data=testzip;
   format Zip fmtzip.;
run;
```

The result of `zip=99999;` is that `**` appears in the first observation of the column labeled “Zip” in the output table.

One way to prevent this problem from occurring is to assign a width when you apply the format, as in this example.

```
proc format;
   value fmtzip 99999="DK";

data testzip;
   zip=27609;
   output;
   zip=99999;
   output;
run;

proc print data=testzip;
   format Zip fmtzip5.;
run;
```

The result of `format Zip fmtzip5.;` is that adequate space is specified for `27609` to appear correctly in the first observation of the column labeled “Zip” in the output table.

You can also prevent the problem by specifying the DEFAULT or MIN options when you create the format, as in this example.

```
proc format;
   value fmtzip (default=5) 99999="DK";

data testzip;
   zip=27609;
   output;
   zip=99999;
   output;
run;

proc print data=testzip;
   format Zip fmtzip5.;
run;
```

The result of including `(default=5)` in the value specification is that adequate space is specified for `27609` to appear correctly in the first observation of the column labeled “Zip” in the output table.

Adding blank spaces at the end of a specified value increases the width of the value. For example, the specified value DK is not wide enough for 99999. Adding three blank spaces to the value when you specify DK provides five spaces for the 99999 value.

Note: If you add blank spaces to a specified value, be sure to add enough blank spaces to accommodate the longest value that the format might handle.

For more information about how SAS formats widths, see "Syntax " in *SAS Formats and Informats: Reference*.

For more information about format values, see "Using a Function to Format Values" on page 1132. For examples, see "Example 8: Creating a Format for Character Values" on page 1160 and "Example 20: Creating a Function to Use as a Format" on page 1198.

range
a list of values (for example, 12–68 or **'A'-'Z'**). For ranges with character strings, be sure to enclose each string in single quotation marks. For example, if you want a range that includes character strings from A to Z, then specify the range as **'A'-'Z'**, with single quotation marks around the **A** and around the **Z**.

If you specify **'A-Z'**, then the procedure interprets it as a three-character string with **A** as the first character, a hyphen (-) as the second character, and a **Z** as the third character.

In numeric user-defined informats, the procedure interprets an unquoted numeric range on the left side of a *value-range-set* as a numeric range. In a character user-defined informat, the procedure interprets an unquoted numeric range on the left side of a **value-range-set** as a character string. For example, in a character informat, the range **12–86** is interpreted as **'12'–'86'**.

You can use LOW or HIGH as one value in a range, and you can use the range LOW-HIGH to encompass all values. For example, the following are valid ranges:

```
low-'ZZ'
35-high
low-high
other
```

In numeric ranges, LOW includes the lowest numeric value, excluding missing values. HIGH includes the largest value in the range. In character ranges, LOW includes missing values. OTHER includes missing values for both numeric and character formats.

You can use the less than (<) symbol to exclude values from ranges. If you are excluding the first value in a range, then put the < exclusion operator after the value. If you are excluding the last value in a range, then put the < exclusion operator before the value. For example, the following range does not include 0:

```
0<-100
```

Likewise, the following range does not include 100:

```
0-<100
```

> **TIP** When you use the < exclusion operator to place values in ranges, use the option FUZZ=0 in the VALUE statement for numeric formats. This is not necessary for character formats because FUZZ=0 is the default.

If a value at the high end of one range also appears at the low end of another range, and you do not use the < exclusion operator, then PROC FORMAT assigns the value to the first range. For example, in the following ranges, the value **AJ** is part of the first range:

```
'AA'-'AJ'=1 'AJ'-'AZ'=2
```

In this example, to include the value **AJ** in the second range, use the < exclusion operator on the first range:

```
'AA'-<'AJ'=1 'AJ'-'AZ'=2
```

If you overlap values in ranges, then PROC FORMAT returns an error message unless, for the VALUE statement, the MULTILABEL option is specified. For example, the following ranges will cause an error: `'AA'-'AK'=1 'AJ'-'AZ'=2`.

Each *value-or-range* can be up to 32,767 characters. If *value-or-range* has more than 32,767 characters, then the procedure truncates the value after it processes the first 32,767 characters.

Note: You do not have to account for every value on the left side of the equal sign. Those values are converted using the default informat or format. For example, the following VALUE statement creates the TEMP. format, which prints all occurrences of 98.6 as **NORMAL**:

```
value temp 98.6='NORMAL';
```

If the value were 96.9, then the printed result would be **96.9**.

Using a Function to Format Values

SAS provides a way to format a value by first performing a function on a value. By using a function to format values, you can create customized formats. For example, SAS provides four formats to format dates by quarters, YYQ*w*., YYQ*xw*., YYQR*w*., and YYQR*xw*. None of these formats satisfy your requirement to use Q1, Q2, Q3, or Q4. You can create a function using the FCMP procedure that creates the Q1, Q2, Q3, and Q4 values based on a date and a SAS format, and then use that function in the FORMAT procedure to create a format.

Here are the steps to create and use a function to format values:

1. Use the FCMP procedure to create the function.
2. Use the OPTIONS statement to make the function available to SAS by specifying the location of the function in the CMPLIB= system option.

3 Use the FORMAT procedure to create a new format.

4 Use the new format in your SAS program.

Here is an example:

```
/* Create a function that creates the value Qx from a formatted value.
*/

proc fcmp outlib=work.functions.smd;

   function qfmt(date) $;
      length qnum $4;
      qnum=put(date,yyq4.);
      if substr(qnum,3,1)='Q'
         then return(substr(qnum,3,2));
      else return(qnum);
   endsub;
run;

/* Make the function available to SAS. */

options cmplib=(work.functions);

/* Create a format using the function created by the FCMP procedure. */

proc format;
   value qfmt
         other=[qfmt()]; run;

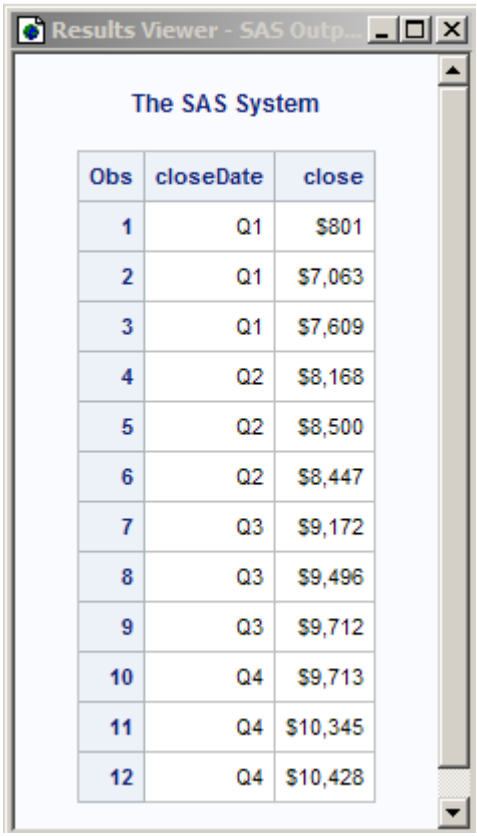
/* Use the format in a SAS program.  */

data djia2013;
      input closeDate date7. close;
      datalines;
01jan13 800.86
02feb13 7062.93
02mar13 7608.92
01apr13 8168.12
01may13 8500.33
01jun13 8447.00
01jul13 9171.61
03aug13 9496.28
01sep13 9712.28
01oct13 9712.73
02nov13 10344.84
02dec13 10428.05
run;

proc print data=djia2013;
format closedate qfmt. close dollar9.;
run;
```

Here is the output:

Output 30.1 *Dow Jones Closings by Quarter*



Obs	closeDate	close
1	Q1	$801
2	Q1	$7,063
3	Q1	$7,609
4	Q2	$8,168
5	Q2	$8,500
6	Q2	$8,447
7	Q3	$9,172
8	Q3	$9,496
9	Q3	$9,712
10	Q4	$9,713
11	Q4	$10,345
12	Q4	$10,428

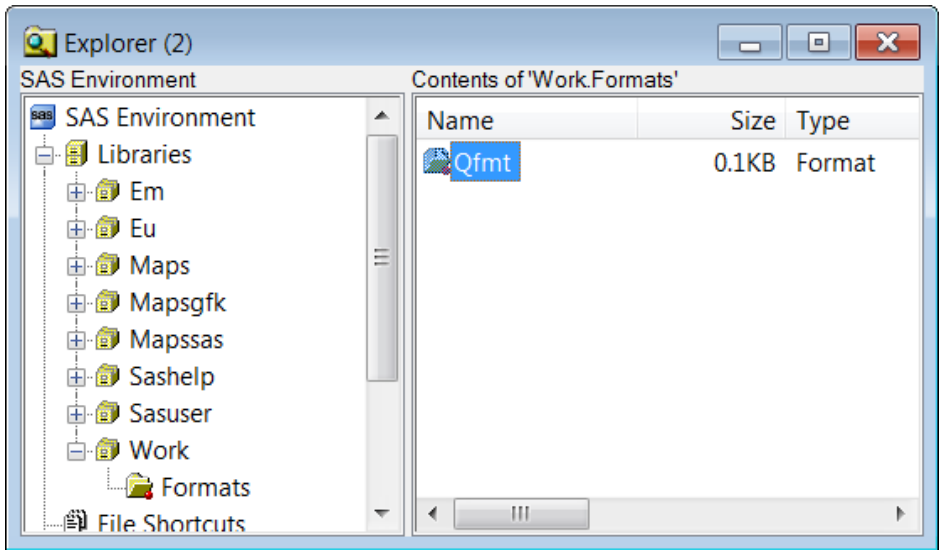
You can use the function format as the value to OTHER=.

Viewing a Format Definition Using SAS Explorer

After you create a format, you can view the definition for the format using SAS Explorer.

1 Select **View** ⇨ **Explorer**.

2 Open the format folder. To view the default format folder, expand **Libraries** ⇨ **Work** and select **Formats**.



3 To view the format description, do one of the following actions on the format name in the contents pane:

- double-click the format name
- right-click the format name and select **View**

The format description appears in the Results Viewer window.

The SAS System

FORMAT NAME: QFMT LENGTH: 6 NUMBER OF VALUES: 1 MIN LENGTH: 1 MAX LENGTH: 40 DEFAULT LENGTH: 6 FUZZ: STD		
START	END	LABEL (VER. V7|V8 11OCT2012:13:08:36)
OTHER	**OTHER**	[QFMT()]

Results: FORMAT Procedure

Output Control Data Set

The output control data set contains information that describes informats or formats. Output control data sets have a number of uses. For example, an output control data set can be edited with a DATA step to programmatically change value ranges or can be subset with a DATA step to create new formats and informats. In addition, you can move formats and informats from one operating environment to another by creating an output control data set, using the CPORT procedure to

create a transfer file of the data set. Then, use the CIMPORT and FORMAT procedures in the target operating environment to create the formats and informats there.

You create an output control data set with the CNTLOUT= option in the PROC FORMAT statement. You use output control data sets, or a set of observations from an output control data set, as an input control data set in a subsequent PROC FORMAT step using the CNTLIN= option.

Output control data sets contain an observation for every value or range in each of the informats or formats in the LIBRARY= catalog. The data set consists of variables that give either global information about each format and informat created in the PROC FORMAT step or specific information about each range and value.

The variables in the output control data set are as follows:

DATATYPE
enables the use of directives in a picture as a template to format date, time, or datetime values.

DECP
specifies the separator character for the fractional part of a number.

DEFAULT
specifies a numeric variable that indicates the default length for format or informat.

DIG3SEP
specifies the three-digit separator character for a number.

END
specifies a character variable that gives the range's ending value.

EEXCL
specifies a character variable that indicates whether the range's ending value is excluded. Valid values are as follows:

Y
specifies that the range's ending value is excluded.

N
specifies that the range's ending value is not excluded.

FILL
for picture formats, specifies a numeric variable whose value is the value of the FILL= option.

FMTNAME
specifies a character variable whose value is the format or informat name.

FUZZ
specifies a numeric variable whose value is the value of the FUZZ= option.

HLO
specifies a character variable that contains range information about the format or informat. The following valid values can appear in any combination:

F
specifies a standard SAS format or informat that is used with a value.

H
specifies that a range's ending value is HIGH.

I
specifies a numeric informat range.

J
specifies justification for an informat.

L
specifies that a range's starting value is LOW.

M
specifies that the MULTILABEL option is in effect.

N
specifies that the format or informat has no ranges, including no OTHER= range.

O
specifies that the range is OTHER.

R
specifies that the ROUND option is in effect.

S
specifies that the NOTSORTED option is in effect.

U
specifies that the UPCASE option for an informat be used.

LABEL
specifies a character variable whose value is associated with a format or an informat.

LANGUAGE
specifies the language that is used for weekdays and months that you can substitute in a date, time, or datetime picture. If you specify a language that is not supported or is invalid, English is used.

LENGTH
specifies a numeric variable whose value is the value of the LENGTH= option.

MAX
specifies a numeric variable whose value is the value of the MAX= option.

MIN
specifies a numeric variable whose value is the value of the MIN= option.

MULT
specifies a numeric variable whose value is the value of the MULT= option.

NOEDIT
for picture formats, specifies a numeric variable whose value indicates whether the NOEDIT option is in effect. Valid values are as follows:

1
specifies that the NOEDIT option is in effect.

0
specifies that the NOEDIT option is not in effect.

PREFIX
for picture formats, specifies a character variable whose value is the value of the PREFIX= option.

SEXCL
specifies a character variable that indicates whether the range's starting value is excluded. Valid values are as follows:

Y
specifies that the range's starting value is excluded.

N
specifies that the range's starting value is not excluded.

START
specifies a character variable that gives the range's starting value.

TYPE
specifies a character variable that indicates the type of format. Possible values are as follows:

C
specifies a character format.

I
specifies a numeric informat.

J
specifies a character informat.

N
specifies a numeric format (excluding pictures).

P
specifies a picture format.

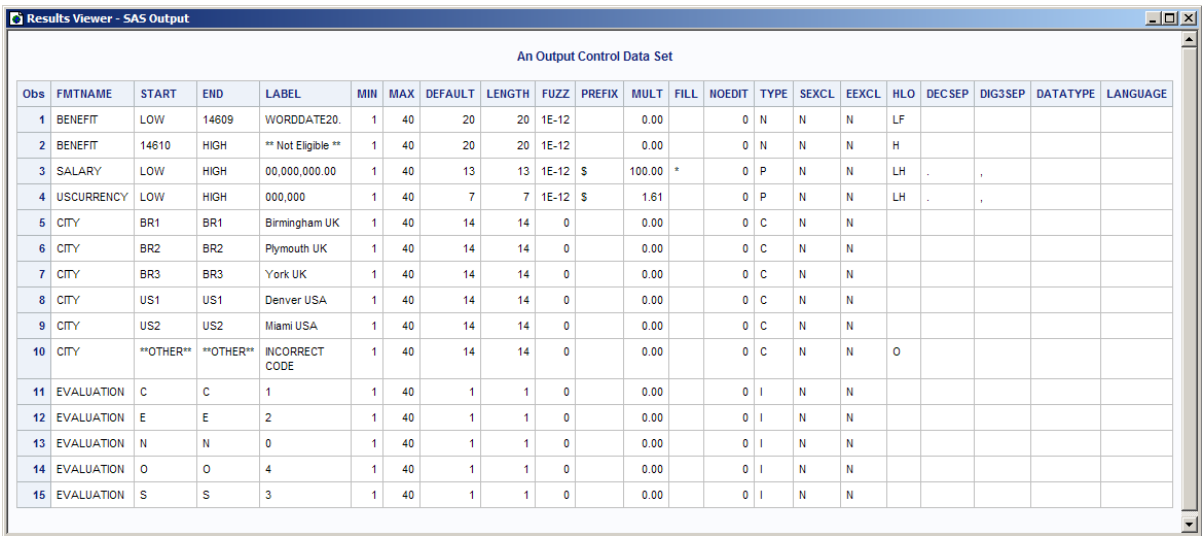
This table specifies TYPE values for creating formats and informats using PROC FORMAT and the CNTLIN option. For example, in Scenario 1 if START=Numeric and LABEL=Numeric, then TYPE=I and you can use the INPUT function to create a numeric column. See "Example 13: Creating a Format from a CNTLIN= Data Set" for an example of creating a format using PROC FORMAT and the CNTLIN option.

Table 30.4 *TYPE Values*

Scenarios	Format/Informat	START	LABEL	TYPE
1	Format	Numeric	Character	N
2	Format	Character	Character	C
3	Informat	Character	Numeric	I
4	Informat	Character	Character	J

The following output shows an output control data set that contains information about all the informats and formats created in the FORMAT procedure examples.

Output 30.2 *Output Control Data Set for PROC FORMAT Examples*



Results Viewer - SAS Output

An Output Control Data Set

Obs	FMTNAME	START	END	LABEL	MIN	MAX	DEFAULT	LENGTH	FUZZ	PREFIX	MULT	FILL	NOEDIT	TYPE	SEXCL	EEXCL	HLO	DECSEP	DIG3SEP	DATATYPE	LANGUAGE
1	BENEFIT	LOW	14609	WORDDATE20.	1	40	20	20	1E-12		0.00		0	N	N	N	LF				
2	BENEFIT	14610	HIGH	** Not Eligible **	1	40	20	20	1E-12		0.00		0	N	N	N	H				
3	SALARY	LOW	HIGH	00,000,000.00	1	40	13	13	1E-12	$	100.00	*	0	P	N	N	LH	.	,		
4	USCURRENCY	LOW	HIGH	000,000	1	40	7	7	1E-12	$	1.61		0	P	N	N	LH	.	,		
5	CITY	BR1	BR1	Birmingham UK	1	40	14	14	0		0.00		0	C	N	N					
6	CITY	BR2	BR2	Plymouth UK	1	40	14	14	0		0.00		0	C	N	N					
7	CITY	BR3	BR3	York UK	1	40	14	14	0		0.00		0	C	N	N					
8	CITY	US1	US1	Denver USA	1	40	14	14	0		0.00		0	C	N	N					
9	CITY	US2	US2	Miami USA	1	40	14	14	0		0.00		0	C	N	N					
10	CITY	**OTHER**	**OTHER**	INCORRECT CODE	1	40	14	14	0		0.00		0	C	N	N	O				
11	EVALUATION	C	C	1	1	40	1	1	0		0.00		0	I	N	N					
12	EVALUATION	E	E	2	1	40	1	1	0		0.00		0	I	N	N					
13	EVALUATION	N	N	0	1	40	1	1	0		0.00		0	I	N	N					
14	EVALUATION	O	O	4	1	40	1	1	0		0.00		0	I	N	N					
15	EVALUATION	S	S	3	1	40	1	1	0		0.00		0	I	N	N					

You can use the SELECT or EXCLUDE statement to control which formats and informats are represented in the output control data set. For details, see "SELECT Statement" on page 1120 and "EXCLUDE Statement" on page 1091.

Input Control Data Set

You specify an input control data set with the CNTLIN= option in the PROC FORMAT statement. The FORMAT procedure uses the data in the input control data set to construct informats and formats. Thus, you can create informats and formats without writing INVALUE, PICTURE, or VALUE statements.

The input control data set must have these characteristics:

- For both numeric and character formats, the data set must contain the variables FMTNAME, START, and LABEL, which are described in "Output Control Data Set" on page 1135. The remaining variables are not always required.
- If you are creating a character format or informat, then you must either begin the format or informat name with a dollar sign ($) or specify a TYPE variable with the value `C`.
- If you are creating a PICTURE statement format, then you must specify a TYPE variable with the value `P`.
- If you are creating a format with ranges of input values, then you must specify the END variable. If range values are to be noninclusive, then the variables SEXCL and EEXCL must each have a value of `Y`. Inclusion is the default.
- If you are creating a format with the CNTLIN= option, the value of LOW or OTHER for the START variable and the value of HIGH for the END variable are interpreted as their corresponding keywords of LOW, OTHER, or HIGH. This interpretation occurs whether you specify the values in uppercase or lowercase. If you want the explicit values of LOW, OTHER, or HIGH to be used, then specify the HLO variable with the values as described below.

If you specify `START='LOW'`, and the HLO variable does not contain 'L', then the literal value of LOW is used. If you specify `START='OTHER'`, and the HLO variable does not contain 'O', then the literal value of OTHER is used. If you specify `END='HIGH'`, and the HLO variable does not contain 'H', then the literal value of HIGH is used.

You can create more than one format from an input control data set if the observations for each format are grouped together.

You can use a VALUE, INVALUE, or PICTURE statement in the same PROC FORMAT step with the CNTLIN= option. If the VALUE, INVALUE, or PICTURE statement is creating the same informat or format that the CNTLIN= option is creating, then the VALUE, INVALUE, or PICTURE statement creates the informat or format and the CNTLIN= data set is not used. However, you can create an informat or format with VALUE, INVALUE, or PICTURE and create a different informat or format with CNTLIN= in the same PROC FORMAT step.

For an example featuring an input control data set, see "Example 13: Creating a Format from a CNTLIN= Data Set" on page 1173.

Procedure Output

The FORMAT procedure prints output only when you specify the FMTLIB option or the PAGE option in the PROC FORMAT statement. The printed output is a table for each format or informat entry in the catalog that is specified in the LIBRARY= option. The output also contains global information and the specifics of each value or range that is defined for the format or informat. You can use the SELECT or EXCLUDE statement to control which formats and informats are represented in the FMTLIB output. For details, see "SELECT Statement" on page 1120 and "EXCLUDE Statement" on page 1091. For an example, see "Example 15: Printing the Description of Informats and Formats" on page 1183.

The FMTLIB output shown in the following output contains a description of the $CITY. format, which is created in "Example 8: Creating a Format for Character Values" on page 1160, and the EVALUATION. informat, which is created in "Example 12: Converting Raw Character Data to Numeric Values" on page 1170.

Output 30.3 *Output from PROC FORMAT with the FMTLIB Option*

FORMAT NAME: $CITY LENGTH: 14 NUMBER OF VALUES: 6
MIN LENGTH: 1 MAX LENGTH: 40 DEFAULT LENGTH: 14 FUZZ: 0

START	END	LABEL (VER. V7|V8 12OCT2012:11:33:26)
BR1	BR1	Birmingham UK
BR2	BR2	Plymouth UK
BR3	BR3	York UK
US1	US1	Denver USA
US2	US2	Miami USA
OTHER	**OTHER**	INCORRECT CODE

INFORMAT NAME: @EVALUATION LENGTH: 1
MIN LENGTH: 1 MAX LENGTH: 40 DEFAULT LENGTH: 1 FUZZ: 0

START	END	INVALUE(VER. 9.4 12OCT2012:11:34:18)
C	C	1
E	E	2

INFORMAT NAME: @EVALUATION LENGTH: 1
MIN LENGTH: 1 MAX LENGTH: 40 DEFAULT LENGTH: 1 FUZZ: 0

START	END	INVALUE (CONT'D)
N	N	0
O	O	4
S	S	3

The fields are described below in the order in which they appear in the output, from left to right:

INFORMAT NAME or **FORMAT NAME**
the name of the informat or format. Informat names begin with an at-sign (@).

LENGTH
the length of the informat or format. PROC FORMAT determines the length in the following ways:

- For character informats, the value for LENGTH is the length of the longest raw data value on the left side of the equal sign.
- For numeric informats, the following is true:
  - LENGTH is 12 if all values on the left side of the equal sign are numeric.

- LENGTH is the same as the longest raw data value on the left side of the equal sign.

- For formats, the value for LENGTH is the length of the longest value on the right side of the equal sign.

In the output for $CITY., the LENGTH is 14 because the longest picture is 14 characters.

In the output for @EVALUATION., the length is 1 because 1 is the longest raw data value on the left side of the equal sign.

NUMBER OF VALUES
the number of values or ranges associated with the informat or format. NOZEROS. has 4 ranges, and EVAL. has 5.

MIN LENGTH
the minimum length of the informat or format. The value for MIN LENGTH is 1 unless you specify a different minimum length with the MIN= option.

MAX LENGTH
the maximum length of the informat or format. The value for MAX LENGTH is 40 unless you specify a different maximum length with the MAX= option.

DEFAULT LENGTH
the length of the longest value in the INVALUE or LABEL field, or the value of the DEFAULT= option.

FUZZ
the fuzz factor. For informats, FUZZ always is 0. For formats, the value for this field is STD if you do not use the FUZZ= option. STD signifies the default fuzz value.

START
the beginning value of a range. FMTLIB prints only the first 16 characters of a value in the START and END columns.

END
the ending value of a range. The exclusion sign (<) appears after the values in START and END, if the value is excluded from the range.

INVALUE
appears only for informats and contains the values that have informats. The SAS version specifies the version in which the informat is compatible. The date indicates the date in which the informat was created.

Note: If SAS displays version numbers V7 | V8, then the informat is compatible with those versions. If it is not compatible with earlier releases, the release that created the informat is shown. Version V9 supports long informat names (more than eight characters), and V7 | V8 do not.

LABEL
LABEL appears only for formats and contains either the formatted value or picture. The SAS version specifies the version in which the format is compatible. The date indicates the date in which the format was created.

Note: If SAS displays version numbers V7 | V8, then the format is compatible with those versions. If it is not compatible with earlier releases, the release that created the format is shown. Version V9 supports long format names (more than eight characters), and V7 | V8 do not.

For picture formats, such as NOZEROS., the LABEL section contains the PREFIX=, FILL=, and MULT= values. To note these values, FMTLIB prints the letters **P**, **F**, and **M** to represent each option, followed by the value. For example, in the LABEL section, **P-.** indicates that the prefix value is a hyphen followed by a period.

FMTLIB prints only 40 characters in the LABEL column.

Examples: FORMAT Procedure

Example 1: Create a Format Library in a CAS Session

Features: PROC FORMAT statement option
CASFMTLIB
CAS statement

Details

This example uses the CASFMTLIB option to create a format library in a CAS session. It associates the format library with a table in the WORK directory and assigns a CAS engine libref.

Program

```
cas casauto sessopts=(caslib="casuser");
caslib _all_ assign;

libname proclib cas;
proc format casfmtlib='myformats';
     value hospx
```

```
      1='New_York            '
      2='Massachusetts_General'
      3='Los_Angeles'
      4='Mary_Fletcher';
run;

data clinicalTrial;
  input hospital treatment $ @@;
  severity=rannor(1323)*5 + 10;
  format hospital hospx.;
  cards;
3 B  3 B  3 C   3 C
1 A  1 A  1 A   1 B
1 B  1 B  1 C   1 C
1 C  1 D  1 D   1 D
2 A  2 A  2 A   2 B
2 B  2 B  2 C   2 C
2 C  2 D  2 D   2 D
3 A  3 A  3 A   3 B
3 C  3 D  3 D   3 D
4 A  4 A  4 A   4 B
4 B  4 B  4 C   4 C
4 C  4 D  4 D   4 D
;

data proclib.clinicalTrial;
       set work.clinicalTrial;
run;

proc regselect data=proclib.clinicalTrial;   class treatment hospital;
   model severity=treatment hospital;
run;
```

Program Description

Create a format library in a CAS session. Assign a library with the LIBNAME statement. PROC FORMAT creates a format named *hospx*. The CASFMTLIB option specifies the name of the format library *myformats* in the CAS session.

```
cas casauto sessopts=(caslib="casuser");
caslib _all_ assign;

libname proclib cas;
proc format casfmtlib='myformats';
     value hospx
       1='New_York            '
       2='Massachusetts_General'
       3='Los_Angeles'
       4='Mary_Fletcher';
run;
```

Associate the HOSPX format with a column or variable.

```
data clinicalTrial;
  input hospital treatment $ @@;
  severity=rannor(1323)*5 + 10;
```

```
  format hospital hospx.;
  cards;
3 B  3 B  3 C   3 C
1 A  1 A  1 A   1 B
1 B  1 B  1 C   1 C
1 C  1 D  1 D   1 D
2 A  2 A  2 A   2 B
2 B  2 B  2 C   2 C
2 C  2 D  2 D   2 D
3 A  3 A  3 A   3 B
3 C  3 D  3 D   3 D
4 A  4 A  4 A   4 B
4 B  4 B  4 C   4 C
4 C  4 D  4 D   4 D
;
```

Send actions to the CAS session. The LIBNAME statement assigns a CAS engine libref that is used to identify the table in the REGSELECT procedure step.

```
data proclib.clinicalTrial;
        set work.clinicalTrial;
run;

proc regselect data=proclib.clinicalTrial;   class treatment hospital;
   model severity=treatment hospital;
run;
```

LOG

Example Code 30.1 *Create a Format Library in a CAS Session, Part 1*

```
1          OPTIONS NONOTES NOSTIMER NOSOURCE NOSYNTAXCHECK;
 56
 57         cas casauto sessopts=(caslib="casuser");
 NOTE: 'CASUSER(userid)' is now the active caslib.
 NOTE: The CAS statement request to update one or more session options        for
session CASAUTO completed.
 58         caslib _all_ assign;
 NOTE: A SAS Library associated with a caslib can only reference library member
       names that conform to SAS Library naming conventions.
 NOTE: CASLIB CASUSER(userid) for session CASAUTO will be mapped to SAS Library
CASUSER.
 NOTE: CASLIB Formats for session CASAUTO will be mapped to SAS Library FORMATS.
 NOTE: CASLIB Models for session CASAUTO will be mapped to SAS Library MODELS.
 NOTE: CASLIB Public for session CASAUTO will be mapped to SAS Library PUBLIC.
 59
 60         libname proclib cas;
 NOTE: Libref PROCLIB was successfully assigned as follows:
       Engine:        CAS
       Physical Name: c0d2aee4-4628-5b42-b740-513df8d08070
 61         proc format casfmtlib='myformats';
 NOTE: Both CAS based formats and catalog-based formats will be written.
       The CAS based formats will be written to the session
       CASAUTO.
 62              value hospx
 63                1='New_York            '
 64                2='Massachusetts_General'
 65                3='Los_Angeles'
 66                4='Mary_Fletcher';
 NOTE: Format library MYFORMATS added. Format search update using parameter
       APPEND completed.
 NOTE: Format HOSPX has been output.
 67         run;

 NOTE: PROCEDURE FORMAT used (Total process time):
       real time           0.04 seconds
       cpu time            0.00 seconds

 68
 69         data clinicalTrial;
 70           input hospital treatment $ @@;
 71           severity=rannor(1323)*5 + 10;
 72           format hospital hospx.;
 73           datalines;

 NOTE: SAS went to a new line when INPUT statement reached past the end
       of a line.
 NOTE: The data set WORK.CLINICALTRIAL has 48 observations and 3 variables.
 NOTE: DATA statement used (Total process time):
       real time           0.00 seconds
       cpu time            0.01 seconds
```

Example Code 30.2 *Create a Format Library in a CAS Session, Part 2*

```
88         data proclib.clinicalTrial;
89                 set work.clinicalTrial;
90         run;

NOTE: There were 48 observations read from the data set WORK.CLINICALTRIAL.
NOTE: The data set PROCLIB.CLINICALTRIAL has 48 observations and 3 variables.
NOTE: DATA statement used (Total process time):
      real time           0.08 seconds
      cpu time            0.01 seconds

91
92         proc regselect data=proclib.clinicalTrial;
93            class treatment hospital;
94            model severity=treatment hospital;
95         run;

NOTE: The Cloud Analytic Services server processed the request in
      0.065319 seconds.
NOTE: PROCEDURE REGSELECT used (Total process time):
      real time           0.25 seconds
      cpu time            0.10 seconds

96
97
98         OPTIONS NONOTES NOSTIMER NOSOURCE NOSYNTAXCHECK;
```

Creating a Format Library in a CAS Session

The output is divided into sections only for documentation appearances.

The REGSELECT Procedure

Number of Observations Read	48
Number of Observations Used	48

Class Level Information

Class	Levels	Values
treatment	4	A B C D
hospital	4	Los_Angeles Mary_Fletcher Massachusetts_General New_York

Dimensions

Number of Effects	3
Number of Parameters	9

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	251.03651	41.83942	2.02	0.0845
Error	41	848.39550	20.69257		
Corrected Total	47	1099.43201			

Root MSE	4.54891
R-Square	0.22833
Adj R-Sq	0.11541
AIC	201.86300
AICC	205.55531
SBC	164.96141
ASE	17.67491

Parameter Estimates

Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	13.240102	1.737143	7.62	<.0001
treatment A	1	1.825309	1.857084	0.98	0.3314
treatment B	1	-1.711518	1.857084	-0.92	0.3621
treatment C	1	-2.357254	1.857084	-1.27	0.2115
treatment D	0	0	.	.	.
hospital Los_Angeles	1	-2.844992	1.857084	-1.53	0.1332
hospital Mary_Fletcher	1	-2.539727	1.857084	-1.37	0.1789
hospital Massachusetts_General	1	-4.498280	1.857084	-2.42	0.0199
hospital New_York	0	0	.	.	.

Task Timing

Task	Seconds	Percent
Setup and Parsing	0.00	6.29%
Levelization	0.01	59.60%
Model Initialization	0.00	0.29%
SSCP Computation	0.00	16.01%
Model Fitting	0.00	1.69%
Cleanup	0.00	16.00%
Total	0.02	100.00%

Example 2: Create the Example Data Set

Details

Several examples in this section use the PROCLIB.STAFF data set. In addition, many of the informats and formats that are created in these examples are stored in Library.Formats. The output data set shown in "Output Control Data Set" on page 1135 contains a description of these informats and the formats.

The variables are about a small subset of employees who work for a corporation that has sites in the U.S. and Britain. The data contain the name, identification number, salary (in British pounds), location, and date of hire for each employee.

Program

```
libname proclib 'SAS-library';

data proclib.staff;
   infile datalines dlm='#';
   input Name & $16. IdNumber $ Salary
         Site $ HireDate date8.;
   format hiredate date8.;
   datalines;
Capalleti, Jimmy#  2355# 21163# BR1# 30JAN13
Chen, Len#         5889# 20976# BR1# 18JUN06
Davis, Brad#       3878# 19571# BR2# 20MAR04
Leung, Brenda#     4409# 34321# BR2# 18SEP94
Martinez, Maria#   3985# 49056# US2# 10JAN93
Orfali, Philip#    0740# 50092# US2# 16FEB03
Patel, Mary#       2398# 35182# BR3# 02FEB90
Smith, Robert#     5162# 40100# BR5# 15APR06
Sorrell, Joseph#   4421# 38760# US1# 19JUN11
Zook, Carla#       7385# 22988# BR3# 18DEC10
;
```

Program Description

```
libname proclib 'SAS-library';
```

Create the data set PROCLIB.STAFF. The INPUT statement assigns the names Name, IdNumber, Salary, Site, and HireDate to the variables that appear after the DATALINES statement. The FORMAT statement assigns the standard SAS format DATE7. to the variable HireDate.

```
data proclib.staff;
   infile datalines dlm='#';
   input Name & $16. IdNumber $ Salary
         Site $ HireDate date8.;
   format hiredate date8.;
   datalines;
Capalleti, Jimmy#  2355# 21163# BR1# 30JAN13
Chen, Len#         5889# 20976# BR1# 18JUN06
Davis, Brad#       3878# 19571# BR2# 20MAR04
Leung, Brenda#     4409# 34321# BR2# 18SEP94
Martinez, Maria#   3985# 49056# US2# 10JAN93
Orfali, Philip#    0740# 50092# US2# 16FEB03
Patel, Mary#       2398# 35182# BR3# 02FEB90
Smith, Robert#     5162# 40100# BR5# 15APR06
Sorrell, Joseph#   4421# 38760# US1# 19JUN11
Zook, Carla#       7385# 22988# BR3# 18DEC10
;
```

Example 3: Creating a Picture Format

Features:
- PROC FORMAT statement options
  - LIBRARY=
- PICTURE statement options
  - MULT=
  - PREFIX=
- LIBRARY libref
- LOW and HIGH keywords

Data set: PROCIB.STAFF from Example 1

Details

This example uses a PICTURE statement to create a format that prints the values for the variable Salary in the data set PROCLIB.STAFF in U.S. dollars.

Program

```
libname proclib 'SAS-library-1';
libname library 'SAS-library-2';

options nodate pageno=1 linesize=80 pagesize=40;

   proc format library=library;

      picture uscurrency low-high='000,000' (mult=1.61 prefix='$');
   run;
```

```
proc print data=proclib.staff noobs label;

   label salary='Salary in U.S. Dollars';
   format salary uscurrency.;

   title 'PROCLIB.STAFF with a Format for the Variable Salary';
run;
```

Program Description

Assign two SAS library references (PROCLIB and LIBRARY). Assigning a library reference LIBRARY is useful in this case because if you use PROC FORMAT, then SAS automatically searches for informats and formats in any library that is referenced with the LIBRARY libref.

```
libname proclib 'SAS-library-1';
libname library 'SAS-library-2';
```

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Specify that user-defined formats will be stored in the catalog Library.Formats. The LIBRARY= option specifies a SAS catalog that will contain the formats or informats that you create with PROC FORMAT. When you create the library named LIBRARY, SAS automatically creates a catalog named FORMATS inside LIBRARY.

```
proc format library=library;
```

Define the USCURRENCY. picture format. The PICTURE statement creates a template for printing numbers. LOW-HIGH ensures that all values are included in the range. The MULT= statement option specifies that each value is multiplied by 1.61. The PREFIX= statement adds a US dollar sign to any number that you format. The picture contains six digit selectors, five for the salary and one for the dollar sign prefix.

```
   picture uscurrency low-high='000,000' (mult=1.61 prefix='$');
run;
```

Print the PROCLIB.STAFF data set. The NOOBS option suppresses the printing of observation numbers. The LABEL option uses variable labels instead of variable names for column headings.

```
proc print data=proclib.staff noobs label;
```

Specify a label and format for the Salary variable. The LABEL statement substitutes the specific label for the variable in the report. In this case, “Salary in US Dollars” is substituted for the variable Salary for this print job only. The FORMAT statement associates the USCurrency. format with the variable name Salary for the duration of this procedure step.

```
label salary='Salary in U.S. Dollars';
format salary uscurrency.;
```

Specify the title.

```
   title 'PROCLIB.STAFF with a Format for the Variable Salary';
run;
```

Output

Output 30.4 *PROCLIB.STAFF with a Format for the Variable Salary*

PROCLIB.STAFF with a Format for the Variable Salary

Name	IdNumber	Salary in U.S. Dollars	Site	HireDate
Capalleti, Jimmy	2355	$34,072	BR1	30JAN09
Chen, Len	5889	$33,771	BR1	18JUN06
Davis, Brad	3878	$31,509	BR2	20MAR04
Leung, Brenda	4409	$55,256	BR2	18SEP94
Martinez, Maria	3985	$78,980	US2	10JAN93
Orfali, Philip	0740	$80,648	US2	16FEB03
Patel, Mary	2398	$56,643	BR3	02FEB90
Smith, Robert	5162	$64,561	BR5	15APR06
Sorrell, Joseph	4421	$62,403	US1	19JUN11
Zook, Carla	7385	$37,010	BR3	18DEC10

Example 4: Creating a Picture Format for Large Dollar Amounts

Features: PICTURE statement option
MULT

Format: BIGMONEY.

Details

This example uses the MULT option of the PICTURE statement to format dollars that displays M, B, or T to indicate millions, billions, and trillions of dollars,

respectively. The example uses exponential notation as well as decimal notation in the format definition.

> **TIP** This example uses dollar values without cents and rounding is not necessary. If your dollar values include cents, you can use the ROUND option in the PICTURE statement to round values to the nearest dollar value. For more information, see "ROUND" on page 1106.

Program

```
proc format;
   picture bigmoney (fuzz=0)
      1E06-<1000000000='0000 M' (prefix='$' mult=.000001)
      1E09-<1000000000000='0000 B' (prefix='$' mult=1E-09)
      1E12-<1000000000000000='0000 T' (prefix='$' mult=1E-012);
run;

data mult;
   do i=5 to 12;
      x=16**i;
      put x=comma20. x= bigmoney.;
   end;
run;
```

Program Description

Create the BIGMONEY format. The BIGMONEY. format defines three value-range sets to format millions, billions, and trillions of dollars. 1E06 is one million, 1E09 is one billion, and 1E12 is one trillion. The < exclusion operator indicates not to include the number that follows in the range. A best practice is to use the FUZZ=0 option when you use the exclusion operator to ensure accurate numbers. For a million dollars, the range is 1,000,000 to 999,999,999. The label that is specified on the right side of the equal sign uses 4 zeros as digit selectors. The zero-digit selector specifies not to print leading zeros. The first digit selector is necessary to print the $ prefix symbol when the value is three digits. The value .000001 for the MULT= option is another way to write 1E-06, which is one millionth. Multiplying a value by the millionth, billionth, and trillionth multipliers return the number of millions, billions, and trillions of dollars.

```
proc format;
   picture bigmoney (fuzz=0)
      1E06-<1000000000='0000 M' (prefix='$' mult=.000001)
      1E09-<1000000000000='0000 B' (prefix='$' mult=1E-09)
      1E12-<1000000000000000='0000 T' (prefix='$' mult=1E-012);
run;
```

Generate large numbers to format as dollars.

```
data mult;
   do i=5 to 12;
```

```
      x=16**i;
      put x=comma20. x= bigmoney.;
   end;
run;
```

LOG

Example Code 30.3 *Formatted Millions, Billions, and Trillions Dollar Amounts*

```
x=1,048,576 x=$1 M
x=16,777,216 x=$16 M
x=268,435,456 x=$268 M
x=4,294,967,296 x=$4 B
x=68,719,476,736 x=$68 B
x=1,099,511,627,776 x=$1 T
x=17,592,186,044,416 x=$17 T
x=281,474,976,710,656 x=$281 T
```

Program

```
proc format;
   picture bigmoney (fuzz=0)
      1E06-<1000000000='0000.99 M' (prefix='$' mult=.0001)
      1E09-<1000000000000='0000.99 B' (prefix='$' mult=1E-07)
      1E12-<1000000000000000='0000.99 T' (prefix='$' mult=1E-010);
run;

data mult;
   do i=5 to 12;
      x=16**i;
      put x=comma20. x= bigmoney.;
   end;
run;
```

Program Description

In this program, the BIGMONEY. format is modified to display a more accurate number by adding decimal values.

Modify the BIGMONEY format. To display a more accurate number, the picture value and the MULT= value are modified. To display two decimal values, .99 is added to the picture. To calculate two decimal values, the value in the MULT= option is reduced from one millionth to one ten-thousandth. When 16^5 is multiplied by .0001, the results is 104.8576. The decimal values are truncated and the 104 is placed in the picture beginning on the right. The resulting formatted value is 1.04 M.

```
proc format;
   picture bigmoney (fuzz=0)
      1E06-<1000000000='0000.99 M' (prefix='$' mult=.0001)
      1E09-<1000000000000='0000.99 B' (prefix='$' mult=1E-07)
```

```
      1E12-<1000000000000000='0000.99 T' (prefix='$' mult=1E-010);
run;
```

Generate large numbers to format as dollars.

```
data mult;
   do i=5 to 12;
      x=16**i;
      put x=comma20. x= bigmoney.;
   end;
run;
```

LOG

Example Code 30.4 *More Precisely Formatted Large Dollar Amounts*

```
x=1,048,576 x=$1.04 M
x=16,777,216 x=$16.77 M
x=268,435,456 x=$268.43 M
x=4,294,967,296 x=$4.29 B
x=68,719,476,736 x=$68.71 B
x=1,099,511,627,776 x=$1.09 T
x=17,592,186,044,416 x=$17.59 T
x=281,474,976,710,656 x=$281.47 T
```

Example 5: Filling a Picture Format

Features: PICTURE statement options
FILL=
PREFIX=

Details

This example does the following tasks:

- prefixes the formatted value with a specified character
- fills the leading blanks with a specified character
- shows the interaction between the FILL= and PREFIX= options

Program

```
data pay;
   input Name $ MonthlySalary;
```

```
   datalines;
Liu   1259.45
Lars  1289.33
Kim   1439.02
Wendy 1675.21
Alex  1623.73
;

proc format;
   picture salary low-high='00,000,000.00' (fill='*' prefix='$');
run;

proc print data=pay noobs;
   format monthlysalary salary.;

   title 'Printing Salaries for a Check';
run;
```

Program Description

Create the PAY data set. The PAY data set contains the monthly salary for each employee.

```
data pay;
   input Name $ MonthlySalary;
   datalines;
Liu   1259.45
Lars  1289.33
Kim   1439.02
Wendy 1675.21
Alex  1623.73
;
```

Define the SALARY. picture format and specify how the picture will be filled. When FILL= and PREFIX= PICTURE statement options appear in the same picture, the format places the prefix and then the fill characters. The SALARY. format fills the picture with the fill character because the picture has zeros as digit selectors. The left-most comma in the picture is replaced by the fill character.

```
proc format;
   picture salary low-high='00,000,000.00' (fill='*' prefix='$');
run;
```

Print the PAY data set. The NOOBS option suppresses the printing of observation numbers. The FORMAT statement temporarily associates the SALARY. format with the variable MonthlySalary.

```
proc print data=pay noobs;
   format monthlysalary salary.;
```

Specify the title.

```
   title 'Printing Salaries for a Check';
run;
```

Output

Output 30.5 *Printing Salaries for a Check*

Printing Salaries for a Check

Name	Monthly Salary
Liu	****$1,259.45
Lars	****$1,289.33
Kim	****$1,439.02
Wendy	****$1,675.21
Alex	****$1,623.73

Example 6: Create a Date or Time Format with Directives

Features: PICTURE statement option
DATATYPE=TIME
directives

Details

This example uses directives to format date, time, and datetime values. It also uses directives on more than one value-range pair.

Program

```
proc format;
   picture mytime  (round)
      low-<86400='%H hours, %M minutes'          (datatype=time)    1
      86400-high='%n days, %H hours, %M minutes' (datatype=time) ; 2
      /*  86400=number of seconds in one day */
run;

data test;
   input xtime;
   newtime=put(xtime,mytime.);
datalines;
```

```
12345
46987
86400
99999
172800
1012345
3333333
;

run;

proc print data=test;
run;
```

Program Description

Use directives with the keywords LOW, HIGH, and LOW–HIGH. The directives format the date, time, and datetime values.

```
proc format;
   picture mytime  (round)
      low-<86400='%H hours, %M minutes'          (datatype=time)    1
      86400-high='%n days, %H hours, %M minutes' (datatype=time) ; 2
      /*  86400=number of seconds in one day */
run;
```

1 The %H and %M directives specify that the hours and minutes are identified in the output. The DATATYPE option enables the use of directives in the picture.

2 The %n, %H, %M directives specify that the days, hours, and minutes are identified in the output.

Create the data set.

```
data test;
   input xtime;
   newtime=put(xtime,mytime.);
datalines;
12345
46987
86400
99999
172800
1012345
3333333
;

run;
```

Print the contents of the data set.

```
proc print data=test;
run;
```

Output 30.6 *The Test data set with formatted values*

The SAS System

Obs	xtime	newtime
1	12345	3 hours, 25 minutes
2	46987	13 hours, 3 minutes
3	86400	1 days, 0 hours, 0 minutes
4	99999	1 days, 3 hours, 46 minutes
5	172800	2 days, 0 hours, 0 minutes
6	1012345	11 days, 17 hours, 12 minutes
7	3333333	38 days, 13 hours, 55 minutes

Example 7: Change the 24–Hour Clock to 00:00:01–24:00:00

Features: PICTURE statement option
DATATYPE=DATETIME_UTIL

Details

At times, you might need to express midnight as 24:00, or you need to use a datetime hour range 00:00:01–24:00:00. The hour value range for DATATYPE=DATETIME is 00:00:00–23:59:59. This example uses the option DATATYPE=DATETIME_UTIL to express hours in the range 00:00:01–24:00:00, and shows a date change if you use 00:00:00.

Program

```
proc format;
  picture  hours (default=19)
          other='%Y-%0m-%0d %0H:%0M:%0S' (datatype=datetime_util);
run;

data _null_;
  x = '01jul2015:00:00:01'dt; put x=hours.;
  x = '01jul2015:00:00:00'dt; put x=hours.;
run;
```

Program Description

Use the DATATYPE=DATETIME_UTIL option to use the hour range 00:00:01–24:00:00.

```
proc format;
  picture  hours (default=19)
          other='%Y-%0m-%0d %0H:%0M:%0S' (datatype=datetime_util);
run;
```

Compare Date Values. The first datetime value is in the range 00:00:01 and shows the day as July 1. The second datetime value is not in the range 00:00:01–24:00:00 and shows results as midnight of the previous day.

```
data _null_;
  x = '01jul2015:00:00:01'dt; put x=hours.;
  x = '01jul2015:00:00:00'dt; put x=hours.;
run;
```

Log

Example Code 30.5 *Using Hour Range 00:00:01–24:00:00*

```
x=2015-07-01 00:01:00
x=2015-06-30 24:00:00
```

Example 8: Creating a Format for Character Values

Features: VALUE statement option
OTHER

Data set: PROCLIB.STAFF

Format: USCURRENCY. from Example 2

Details

This example uses a VALUE statement to create a character format that prints a value of a character variable as a different character string.

Program

```
libname proclib 'SAS-library-1';
```

```
libname library 'SAS-library-2';


   proc format library=library;

      value  $city 'BR1'='Birmingham UK'
                   'BR2'='Plymouth UK'
                   'BR3'='York UK'
                   'US1'='Denver USA'
                   'US2'='Miami USA'
                   other='INCORRECT CODE';
   run;

proc print data=proclib.staff noobs label;

   label salary='Salary in U.S. Dollars';

   format salary uscurrency. site $city.;

   title 'PROCLIB.STAFF with a Format for the Variables';
   title2 'Salary and Site';
run;
```

Program Description

Assign two SAS library references (PROCLIB and LIBRARY). Assigning a library reference LIBRARY is useful in this case because if you use PROC FORMAT, then SAS automatically searches for informats and formats in any library that is referenced with the LIBRARY libref.

```
libname proclib 'SAS-library-1';
libname library 'SAS-library-2';
```

Create the catalog named Library.Formats, where the user-defined formats will be stored. The LIBRARY= option specifies a permanent storage location for the formats that you create. It also creates a catalog named FORMAT in the specified library. If you do not use LIBRARY=, then SAS temporarily stores formats and informats that you create in a catalog named Work.Formats.

```
   proc format library=library;
```

Define the $CITY. format. The special codes BR1, BR2, and so on, are converted to the names of the corresponding cities. The keyword OTHER specifies that values in the data set that do not match any of the listed city code values are converted to the value INCORRECT CODE.

```
      value  $city 'BR1'='Birmingham UK'
                   'BR2'='Plymouth UK'
                   'BR3'='York UK'
                   'US1'='Denver USA'
                   'US2'='Miami USA'
                   other='INCORRECT CODE';
   run;
```

Print the PROCLIB.STAFF data set. The NOOBS option suppresses the printing of observation numbers. The LABEL option uses variable labels instead of variable names for column headings.

```
proc print data=proclib.staff noobs label;
```

Specify a label for the Salary variable. The LABEL statement substitutes the label "Salary in U.S. Dollars" for the name SALARY.

```
label salary='Salary in U.S. Dollars';
```

Specify formats for Salary and Site. The FORMAT statement temporarily associates the USCURRENCY. format with the variable SALARY and also temporarily associates the format $CITY. with the variable SITE.

```
format salary uscurrency. site $city.;
```

Specify the titles.

```
title 'PROCLIB.STAFF with a Format for the Variables';
title2 'Salary and Site';
run;
```

Output

Output 30.7 *PROCLIB.STAFF with Formatted Variables for Salary and Site*

PROCLIB.STAFF with a Format for the Variables Salary and Site

Name	IdNumber	Salary in U.S. Dollars	Site	HireDate
Capalleti, Jimmy	2355	$34,072	Birmingham UK	30JAN09
Chen, Len	5889	$33,771	Birmingham UK	18JUN06
Davis, Brad	3878	$31,509	Plymouth UK	20MAR04
Leung, Brenda	4409	$55,256	Plymouth UK	18SEP94
Martinez, Maria	3985	$78,980	Miami USA	10JAN93
Orfali, Philip	0740	$80,648	Miami USA	16FEB03
Patel, Mary	2398	$56,643	York UK	02FEB90
Smith, Robert	5162	$64,561	INCORRECT CODE	15APR06
Sorrell, Joseph	4421	$62,403	Denver USA	19JUN11
Zook, Carla	7385	$37,010	York UK	18DEC10

Example 9: Creating a Format for Missing and Nonmissing Variable Values

Features: VALUE statement

VALUE statement option
OTHER

Data set: EDUCATION

Details

The EDUCATION data set reports dropout rates and math scores for several states, and indicates a region for each state.

In this example, you use the VALUE statement to create the text value n/a for all math score missing values. All nonmissing math score values are formatted using the 5.1 format.

The example then prints the dropout rate and math scores for each state, by region.

Program

```
options obs=20;


proc format;
   value myfmt .='n/a' other=[5.1];
run;

proc sort data=education;
   by region;
run;

proc print data=education;
   by region;
   var state dropOutRate mathScore;
   format mathScore myfmt.;
run;
```

Program Description

Set the number of observations to print.

```
options obs=20;
```

Create a format for the Mathscore variable values. Use the VALUE statement to create the format MYFMT. for the Mathscore variable. When the program encounters a missing Mathscore value, the value is formatted as n/a. All other values for Mathscore are formatted using the 5.1 format.

```
proc format;
   value myfmt .='n/a' other=[5.1];
run;
```

Sort and print the data. Use PROC SORT to sort the data set by region. To print the data by region, specify the region variable in the PROC PRINT BY statement. To report the state, dropout rate, and math scores, use the VAR statement and specify the state, dropOutRate, and mathScore variables. Finally, use the FORMAT statement to tell SAS to format the mathScore variable using the MYFMT. format.

```
proc sort data=education;
   by region;
run;

proc print data=education;
   by region;
   var state dropOutRate mathScore;
   format mathScore myfmt.;
run;
```

Output

Output 30.8 *Dropout Rates and Math Scores for Each State in a Region*

The SAS System

Region=MW

Obs	State	DropoutRate	Math Score
1	Illinois	21.5	260.0
2	Indiana	13.8	267.0
3	Iowa	13.6	278.0
4	Kansas	17.9	n/a

Region=NE

Obs	State	DropoutRate	Math Score
5	Connecticut	16.8	270.0
6	Delaware	28.5	261.0
7	Maine	22.5	n/a
8	Maryland	26.0	260.0

Region=SE

Obs	State	DropoutRate	Math Score
9	Alabama	22.3	252.0
10	Arkansas	11.5	256.0
11	Florida	38.5	255.0
12	Georgia	27.9	258.0
13	Kentucky	32.7	256.0
14	Louisiana	43.1	246.0

Region=W

Obs	State	DropoutRate	Math Score
15	Alaska	35.8	n/a
16	Arizona	31.2	259.0
17	California	32.7	256.0
18	Colorado	24.7	267.0
19	Hawaii	18.3	251.0
20	Idaho	21.8	272.0

Example 10: Creating an Informat Using Perl Regular Expressions

Features: INVALUE statement options
REGEXP
REGEXPE

Details

This example uses two Perl regular expressions to create an informat. The informat using the first expression verifies that the input is an integer and reads the integer. The second informat uses a regular expression that invokes substitution to read a number different from the input value.

Program

```
proc format;
```

```
   invalue isnum (default=5) '/[0-9]/' (regexp) = _same_ other=_error_;
   invalue x1to2x(default=5) 's/1/2/' (regexpe) = _same_ other=_same_;
run;


data _null_;
   input x:isnum. y:x1to2x.;
   put x= y=;
   datalines;
1 121
2 145
a 232
run;
```

Program Description

Create new informats. If the input is a decimal integer, the ISNUM. format reads the number. Otherwise, SAS writes an error to the log. The X1TO2X. informat substitutes all 1s in the input value with a 2.

```
proc format;
   invalue isnum (default=5) '/[0-9]/' (regexp) = _same_ other=_error_;
   invalue x1to2x(default=5) 's/1/2/' (regexpe) = _same_ other=_same_;
run;
```

Read the data. The first two lines of data are valid. The first input value 121 is formatted as 222 because a 1 is substituted with a 2. The input value of 145 is formatted as 245 using the same substitution rule. The third line produces an error because the value for `x` is a character.

```
data _null_;
   input x:isnum. y:x1to2x.;
   put x= y=;
   datalines;
1 121
2 145
a 232
run;
```

LOG

```
1    proc format;
2         invalue isnum (default=5) '/[0-9]/' (regexp) = _same_ other=_error_;
NOTE: Informat ISNUM has been output.
3         invalue x1to2x(default=5) 's/1/2/' (regexpe) = _same_ other=_same_;
NOTE: Informat X1TO2X has been output.
4         run;

NOTE: PROCEDURE FORMAT used (Total process time):
      real time           0.32 seconds
      cpu time            0.07 seconds


5
6    data _null_;
7        input x:isnum. y:x1to2x.;
8        put x= y=;
9        datalines;

x=1 y=222
x=2 y=245
NOTE: Invalid data for x in line 12 1-1.
x=. y=232
RULE:      ----+----1----+----2----+----3----+----4----+----5----+----6----+----7----
+----8----+--
12          a 232
x=. y=232 _ERROR_=1 _N_=3
```

Example 11: Writing a Format for Dates Using a Standard SAS Format and a Color Background

Features: VALUE statement option
HIGH
PROC PRINT statement
VAR statement STYLE option

Data set: PROCLIB.STAFF

Format: USCURRENCY. from Example 3

Format: $CITY. from Example 7

Details

This example uses an existing format that is supplied by SAS as a formatted value and color codes values based on dates.

Tasks include the following:

- creating a numeric format

- nesting formats
- writing a format using a standard SAS format
- formatting dates using a color scheme

Program

```
libname proclib 'SAS-library-1';
libname library 'SAS-library-2';

proc format library=library;

   value benefit
      low-'31DEC2008'd=[worddate20.]
      '01JAN2009'd-high='  ** Not Eligible **';

   value color
      low-'31DEC2008'd='light green'
      '01JAN2009'd-high='light red';
run;

proc print data=proclib.staff noobs label;
   var name idnumber salary site;
   var hiredate /style=[background=color.];

   label salary='Salary in U.S. Dollars';

   format salary uscurrency. site $city. hiredate benefit.;

   title 'PROCLIB.STAFF with a Format for the Variables';
   title2 'Salary, Site, and HireDate';
run;
```

Program Description

This program defines a format called BENEFIT., which differentiates between employees hired on or before 31DEC2008. The purpose of this program is to indicate any employees who are eligible to receive a benefit, based on a hire date on or before December 31, 2008. All other employees with a later hire date are listed as ineligible for the benefit.

Assign two SAS library references (PROCLIB and LIBRARY). Assigning a library reference LIBRARY is useful in this case because if you use PROC FORMAT, then SAS automatically searches for informats and formats in any library that is referenced with the LIBRARY libref.

```
libname proclib 'SAS-library-1';
libname library 'SAS-library-2';
```

Store the BENEFIT. format in the catalog Library.Formats. The LIBRARY= option specifies the permanent storage location LIBRARY for the formats that you create. If you do not use LIBRARY=, then SAS temporarily stores formats and informats that you create in the catalog Work.Formats.

```
proc format library=library;
```

Define the first range in the BENEFIT. format. This first range differentiates between the employees who were hired on or before 31DEC2008 and those who were hired after that date. The keyword LOW and the SAS date constant '31DEC2008'd create the first range, which includes all date values that occur on or before December 31, 2008. For values that fall into this range, SAS applies the WORDDATE*w*. format. For more information about SAS date constants, see "Dates, Times, and Intervals" in *SAS Language Reference: Concepts*. For more information about the WORDDATE formats, see "WORDDATEw." in *SAS Formats and Informats: Reference*.

```
      value benefit
         low-'31DEC2008'd=[worddate20.]
         '01JAN2009'd-high='  ** Not Eligible **';
```

Define the colors for the ranges. Using the same date ranges, employees who are eligible for a benefit based on the dates are color coded in light green. Employees who are not eligible for a benefit are color coded in a light red.

```
      value color
         low-'31DEC2008'd='light green'
         '01JAN2009'd-high='light red';
   run;
```

Print the data set PROCLIB.STAFF. The NOOBS option suppresses the printing of observation numbers. The LABEL option uses variable labels instead of variable names for column headings. The VAR statement names the variables to be printed. The second VAR statement uses the STYLE= option to name the color. format as the background color for the Hiredate variable.

```
   proc print data=proclib.staff noobs label;
      var name idnumber salary site;
      var hiredate /style=[background=color.];
```

Specify a label for the Salary variable. The LABEL statement substitutes the label "Salary in U.S. Dollars" for the name SALARY.

```
      label salary='Salary in U.S. Dollars';
```

Specify formats for Salary, Site, and Hiredate. The FORMAT statement associates the USCURRENCY. format (created in "Example 3: Creating a Picture Format" on page 1150) with SALARY, the $CITY. format (created in "Example 8: Creating a Format for Character Values" on page 1160) with SITE, and the BENEFIT. format with HIREDATE.

```
      format salary uscurrency. site $city. hiredate benefit.;
```

Specify the titles.

```
      title 'PROCLIB.STAFF with a Format for the Variables';
      title2 'Salary, Site, and HireDate';
   run;
```

Output

Output 30.9 *PROCLIB.STAFF with a Format for the Variables Salary, Site, and HireDate*

PROCLIB.STAFF with a Format for the Variables Salary, Site, and HireDate

Name	IdNumber	Salary in U.S. Dollars	Site	HireDate
Capalleti, Jimmy	2355	$34,072	Birmingham UK	** Not Eligible **
Chen, Len	5889	$33,771	Birmingham UK	June 18, 2006
Davis, Brad	3878	$31,509	Plymouth UK	March 20, 2004
Leung, Brenda	4409	$55,256	Plymouth UK	September 18, 1994
Martinez, Maria	3985	$78,980	Miami USA	January 10, 1993
Orfali, Philip	0740	$80,648	Miami USA	February 16, 2003
Patel, Mary	2398	$56,643	York UK	February 2, 1990
Smith, Robert	5162	$64,561	INCORRECT CODE	April 15, 2006
Sorrell, Joseph	4421	$62,403	Denver USA	** Not Eligible **
Zook, Carla	7385	$37,010	York UK	** Not Eligible **

Example 12: Converting Raw Character Data to Numeric Values

Features: INVALUE statement

Details

This example uses an INVALUE statement to create a numeric informat that converts numeric and character raw data to numeric data.

Program

```
libname proclib 'SAS-library-1';
libname library 'SAS-library-2';

proc format library=library;

   invalue evaluation 'O'=4
```

```
                        'S'=3
                        'E'=2
                        'C'=1
                        'N'=0;
run;

data proclib.points;
   input EmployeeId $ (Q1-Q4) (evaluation.,+1);
   TotalPoints=sum(of q1-q4);
   datalines;
2355 S O O S
5889 2 2 2 2
3878 C E E E
4409 0 1 1 1
3985 3 3 3 2
0740 S E E S
2398 E E C C
5162 C C C E
4421 3 2 2 2
7385 C C C N
;

proc print data=proclib.points noobs;

   title 'The PROCLIB.POINTS Data Set';
run;
```

Program Description

This program converts quarterly employee evaluation grades, which are alphabetic, into numeric values so that reports can be generated that sum the grades up as points.

Set up two SAS library references, one named PROCLIB and the other named LIBRARY.

```
libname proclib 'SAS-library-1';
libname library 'SAS-library-2';
```

Store the EVALUATION. informat in the catalog Library.Formats.

```
proc format library=library;
```

Create the numeric informat EVALUATION.. The INVALUE statement converts the specified values. The letters O (Outstanding), S (Superior), E (Excellent), C (Commendable), and N (None) correspond to the numbers 4, 3, 2, 1, and 0, respectively.

```
   invalue evaluation 'O'=4
                      'S'=3
                      'E'=2
                      'C'=1
                      'N'=0;
run;
```

Create the PROCLIB.POINTS data set. The instream data, which immediately follows the DATALINES statement, contains a unique identification number

(EmployeeId) and bonus evaluations for each employee for each quarter of the year (Q1–Q4). Some of the bonus evaluation values that are listed in the data lines are numbers; others are character values. Where character values are listed in the data lines, the EVALUATION. informat converts the value O to 4, the value S to 3, and so on. The raw data values 0 through 4 are read as themselves because they are not referenced in the definition of the informat. Converting the letter values to numbers makes it possible to calculate the total number of bonus points for each employee for the year. TotalPoints is the total number of bonus points.

```
data proclib.points;
   input EmployeeId $ (Q1-Q4) (evaluation.,+1);
   TotalPoints=sum(of q1-q4);
   datalines;
2355 S O O S
5889 2 2 2 2
3878 C E E E
4409 0 1 1 1
3985 3 3 3 2
0740 S E E S
2398 E E C C
5162 C C C E
4421 3 2 2 2
7385 C C C N
;
```

Print the PROCLIB.POINTS data set. The NOOBS option suppresses the printing of observation numbers.

```
proc print data=proclib.points noobs;
```

Specify the title.

```
   title 'The PROCLIB.POINTS Data Set';
run;
```

Output

Output 30.10 *The PROCLIB.POINT Data Set*

The PROCLIB.POINTS Data Set

EmployeeId	Q1	Q2	Q3	Q4	TotalPoints
2355	3	4	4	3	14
5889	2	2	2	2	8
3878	1	2	2	2	7
4409	0	1	1	1	3
3985	3	3	3	2	11
0740	3	2	2	3	10
2398	2	2	1	1	6
5162	1	1	1	2	5
4421	3	2	2	2	9
7385	1	1	1	0	3

Example 13: Creating a Format from a CNTLIN= Data Set

Features: PROC FORMAT statement option
CNTLIN=
Input control data set

Details

This example shows how to create a format from a SAS data set.

Here are the tasks:

- create a format from an input control data set
- create an input control data set from an existing SAS data set

Program To Create a Temporary Data Set

```
data scale;
   input begin: $char2. end: $char2. amount: $char2.;
   datalines;
0   3    0%
4   6    3%
7   8    6%
9   10   8%
11  16   10%
;

data ctrl;
   length label $ 11;

   set scale(rename=(begin=start amount=label)) end=last;

   retain fmtname 'PercentageFormat' type 'n';

   output;

   if last then do;
      hlo='O';
      label='***ERROR***';
      output;
   end;
run;

proc print data=ctrl noobs;

   title 'The CTRL Data Set';
run;
```

Program Description

Create a temporary data set named scale. The first two variables in the data lines, called BEGIN and END, will be used to specify a range in the format. The third variable in the data lines, called AMOUNT, contains a percentage that will be used as the formatted value in the format. Note that all three variables are character variables as required for PROC FORMAT input control data sets.

```
data scale;
   input begin: $char2. end: $char2. amount: $char2.;
   datalines;
0   3    0%
4   6    3%
7   8    6%
9   10   8%
11  16   10%
;
```

Create the input control data set CTRL and set the length of the LABEL variable. The LENGTH statement ensures that the LABEL variable is long enough to accommodate the label ***ERROR***.

```
data ctrl;
   length label $ 11;
```

Rename variables and create an end-of-file flag. The data set CTRL is derived from WORK.SCALE. RENAME= renames BEGIN and AMOUNT as START and LABEL, respectively. The END= option creates the variable LAST, whose value is set to 1 when the last observation is processed.

```
   set scale(rename=(begin=start amount=label)) end=last;
```

Create the variables Fmtname and Type with fixed values. The RETAIN statement is more efficient than an assignment statement in this case. RETAIN retains the value of Fmtname and Type in the program data vector and eliminates the need for the value to be written on every iteration of the DATA step. Fmtname specifies the name PercentageFormat, which is the format that the input control data set creates. The Type variable specifies that the input control data set will create a numeric format.

```
   retain fmtname 'PercentageFormat' type 'n';
```

Write the observation to the output data set.

```
   output;
```

Create an "other" category. Because the only valid values for this application are 0–16, any other value (such as missing) should be indicated as an error to the user. The IF statement executes only after the DATA step has processed the last observation from the input data set. When IF executes, HLO receives a value of O to indicate that the range is OTHER, and LABEL receives a value of ***ERROR***. The OUTPUT statement writes these values as the last observation in the data set. HLO has missing values for all other observations.

```
   if last then do;
      hlo='O';
      label='***ERROR***';
      output;
   end;
run;
```

Print the control data set, CTRL. The NOOBS option suppresses the printing of observation numbers.

```
proc print data=ctrl noobs;
```

Specify the title.

```
   title 'The CTRL Data Set';
run;
```

Output

Output 30.11 *The CTRL Data Set*

The CTRL Data Set

label	start	end	fmtname	type	hlo
0%	0	3	PercentageFormat	n	
3%	4	6	PercentageFormat	n	
6%	7	8	PercentageFormat	n	
8%	9	10	PercentageFormat	n	
10%	11	16	PercentageFormat	n	
ERROR	11	16	PercentageFormat	n	O

Program To Create the Format

```
proc format library=work cntlin=ctrl;
run;

proc format library=library;
   invalue evaluation 'O'=4
                      'S'=3
                      'E'=2
                      'C'=1
                      'N'=0;
run;

data points;
   input EmployeeId $ (Q1-Q4) (evaluation.,+1);
   TotalPoints=q1+q2+q3+q4;
   datalines;
2355 S O O S
5889 2 . 2 2
3878 C E E E
4409 0 1 1 1
3985 3 3 3 2
0740 S E E S
2398 E E   C
5162 C C C E
4421 3 2 2 2
7385 C C C N
;

proc report data=work.points nowd headskip split='#';
   column employeeid totalpoints totalpoints=Pctage;
   define employeeid / right;
   define totalpoints / 'Total#Points' right;
   define pctage / format=PercentageFormat12. 'Percentage' left;
```

```
   title 'The Percentage of Salary for Calculating Bonus';
run;
```

Program Description

Store the created format in the catalog Work.Formats and specify the source for the format. The CNTLIN= option specifies that the data set CTRL is the source for the format PercentageFormat.

```
proc format library=work cntlin=ctrl;
run;
```

Create the numeric informat EVALUATION.. The INVALUE statement converts the specified values. The letters O (Outstanding), S (Superior), E (Excellent), C (Commendable), and N (None) correspond to the numbers 4, 3, 2, 1, and 0, respectively.

```
proc format library=library;
   invalue evaluation 'O'=4
                      'S'=3
                      'E'=2
                      'C'=1
                      'N'=0;
run;
```

Create the WORK.POINTS data set. The instream data, which immediately follows the DATALINES statement, contains a unique identification number (EmployeeId) and bonus evaluations for each employee for each quarter of the year (Q1–Q4). Some of the bonus evaluation values that are listed in the data lines are numbers; others are character values. Where character values are listed in the data lines, the Evaluation. informat converts the value O to 4, the value S to 3, and so on. The raw data values 0 through 4 are read as themselves because they are not referenced in the definition of the informat. Converting the letter values to numbers makes it possible to calculate the total number of bonus points for each employee for the year. TotalPoints is the total number of bonus points. The addition operator is used instead of the SUM function so that any missing value will result in a missing value for TotalPoints.

```
data points;
   input EmployeeId $ (Q1-Q4) (evaluation.,+1);
   TotalPoints=q1+q2+q3+q4;
   datalines;
2355 S O O S
5889 2 . 2 2
3878 C E E E
4409 0 1 1 1
3985 3 3 3 2
0740 S E E S
2398 E E   C
5162 C C C E
4421 3 2 2 2
7385 C C C N
;
```

Generate a report for WORK.POINTS and associate the PERCENTAGEFORMAT. format with the TotalPoints variable. The DEFINE statement performs the association. The column that contains the formatted values of TotalPoints is using the alias Pctage. Using an alias enables you to print a variable twice, once with a format and once with the default format. For more information about the REPORT procedure, see Chapter 58, "REPORT Procedure," on page 2047.

```
proc report data=work.points nowd headskip split='#';
   column employeeid totalpoints totalpoints=Pctage;
   define employeeid / right;
   define totalpoints / 'Total#Points' right;
   define pctage / format=PercentageFormat12. 'Percentage' left;
   title 'The Percentage of Salary for Calculating Bonus';
run;
```

Output

Output 30.12 *The Percentage of Salary for Calculating Bonus*

The Percentage of Salary for Calculating Bonus

EmployeeId	Total Points	Percentage
2355	14	10%
5889	.	***ERROR***
3878	7	6%
4409	3	0%
3985	11	10%
0740	10	8%
2398	.	***ERROR***
5162	5	3%
4421	9	8%
7385	3	0%

Example 14: Creating an Informat from a CNTLIN= Data Set

Features: PROC FORMAT statement option
CNTLIN=
Input control data set

Details

This example shows how to create an informat from a CNTLIN= data set.

Here are the tasks:

- create an informat from an input control data set
- create an input control data set from an existing SAS data set

Program

```
proc format;
     invalue mytest
       'abc'=1
       'xyz'=2
       other=3;
     invalue $chrtest
       'abc'='xyz'
       other='else';
     run;

data _null_;
     input value:mytest. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;

data _null_;
     input value:$chrtest. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;

data temp;
     length start $8 type $1 hlo $1;
     fmtname='newtest'; type='i';
     start='abc'; label=1; hlo=' '; output;
     start='xyz'; label=2; hlo=' '; output;
     start=' ';   label=3; hlo='O'; output;
     run;

proc format cntlin=temp; run;

data temp;
     length start label $8 type $1 hlo $1;
     fmtname='$newchr'; type='j';
     start='abc'; label='xyz'; hlo=' '; output;
     start=' ';   label='else'; hlo='O'; output;
     run;
```

```
proc format cntlin=temp; run;

data _null_;
     input value:newtest. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;

data _null_;
     input value:$newchr. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;

data temp;
     length start label $8 hlo $1;
     fmtname='@new2test';
     start='abc'; label='1'; hlo=' '; output;
     start='xyz'; label='2'; hlo=' '; output;
     start=' ';   label='3'; hlo='O'; output;
     fmtname='@$new2chr';
     start='abc'; label='xyz'; hlo=' '; output;
     start=' ';   label='else'; hlo='O'; output;
     run;

proc format cntlin=temp; run;

data _null_;
     input value:new2test. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;

data _null_;
     input value:$new2chr. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;


proc print data=temp noobs;
title 'The CTRL Data Set';
run;
```

Program Description

Create informats with an INVALUE statement. Create a numeric informat and a character informat.

```
proc format;
     invalue mytest
       'abc'=1
```

```
        'xyz'=2
        other=3;
      invalue $chrtest
        'abc'='xyz'
        other='else';
      run;
```

Use the numeric informat with instream data. The code should produce 1, 2, 3, and 3 again as the results of VALUE.

```
data _null_;
     input value:mytest. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;
```

Use the character informat with instream data. The code should produce xyz, else, else, and else as the results of VALUE.

```
data _null_;
     input value:$chrtest. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;
```

Create the equivalent of the MYTEST numeric informat using a CNTLIN= data set, and use the informat name of NEWTEST. Specify that the FMTNAME variable has the value NEWTEST. Specify the value 'i' or 'I' for the TYPE variable to indicate that it is a numeric informat. Specify a value of O for other, or a blank value, for the HLO variable.

```
data temp;
     length start $8 type $1 hlo $1;
     fmtname='newtest'; type='i';
     start='abc'; label=1; hlo=' '; output;
     start='xyz'; label=2; hlo=' '; output;
     start=' ';   label=3; hlo='O'; output;
     run;
```

Use the character informat with instream data. The code should produce xyz, else, else, and else as the results of VALUE.

```
proc format cntlin=temp; run;
```

Create a CNTLIN= data set for the character informat. The informat is the equivalent to the $CHRTEST informat that was created above. Specify the name $NEWCHR for it. The value of TYPE should be 'j' or 'J' to indicate that it is a character informat.

```
data temp;
     length start label $8 type $1 hlo $1;
     fmtname='$newchr'; type='j';
     start='abc'; label='xyz'; hlo=' '; output;
     start=' ';   label='else'; hlo='O'; output;
     run;
```

Read in the CNTLIN= data set to create the character informat. This example uses *temp* as the value for CNTLIN. If you are saving the code example, specify a more descriptive name.

```
proc format cntlin=temp; run;
```

Create two DATA steps that are the same as the previously created versions. Use the informat names NEWTEST and $NEWCHR for these versions.

```
data _null_;
     input value:newtest. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;

data _null_;
     input value:$newchr. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;
```

Show that the FMTNAME value can start with an @ to indicate that it is an informat, and that the type variable is not necessary. Numeric and character informats can be created in the same CNTLIN= data set. The label variable must be a character because character formats are being defined. Numeric values are saved as character strings that contain numeric values.

```
data temp;
     length start label $8 hlo $1;
     fmtname='@new2test';
     start='abc'; label='1'; hlo=' '; output;
     start='xyz'; label='2'; hlo=' '; output;
     start=' ';   label='3'; hlo='O'; output;
     fmtname='@$new2chr';
     start='abc'; label='xyz'; hlo=' '; output;
     start=' ';   label='else'; hlo='O'; output;
     run;

proc format cntlin=temp; run;

data _null_;
     input value:new2test. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;

data _null_;
     input value:$new2chr. @@;
     put value=;
     datalines;
abc xyz ghi 4
     run;
```

Print the contents of the CNTLIN= data set. Label the table “The CTRL Data Set.”

```
proc print data=temp noobs;
title 'The CTRL Data Set';
run;
```

Output 30.13 *Contents of the CRTL Data Set*

The CTRL Data Set

start	label	hlo	fmtname
abc	1		@new2test
xyz	2		@new2test
	3	O	@new2test
abc	xyz		@$new2chr
	else	O	@$new2chr

Example 15: Printing the Description of Informats and Formats

Features: PROC FORMAT statement option
FMTLIB
SELECT statement

Format: BENEFIT. from Example 4

Informat: EVALUATION. from Example 6

Details

This example illustrates how to print a description of an informat and a format. The description shows the values that are read in and written.

Program

```
libname library 'SAS-library';

proc format library=library fmtlib;

   select @evaluation benefit;

   title 'FMTLIB Output for the BENEFIT. Format and the';
   title2 'EVALUATION. Informat';
run;
```

Program Description

Set up a SAS library reference named LIBRARY.

```
libname library 'SAS-library';
```

Print a description of EVALUATION. and BENEFIT. The FMTLIB option prints information about the formats and informats in the catalog that the LIBRARY= option specifies. LIBRARY=LIBRARY points to the Library.Formats catalog.

```
proc format library=library fmtlib;
```

Select an informat and a format. The SELECT statement selects EVALUATION. and BENEFIT., which were created in previous examples. The at sign (@) in front of EVALUATION. indicates that EVALUATION. is an informat.

```
   select @evaluation benefit;
```

Specify the titles.

```
   title 'FMTLIB Output for the BENEFIT. Format and the';
   title2 'EVALUATION. Informat';
run;
```

Output

Output 30.14 *FMTLIB Output for the BENEFIT Format and the EVALUATION Informat*

FMTLIB Output for the BENEFIT. Format and the EVALUATION. Informat

FORMAT NAME: BENEFIT LENGTH: 20 NUMBER OF VALUES: 2
MIN LENGTH: 1 MAX LENGTH: 40 DEFAULT LENGTH: 20 FUZZ: STD

START	END	LABEL (VER. V7|V8 17SEP2012:15:53:27)
LOW	17897	[WORDDATE20.]
17898	HIGH	** Not Eligible **

INFORMAT NAME: @EVALUATION LENGTH: 1
MIN LENGTH: 1 MAX LENGTH: 40 DEFAULT LENGTH: 1 FUZZ: 0

START	END	INVALUE(VER. 9.4 17SEP2012:16:10:24)
C	C	1
E	E	2
N	N	0
O	O	4
S	S	3

Example 16: Retrieving a Permanent Format

Features: PROC FORMAT statement option
LIBRARY=
FMTSEARCH= system option

Data set: SAMPLE

This example uses the LIBRARY= option and the FMTSEARCH= system option to store and retrieve a format stored in a catalog other than Work.Formats or Library.Formats.

Program

```
libname proclib 'SAS-library';

proc format library=proclib;

picture nozeros (fuzz=0)
           low -  -1  = '000.00'(prefix='-')
       -1 < - < -.99  = '0.99' (prefix='-.' mult=100)
       -0.99 < - < 0  = '99'    (prefix='-.' mult=100)
                   0  = '0.99'
        0 < - < .99   = '99'    (prefix='.'  mult=100)
           0.99 - <1  = '0.99'  (prefix='.'  mult=100)
            1  - high = '00.99';
run;

options  fmtsearch=(proclib);

data sample;
  input Amount;
   datalines;
-2.051
-.05
-.017
  0
.093
.54
.556
6.6
14.63
0.996
-0.999
-45.00
;
run;

proc print data=sample;
   format amount nozeros.;

   title1 'Retrieving the NOZEROS. Format from PROCLIB.FORMATS';
```

```
   title2 'The SAMPLE Data Set';
run;
```

Program Description

Set up a SAS library reference named PROCLIB.

```
libname proclib 'SAS-library';
```

Store the NOZEROS. format in the PROCLIB.FORMATS catalog.

```
proc format library=proclib;
```

Create the NOZEROS. format. The PICTURE statement defines the picture format NOZEROS. See "Details" on page 1112.

```
picture nozeros (fuzz=0)
           low -  -1  = '000.00'(prefix='-')
       -1 < - < -.99  = '0.99' (prefix='-.' mult=100)
       -0.99 < - < 0  = '99'    (prefix='-.' mult=100)
                   0  = '0.99'
        0 < - < .99   = '99'    (prefix='.'  mult=100)
           0.99 - <1  = '0.99'  (prefix='.'  mult=100)
            1  - high = '00.99';
run;
```

Add the PROCLIB.FORMATS catalog to the search path that SAS uses to find user-defined formats. The FMTSEARCH= system option defines the search path. The FMTSEARCH= system option requires only a libref. FMTSEARCH= assumes that the catalog name is FORMATS if no catalog name appears. Without the FMTSEARCH= option, SAS would not find the NOZEROS. format. For more information, see "FMTSEARCH= System Option" in *SAS System Options: Reference*.

```
options  fmtsearch=(proclib);
```

Create the sample data set.

```
data sample;
  input Amount;
   datalines;
-2.051
-.05
-.017
  0
.093
.54
.556
6.6
14.63
0.996
-0.999
-45.00
;
run;
```

Print the SAMPLE data set. The FORMAT statement associates the NOZEROS. format with the Amount variable.

```
proc print data=sample;
   format amount nozeros.;
```

Specify the titles.

```
   title1 'Retrieving the NOZEROS. Format from PROCLIB.FORMATS';
   title2 'The SAMPLE Data Set';
run;
```

Output

Output 30.15 *Retrieving the NOZEROS. Format from PROCLIB.FORMATS*

Retrieving the NOZEROS. Format from PROCLIB.FORMATS
The SAMPLE Data Set

Obs	Amount
1	-2.05
2	-.05
3	-.01
4	.00
5	.09
6	.54
7	.55
8	6.60
9	14.63
10	.99
11	-.99
12	45.00

Example 17: Writing Ranges for Character Strings

Features: VALUE statement

Data set: PROCLIB.STAFF

This example creates a format and shows how to use ranges with character strings.

Program

```
libname proclib'SAS-library';

data train;
   set proclib.staff(keep=name idnumber);
run;

proc print data=train noobs;

   title 'The TRAIN Data Set without a Format';
run;
```

Program Description

```
libname proclib'SAS-library';
```

Create the TRAIN data set from the PROCLIB.STAFF data set. PROCLIB.STAFF was created in "Example 2: Create the Example Data Set" on page 1149.

```
data train;
   set proclib.staff(keep=name idnumber);
run;
```

Print the data set TRAIN without a format. The NOOBS option suppresses the printing of observation numbers.

```
proc print data=train noobs;
```

Specify the title.

```
   title 'The TRAIN Data Set without a Format';
run;
```

Output

Output 30.16 *The TRAIN Data Set without a Format*

The TRAIN Data Set without a Format

Name	IdNumber
Capalleti, Jimmy	2355
Chen, Len	5889
Davis, Brad	3878
Leung, Brenda	4409
Martinez, Maria	3985
Orfali, Philip	0740
Patel, Mary	2398
Smith, Robert	5162
Sorrell, Joseph	4421
Zook, Carla	7385

Store the format in Work.Formats. Because the LIBRARY= option does not appear, the format is stored in Work.Formats and is available only for the current SAS session.

```
proc format;
```

Create the $SKILLTEST. format. The $SKILLTEST. format prints each employee's identification number and the skills test that they have been assigned. Employees must take either TEST A, TEST B, or TEST C, depending on their last name. The exclusion operator (<) excludes the last value in the range. Thus, the first range includes employees whose last name begins with any letter from A through D, and the second range includes employees whose last name begins with any letter from E through M. The tilde (~) in the last range is necessary to include an entire string that begins with the letter Z.

```
   value $skilltest  'a'-<'e','A'-<'E'='Test A'
                     'e'-<'m','E'-<'M'='Test B'
                     'm'-'z~','M'-'Z~'='Test C';
run;
```

Generate a report of the TRAIN data set. The FORMAT= option in the DEFINE statement associates the $SKILLTEST. format with the Name variable. The column that contains the formatted values of Name is using the alias Test. Using an alias enables you to print a variable twice, once with a format and once with the default format. For more information, see Chapter 58, "REPORT Procedure," on page 2047.

```
proc report data=train nowd headskip;
   column name name=test idnumber;
   define test / display format=$skilltest. 'Test';
```

```
   define idnumber / center;
   title 'Test Assignment for Each Employee';
run;
```

Output

Output 30.17 *Test Assignment for Each Employee*

Test Assignment for Each Employee

Name	Test	IdNumber
Capalleti, Jimmy	Test A	2355
Chen, Len	Test A	5889
Davis, Brad	Test A	3878
Leung, Brenda	Test B	4409
Martinez, Maria	Test C	3985
Orfali, Philip	Test C	0740
Patel, Mary	Test C	2398
Smith, Robert	Test C	5162
Sorrell, Joseph	Test C	4421
Zook, Carla	Test C	7385

Example 18: Creating a Format in a non-English Language

Features: PICTURE statement options
DATATYPE=
LANGUAGE=
LOCALE= system option

Details

This example does the following tasks:

- Creates picture formats using directives for formatting date and datetime values by using the DATATYPE= statement option.

- Uses the LOCALE= system option to specify the locale for German.
- Prints date and datetime values to the SAS log in German using the picture formats.
- Prints a datetime value in French to the log by using the picture format that specifies LANGUAGE=French.

Program

```
proc format;
   picture mdy(default=8) other='%0d%0m%Y' (datatype=date);
   picture langtsda (default=50) other='%A, %d %B, %Y' (datatype=date);
   picture langtsdt (default=50) other='%A, %d,%B, %Y %H %M %S'
                                 (datatype=datetime);
   picture langtsfr (default=50) other='%A, %d %B, %Y %H %M %S'
                                 (datatype=datetime language=french);
   picture alltest (default=100)
           other='%a %A %b %B %d %H %I %j %m %M %p %S %w %U %y %%'
           (datatype=datetime);
run;

option locale = de_DE;

data _null_ ;
   a= 18903;
   b = 1633239000;
   put a= mdy.;
   put a= langtsda.;
   put b= langtsdt.;
   put b= langtsfr.;
   put b= alltest.;
run ;
```

Program Description

Create formats using the PICTURE statement. Each PICTURE statement specifies the date or datetime values to format using directives. %A prints a full weekday name. %B prints a full month name. %d prints the day of the month. %Y prints the year. %H prints the hour (24–hour clock). %M prints the minute. %S prints the seconds. The first three formats print the date or datetime in the language specified by the current value of the LOCALE= system option. The format LANGTSFT. prints the datetime in French. For the remaining directives, see the PICTURE statement on page 1098.

```
proc format;
   picture mdy(default=8) other='%0d%0m%Y' (datatype=date);
   picture langtsda (default=50) other='%A, %d %B, %Y' (datatype=date);
   picture langtsdt (default=50) other='%A, %d,%B, %Y %H %M %S'
                                 (datatype=datetime);
   picture langtsfr (default=50) other='%A, %d %B, %Y %H %M %S'
                                 (datatype=datetime language=french);
   picture alltest (default=100)
```

```
            other='%a %A %b %B %d %H %I %j %m %M %p %S %w %U %y %%'
            (datatype=datetime);
run;
```

Set the LOCALE= system option. de_DE is the locale value for Germany.

```
option locale = de_DE;
```

Print date and datetime values in German and French. The DATA step prints to the SAS log the date and datetime information for 3 October, 2011, 05:30:00 AM. All values are written in German except for the value of `b` when it is formatted using the LANGTSFR. format. The LANGSTSFR. format prints the datetime value in French.

```
data _null_ ;
   a= 18903;
   b = 1633239000;
   put a= mdy.;
   put a= langtsda.;
   put b= langtsdt.;
   put b= langtsfr.;
   put b= alltest.;
run ;
```

The SAS Log Displaying Picture Format Output in German and French

```
1    proc format;
2       picture mdy(default=8) other='%0d%0m%Y' (datatype=date);
NOTE: Format MDY has been output.
3       picture langtsda (default=50) other='%A, %d %B, %Y' (datatype=date);
NOTE: Format LANGTSDA has been output.
4       picture langtsdt (default=50) other='%A, %d,%B, %Y %H %M %S'
5                                     (datatype=datetime);
NOTE: Format LANGTSDT has been output.
6       picture langtsfr (default=50) other='%A, %d %B, %Y %H %M %S'
7                                     (datatype=datetime language=french);
NOTE: Format LANGTSFR has been output.
8       picture alltest (default=100)
9               other='%a %A %b %B %d %H %I %j %m %M %p %S %w %U %y %%'
10              (datatype=datetime);
NOTE: Format ALLTEST has been output.
11   run;

NOTE: PROCEDURE FORMAT used (Total process time):
      real time           0.03 seconds
      cpu time            0.03 seconds


12
13   option locale = de_DE;
14
15   data _null_ ;
16      a= 18903;
17      b = 1633239000;
18      put a= mdy.;
19      put a= langtsda.;
20      put b= langtsdt.;
21      put b= langtsfr.;
22      put b= alltest.;
23   run ;

a=03102011
a=Montag, 3 Oktober, 2011
b=Montag, 3,Oktober, 2011 5 30 0
b=Lundi, 3 octobre, 2011 5 30 0
b=Mo  Montag Okt Oktober 3 5 5 276 10 30 AM 0 2 40 11 %
```

Example 19: Creating a Locale-Specific Format Catalog

Features: PROC FORMAT LOCALE option
FMTSEARCH= system option

Details

This example demonstrates how to create a format in two languages, English and Romanian, and how to access the English and Romanian format catalogs to print a data set in the two languages. The example works best if the SAS session encoding is a latin 2 encoding that supports the Romanian locale.

Program

```
/*no locale information*/
proc format lib=work.formats;
value age low - 5 = 'baby'
6 - 12 = 'child'
13 - 15 = 'teen'
16 - 30 = 'youth'
31 - 50 = 'midlife'
51 - high = 'older';
run;

options locale=ro_RO;

proc format lib = work.formats locale;
value age low - 5 = 'Copil'
6 - 12 = 'Copil'
13 - 15 = 'Adolescent'
16 - 30 = 'Tineretului'
31 - 50 = 'Asta vrei'
51 - high = 'Mai vechi';
run;


options fmtsearch=(work/locale);

/* Set the locale back to English(US) */
options locale=en_US;

data datatst;
input age sex $;
attrib age format= age.;
cards;
5 M
6 F
12 M
13 F
15 M
16 F
30 M
35 F
51 M
100 F
;
```

```
run;
/* Use the English format catalog*/
title "Locale is English, Use the Original Format Catalog";
proc print data=datatst; run;

/* Use the Romanian format catalog*/
options locale=ro_RO;
title 'Locale is ro_RO, Use the Romanian Format Catalog';
proc print data=datatst;run;
```

Program Description

Create the AGE. format in English.

```
/*no locale information*/
proc format lib=work.formats;
value age low - 5 = 'baby'
6 - 12 = 'child'
13 - 15 = 'teen'
16 - 30 = 'youth'
31 - 50 = 'midlife'
51 - high = 'older';
run;
```

Change the locale and create the AGE. format in a locale-specific format catalog. Using the LOCALE= system option, the locale is change to the Romanian locale. In the PROC FORMAT statement, the LOCALE option specifies to create a format catalog that corresponds to the current locale, which is for the Romanian language.

```
options locale=ro_RO;

proc format lib = work.formats locale;
value age low - 5 = 'Copil'
6 - 12 = 'Copil'
13 - 15 = 'Adolescent'
16 - 30 = 'Tineretului'
31 - 50 = 'Asta vrei'
51 - high = 'Mai vechi';
run;
```

Add the locale-specific format catalogs to the format search path. The FMTSEARCH= system option specifies the format catalog to search. Because you can create more than one locale-specific catalog, when /LOCALE is added to a libref in the search list, SAS searches for a catalog that is associated with the current locale.

```
options fmtsearch=(work/locale);
```

Create a data set and print it using the English format catalog. The LOCALE= system option sets the locale to English.

```
/* Set the locale back to English(US) */
options locale=en_US;

data datatst;
input age sex $;
```

```
attrib age format= age.;
cards;
5 M
6 F
12 M
13 F
15 M
16 F
30 M
35 F
51 M
100 F
;
run;
/* Use the English format catalog*/
title "Locale is English, Use the Original Format Catalog";
proc print data=datatst; run;
```

Print the data set Using the Romanian format catalog. Using the LOCALE= system option, the locale is set to the Romanian locale.

```
/* Use the Romanian format catalog*/
options locale=ro_RO;
title 'Locale is ro_RO, Use the Romanian Format Catalog';
proc print data=datatst;run;
```

Here is the data set printed using the English and Romanian format catalogs:

Output 30.18 *A Data Set Printed Using an English and Romanian Format Catalog*

Locale is English, Use the Original Format Catalog

Obs	age	sex
1	baby	M
2	child	F
3	child	M
4	teen	F
5	teen	M
6	youth	F
7	youth	M
8	midlife	F
9	older	M
10	older	F

Locale is ro_RO, Use the Romanian Format Catalog

Obs	age	sex
1	Copil	M
2	Copil	F
3	Copil	M
4	Adolescent	F
5	Adolescent	M
6	Tineretului	F
7	Tineretului	M
8	Asta vrei	F
9	Mai vechi	M
10	Mai vechi	F

Example 20: Creating a Function to Use as a Format

Features:

PROC FCMP statement
CMPLIB= system option
PROC FORMAT statement
Function as a format feature

Details

This example creates a function that converts temperatures from Celsius to Fahrenheit and Fahrenheit to Celsius. The program uses the function as a function in one DATA step and then as a format in another DATA step.

Program

```
proc fcmp outlib=library.functions.smd;
   function ctof(c) $;
      return(cats(((9*c)/5)+32,'F'));
   endsub;

   function ftoc(f) $;
      return(cats((f-32)*5/9,'C'));
   endsub;

run;

options cmplib=(library.functions);

data _null_;
   f=ctof(100);
   put f=;
run;

proc format;
   value ctof (default=10) other=[ctof()];
   value ftoc (default=10) other=[ftoc()];
 run;

data _null_;
   c=100;
   put c=ctof.;
   f=212;
   put f=ftoc.;
run;
```

Program Description

Create the functions that change temperature from Celsius to Fahrenheit and Fahrenheit to Celsius. The FCMP procedure creates the CTOF function to convert Celsius temperatures to Fahrenheit and the FTOC to convert Fahrenheit temperatures to Celsius.

```
proc fcmp outlib=library.functions.smd;
   function ctof(c) $;
      return(cats(((9*c)/5)+32,'F'));
   endsub;

   function ftoc(f) $;
      return(cats((f-32)*5/9,'C'));
   endsub;

run;
```

Access the function library. The CMPLIB system option enables the functions to be included during program compilation.

```
options cmplib=(library.functions);
```

Use the function as a function in a SAS program.

```
data _null_;
   f=ctof(100);
   put f=;
run;
```

Create user-defined formats using the functions. The name of the format is the name of the function. When you use a function as a format, you can nest the format as shown by the OTHER keyword.

```
proc format;
   value ctof (default=10) other=[ctof()];
   value ftoc (default=10) other=[ftoc()];
 run;
```

Use the function as a format. This DATA step formats temperatures using a named PUT statement, where you assign a format to a variable in the PUT statement.

```
data _null_;
   c=100;
   put c=ctof.;
   f=212;
   put f=ftoc.;
run;
```

Output: Log

Example Code 30.6 *The SAS Log After Creating a Function to Use as a Format*

```
323  proc fcmp outlib=library.functions.smd;
324     function ctof(c) $;
325        return(cats(((9*c)/5)+32,'F'));
326     endsub;
327
328     function ftoc(f) $;
329        return(cats((f-32)*5/9,'C'));
330     endsub;
331
332  run;

NOTE: Function ftoc saved to library.functions.smd.
NOTE: Function ctof saved to library.functions.smd.
NOTE: PROCEDURE FCMP used (Total process time):
      real time           17.59 seconds
      cpu time            1.26 seconds


333
334  options cmplib=(library.functions);
335
336  data _null_;
337     f=ctof(100);
338     put f=;
339  run;

f=212F
NOTE: DATA statement used (Total process time):
      real time           0.50 seconds
      cpu time            0.01 seconds


340
341  proc format;
342        value ctof (default=10) other=[ctof()];
NOTE: Format CTOF has been output.
343        value ftoc (default=10) other=[ftoc()];
NOTE: Format FTOC has been output.
344        run;

NOTE: PROCEDURE FORMAT used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


345
346  data _null_;
347     c=100;
348     put c=ctof.;
349     f=212;
350     put f=ftoc.;
351  run;

c=212F
f=100C
```

Example 21: Using a Format to Create a Drill-down Table

Features: VALUE statement
PROC PRINT FORMAT statement

Details

This example creates an HTML table that has population information about five U.S. states. The name of the state is a link to the state's website. The link is created using a user-defined format to format the state name. This example does the following:

- creates the data set that contains the state population information
- creates a user-defined format using the VALUE statement, where the value is an HTML link (<a>) element
- defines the name of the HTML file and the titles for the HTML file
- prints the HTML table using the user-defined format

Program

```
data mydata;
   format population comma12.0;
   label st='State';
   label population='Population';
   input st $ 1-2 population;
   year=2000;
   datalines;
VA  7078515
NC  8049313
SC  4012012
GA  8186453
FL 15982378
;
run;

proc format;
value $COMPND
'VA'='<a href=http://www.va.gov>VA</a>'
'NC'='<a href=http://www.nc.gov>NC</a>'
'SC'='<a href=http://www.sc.gov>SC</a>'
'GA'='<a href=http://www.ga.gov>GA</a>'
```

```
'FL'='<a href=http://www.fl.gov>FL</a>';
run;

ods html file="c:\mySAS\html\Drilldown.htm"
 (title="An ODS HTML Drill-down Table Using a User-defined Format in
the PRINT
 Procedure");

title h=.25in "Year 2000 U.S. Census Population";
title2 color=gray "An ODS HTML Drill-down Table Using a User-defined
Format in
the PRINT Procedure";
footnote color=gray "(Click the underlined text to drill down.)";

options nodate;
proc print data=mydata label noobs;
 var st population;
 format st $compnd. ;
run;

ods html close;
ods html;
```

Program Description

Create the data set. The mydata DATA step creates a data set that contains information about five U.S. state populations based on the census taken in the year 2000. The variables that are created assign data for the year of the census, the state abbreviations, and the state population.

```
data mydata;
   format population comma12.0;
   label st='State';
   label population='Population';
   input st $ 1-2 population;
   year=2000;
   datalines;
VA  7078515
NC  8049313
SC  4012012
GA  8186453
FL 15982378
;
run;
```

Create the $COMPND. format. The $COMPND. format formats each state as a link to the state's respective website.

```
proc format;
value $COMPND
'VA'='<a href=http://www.va.gov>VA</a>'
'NC'='<a href=http://www.nc.gov>NC</a>'
'SC'='<a href=http://www.sc.gov>SC</a>'
'GA'='<a href=http://www.ga.gov>GA</a>'
'FL'='<a href=http://www.fl.gov>FL</a>';
run;
```

Set up the table filename and table titles. The ODS HTML FILE= option names the directory and filename where SAS saves the HTML output.

```
ods html file="c:\mySAS\html\Drilldown.htm"
 (title="An ODS HTML Drill-down Table Using a User-defined Format in
the PRINT
 Procedure");

title h=.25in "Year 2000 U.S. Census Population";
title2 color=gray "An ODS HTML Drill-down Table Using a User-defined
Format in
the PRINT Procedure";
footnote color=gray "(Click the underlined text to drill down.)";
```

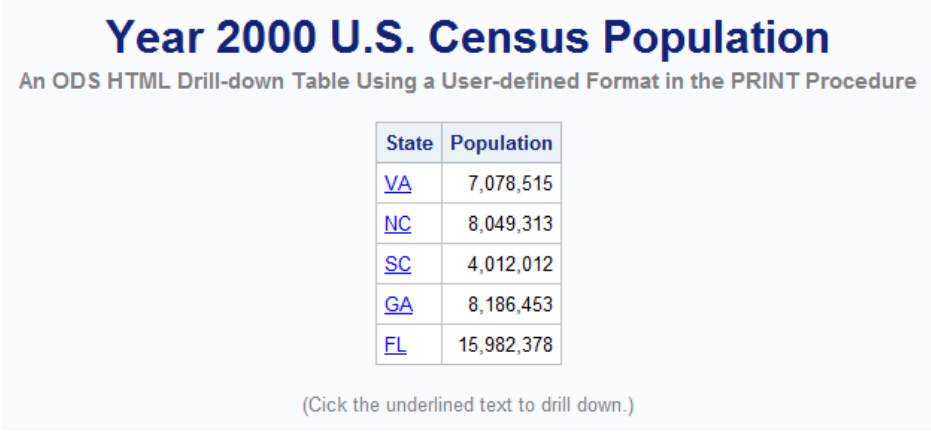
Print the table and close and reopen the HTML destination. The PRINT procedure uses the format $COMPND. to format the state name. The formatted name is a link to the state's respective website. The ODS HTML statements close and reopen the HTML destination so that future output does not overwrite the HTML file that you just created.

```
options nodate;
proc print data=mydata label noobs;
 var st population;
 format st $compnd. ;
run;

ods html close;
ods html;
```

Output

Output 30.19 *Using a Format to Create Drill-down Text in an HTML Table*



Year 2000 U.S. Census Population

An ODS HTML Drill-down Table Using a User-defined Format in the PRINT Procedure

State	Population
VA	7,078,515
NC	8,049,313
SC	4,012,012
GA	8,186,453
FL	15,982,378

(Cick the underlined text to drill down.)

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FSLIST Procedure

Overview: FSLIST Procedure

What Does the FSLIST Procedure Do?

The FSLIST procedure enables you to browse, within a SAS session, external files that are not SAS data sets. Because the files are displayed in an interactive window, the procedure provides a highly convenient mechanism for examining file contents. In addition, you can copy text from the FSLIST window into any window that uses the SAS Text Editor.

Syntax: FSLIST Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

PROC FSLIST FILEREF=*file-specification* | UNIT=*nn* <*options*>;

PROC FSLIST DDNAME=*file-specification* | UNIT=*nn* <*options*>;

PROC FSLIST DD=*file-specification* | UNIT=*nn* <*options*>;

Statement	Task
PROC FSLIST	Initiate the FSLIST procedure and specify the external file to browse

PROC FSLIST Statement

Enables you to browse external files that are not SAS data sets within a SAS session.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Syntax

PROC FSLIST FILEREF=*file-specification* | UNIT=*nn* <*options*>;

PROC FSLIST DDNAME=*file-specification* | UNIT=*nn* <*options*>;

PROC FSLIST DD=*file-specification* | UNIT=*nn* <*options*>;

Summary of Optional Arguments

CAPS

NOCAPS
: controls how search strings for the FIND command are treated.

CC

FORTCC

NOCC
: indicates whether carriage-control characters are used to format the display.

HSCROLL=*n* | HALF | PAGE
: indicates the default horizontal scroll amount for the LEFT and RIGHT commands.

NOBORDER
: suppresses the sides and bottom of the FSLIST window's border.

NUM

NONUM
: controls the display of line sequence numbers.

OVP

NOOVP
indicates whether the carriage-control code for overprinting is in effect.

Required Arguments

FILEREF | DDNAME | DD=*file-specification*
specifies the external file to browse. *File-specification* can be one of the following:

'external-file'
is the complete operating environment file specification (called the fully qualified pathname under some operating environments) for the external file. You must enclose the name in quotation marks.

fileref
is a fileref that has been previously assigned to the external file. You can use the FILENAME statement to associate a fileref with an actual filename. For more information, see "FILENAME Statement" in *SAS Global Statements: Reference*.

UNIT=*nn*
defines the FORTRAN-style logical unit number of the external file to browse. This option is useful when the file to browse has a fileref of the form FT*nn*F001, where *nn* is the logical unit number that is specified in the UNIT= argument. For example, you can specify the following: `proc fslist unit=20;` instead of `proc fslist fileref=ft20f001;`

Optional Arguments

CAPS | NOCAPS
controls how search strings for the FIND command are treated:

CAPS
converts search strings into uppercase unless they are enclosed in quotation marks. For example, with this option in effect, the command `find nc`locates occurrences of **NC**, but not **nc**. To locate lowercase characters, enclose the search string in quotation marks: `find 'nc'`

NOCAPS
does not perform a translation. The FIND command locates only those text strings that exactly match the search string.

The default is NOCAPS. You can use the CAPS command in the FSLIST window to change the behavior of the procedure while you are browsing a file.

CC | FORTCC | NOCC
indicates whether carriage-control characters are used to format the display. You can specify one of the following values for this option:

CC
uses the native carriage-control characters of the operating environment.

FORTCC
uses FORTRAN-style carriage control. The first column of each line in the external file is not displayed. The character in this column is interpreted as a

carriage-control code. The FSLIST procedure recognizes the following carriage-control characters:

+
skip zero lines and print (overprint).

blank
skip one line and print (single space).

0
skip two lines and print (double space).

-
skip three lines and print (triple space).

1
go to new page and print.

NOCC
treats carriage-control characters as regular text.

If the FSLIST procedure can determine from the file's attributes that the file contains carriage-control information, then that carriage-control information is used to format the displayed text. In this case, the CC option is the default. Otherwise, the entire contents of the file are treated as text. In this case, the NOCC option is the default.

Note: Under some operating environments, FORTRAN-style carriage control is the native carriage control. For these environments, the FORTCC and CC options produce the same behavior.

HSCROLL=*n* | HALF | PAGE
indicates the default horizontal scroll amount for the LEFT and RIGHT commands. The following values are valid:

n
sets the default scroll amount to *n* columns.

HALF
sets the default scroll amount to half the window width.

PAGE
sets the default scroll amount to the full window width.

The default is HSCROLL=HALF. You can use the HSCROLL command in the FSLIST window to change the default scroll amount.

NOBORDER
suppresses the sides and bottom of the FSLIST window's border. When this option is used, text can appear in the columns and row that are normally occupied by the border.

NUM | NONUM
controls the display of line sequence numbers in files that have a record length of 80 and contain sequence numbers in columns 73 through 80. NUM displays the line sequence numbers. NONUM suppresses them.

Default NONUM

OVP | NOOVP
indicates whether the carriage-control code for overprinting is in effect:

OVP
causes the procedure to honor the overprint code and print the current line over the previous line when the code is encountered.

NOOVP
causes the procedure to ignore the overprint code and print each line from the file on a separate line of the display.

Usage: FSLIST Procedure

FSLIST Command

Initiates an FSLIST session from any SAS window. The command enables you to use either a fileref or a filename to specify the file to browse. It also enables you to specify how carriage-control information is interpreted.

Syntax

FSLIST <* | ? | *file-specification <carriage-control-option <overprinting-option>>*>

Without Arguments

If you do not specify any of these three arguments, then a selection window appears that enables you to select an external filename.

Optional Arguments

*
opens a dialog box in which you can specify the name of the file to browse, along with various FSLIST procedure options. In the dialog box, you can specify either a physical filename, a fileref, or a directory name. If you specify a directory name, then a selection list of the files in the directory appears, from which you can choose the desired file.

?

opens a selection window from which you can choose the external file to browse. The selection list in the window includes all external files that are identified in the current SAS session (all files with defined filerefs).

To select a file, position the cursor on the corresponding fileref and press Enter.

Notes Only filerefs that are defined within the current SAS session appear in the selection list. Under some operating environments, it is possible to allocate filerefs outside of SAS. Such filerefs do not appear in the selection list that is displayed by the FSLIST command.

The selection window is not opened if no filerefs have been defined in the current SAS session. Instead, an error message is written, instructing you to enter a filename with the FSLIST command.

file-specification

identifies the external file to browse. *File-specification* can be one of the following:

'external-file'

the complete operating environment file specification (called the fully qualified pathname under some operating environments) for the external file. You must enclose the name in quotation marks.

If the specified file is not found, then a selection window appears that shows all available filerefs.

fileref

a fileref that is currently assigned to an external file. If you specify a fileref that is not currently defined, then a selection window appears that shows all available filerefs. An error message in the selection window indicates that the specified fileref is not defined.

If you specify *file-specification* with the FSLIST command, then you can also use the following carriage control or overprinting options. These options are not valid with the ? argument, or when no argument is used:

CC
FORTCC
NOCC

indicates whether carriage-control characters are used to format the display.

If the FSLIST procedure can determine from the file's attributes that the file contains carriage-control information, then that carriage-control information is used to format the displayed text. In this case, the CC option is the default. Otherwise, the entire contents of the file are treated as text. In this case, the NOCC option is the default.

You can specify one of the following values for this option:

CC

uses the native carriage-control characters of the operating environment.

FORTCC
uses FORTRAN-style carriage control. See the discussion of the PROC FSLIST statement's FORTCC option for details.

NOCC
treats carriage-control characters as regular text.

OVP | NOOVP
indicates whether the carriage-control code for overprinting is honored. OVP causes the overprint code to be honored. NOOVP causes it to be ignored. The OVP option is ignored if NOCC is in effect.

Default NOOVP

Using the FSLIST Window

Overview of the FSLIST Window

The FSLIST window displays files for browsing only. You cannot edit files in the FSLIST window. However, you can copy text from the FSLIST window into a paste buffer in the following ways, depending on your operating environment:

- Use a mouse to select text, and select **Copy** from the **Edit** menu.
- Use the global MARK and STORE commands.

Depending on your operating environment, the text that you copy can then be pasted into any SAS window that uses the SAS text editor, including the FSLETTER window in SAS/FSP software, or into any other application that allows pasting of text.

You can use commands in the command window or command line to control the FSLIST window.

FSLIST Window Commands

Global Commands

In the FSLIST window, you can use any of the global commands that are described in the *SAS/FSP Procedures Guide*.

Scrolling Commands

n
scrolls the window so that line *n* of text is at the top of the window. Type the desired line number in the command window or on the command line and press Enter. If *n* is greater than the number of lines in the file, then the last few lines of the file are displayed at the top of the window.

BACKWARD <*n*|HALF | PAGE | MAX>
scrolls vertically toward the first line of the file. The following scroll amounts can be specified:

n
scrolls upward by the specified number of lines.

HALF
scrolls upward by half the number of lines in the window.

PAGE
scrolls upward by the number of lines in the window.

MAX
scrolls upward until the first line of the file is displayed.

If the scroll amount is not explicitly specified, then the window is scrolled by the amount that was specified in the most recent VSCROLL command. The default VSCROLL amount is PAGE.

BOTTOM
scrolls downward until the last line of the file is displayed.

FORWARD <*n*|HALF | PAGE | MAX>
scrolls vertically toward the end of the file. The following scroll amounts can be specified:

n
scrolls downward by the specified number of lines.

HALF
scrolls downward by half the number of lines in the window.

PAGE
scrolls downward by the number of lines in the window.

MAX
scrolls downward until the first line of the file is displayed.

If the scroll amount is not explicitly specified, then the window is scrolled by the amount that was specified in the most recent VSCROLL command. The default VSCROLL amount is PAGE. Regardless of the scroll amount, this command does not scroll beyond the last line of the file.

HSCROLL <*n*|HALF | PAGE>
sets the default horizontal scrolling amount for the LEFT and RIGHT commands. The following scroll amounts can be specified:

n
sets the default scroll amount to the specified number of columns.

HALF
sets the default scroll amount to half the number of columns in the window.

PAGE
sets the default scroll amount to the number of columns in the window.

The default HSCROLL amount is HALF.

LEFT <*n*|HALF | PAGE | MAX>
scrolls horizontally toward the left margin of the text. This command is ignored unless the file width is greater than the window width. The following scroll amounts can be specified:

n
scrolls left by the specified number of columns.

HALF
scrolls left by half the number of columns in the window.

PAGE
scrolls left by the number of columns in the window.

MAX
scrolls left until the left margin of the text is displayed at the left edge of the window.

If the scroll amount is not explicitly specified, then the window is scrolled by the amount that was specified in the most recent HSCROLL command. The default HSCROLL amount is HALF. Regardless of the scroll amount, this command does not scroll beyond the left margin of the text.

RIGHT <*n*|HALF | PAGE | MAX>
scrolls horizontally toward the right margin of the text. This command is ignored unless the file width is greater than the window width. The following scroll amounts can be specified:

n
scrolls right by the specified number of columns.

HALF
scrolls right by half the number of columns in the window.

PAGE
scrolls right by the number of columns in the window.

MAX
scrolls right until the right margin of the text is displayed at the left edge of the window.

If the scroll amount is not explicitly specified, then the window is scrolled by the amount that was specified in the most recent HSCROLL command. The default HSCROLL amount is HALF. Regardless of the scroll amount, this command does not scroll beyond the right margin of the text.

TOP
scrolls upward until the first line of text from the file is displayed.

VSCROLL <*n* | HALF | PAGE>
sets the default vertical scrolling amount for the FORWARD and BACKWARD commands. The following scroll amounts can be specified:

n
sets the default scroll amount to the specified number of lines.

HALF
sets the default scroll amount to half the number of lines in the window.

PAGE
sets the default scroll amount to the number of lines in the window.

The default VSCROLL amount is PAGE.

Searching Commands

BFIND <*search-string* <PREFIX | SUFFIX | WORD>>
locates the previous occurrence of the specified string in the file, starting at the current cursor position and proceeding backward toward the beginning of the file. The *search-string* value must be enclosed in quotation marks if it contains embedded blanks.

If a FIND command has previously been issued, then you can use the BFIND command without arguments to repeat the search in the opposite direction.

The CAPS option in the PROC FSLIST statement and the CAPS ON command cause search strings to be converted to uppercase for the purposes of the search, unless the strings are enclosed in quotation marks. See the discussion of the FIND command for details.

By default, the BFIND command locates any occurrence of the specified string, even where the string is embedded in other strings. You can use any one of the following options to alter the command's behavior:

PREFIX
causes the search string to match the text string only when the text string occurs at the beginning of a word.

SUFFIX
causes the search string to match the text string only when the text string occurs at the end of a word.

WORD
causes the search string to match the text string only when the text string is a distinct word.

You can use the RFIND command to repeat the most recent BFIND command.

CAPS <ON | OFF>
controls how the FIND, BFIND, and RFIND commands locate matches for a search string. By default, the FIND, BFIND, and RFIND commands locate only those text strings that exactly match the search string as it was entered. When you issue the CAPS command, the FIND, BFIND, and RFIND commands convert search strings into uppercase for the purposes of searching (displayed text is not affected), unless the strings are enclosed in quotation marks. Strings in quotation marks are not affected.

For example, after you issue a CAPS ON command, both of the following commands locate occurrences of **`NC`** but not occurrences of **`nc`**: `find NC`, `find`

`nc`. If you omit the ON or OFF argument, then the CAPS command acts as a toggle, turning the attribute on if it was off or off if it was on.

FIND *search-string* <NEXT | FIRST | LAST | PREV | ALL> <PREFIX | SUFFIX | WORD>

locates an occurrence of the specified *search-string* in the file. The *search-string* must be enclosed in quotation marks if it contains embedded blanks.

The text in the *search-string* must match the text in the file in terms of both characters and case. For example, the following command locates occurrences of **`raleigh`**: `find raleigh`. The following command locates occurrences of **`Raleigh`**: `find Raleigh`.

When the CAPS option is used with the PROC FSLIST statement or when a CAPS ON command is issued in the window, the search string is converted to uppercase for the purposes of the search, unless the string is enclosed in quotation marks. In that case, the command `find raleigh` will locate only the text **`RALEIGH`** in the file. You must instead use the command `find 'Raleigh'` to locate the text **`Raleigh`**.

You can modify the behavior of the FIND command by adding any one of the following options:

ALL
: reports the total number of occurrences of the string in the file in the window's message line and moves the cursor to the first occurrence.

FIRST
: moves the cursor to the first occurrence of the string in the file.

LAST
: moves the cursor to the last occurrence of the string in the file.

NEXT
: moves the cursor to the next occurrence of the string in the file.

PREV
: moves the cursor to the previous occurrence of the string in the file.

The default option is NEXT.

By default, the FIND command locates any occurrence of the specified string, even where the string is embedded in other strings. You can use any one of the following options to alter the command's behavior:

PREFIX
: causes the search string to match the text string only when the text string occurs at the beginning of a word.

SUFFIX
: causes the search string to match the text string only when the text string occurs at the end of a word.

WORD
: causes the search string to match the text string only when the text string is a distinct word.

After you issue a FIND command, you can use the RFIND command to repeat the search for the next occurrence of the string, or you can use the BFIND command to repeat the search for the previous occurrence.

RFIND
repeats the most recent FIND command, starting at the current cursor position and proceeding forward toward the end of the file.

Display Commands

COLUMN <ON | OFF>
displays a column ruler below the message line in the FSLIST window. The ruler is helpful when you need to determine the column in which a particular character is located. If you omit the ON or OFF specification, then the COLUMN command acts as a toggle, turning the ruler on if it was off and off if it was on.

HEX <ON | OFF>
controls the special hexadecimal display format of the FSLIST window. When the hexadecimal format is turned on, each line of characters from the file occupies three lines of the display. The first is the line displayed as characters. The next two lines of the display show the hexadecimal value of the operating environment's character codes for the characters in the line of text. The hexadecimal values are displayed vertically, with the most significant byte on top. If you omit the ON or OFF specification, then the HEX command acts as a toggle, turning the hexadecimal format on if it was off and off if it was on.

NUMS <ON | OFF>
controls whether line numbers are shown at the left side of the window. By default, line numbers are not displayed. If line numbers are turned on, then they remain at the left side of the display when text in the window is scrolled right and left. If you omit the ON or OFF argument, then the NUMS command acts as a toggle, turning line numbering on if it was off or off if it was on.

Other Commands

BROWSE *fileref* | '*actual-filename*' <CC | FORTCC | NOCC <OVP | NOOVP>>
closes the current file and displays the specified file in the FSVIEW window. You can specify either a fileref previously associated with a file or an actual filename enclosed in quotation marks. The BROWSE command also accepts the same carriage-control options as the FSLIST command. See "Optional Arguments" on page 1209 for details.

END
closes the FSLIST window and ends the FSLIST session.

HELP <*command*>
opens a Help window that provides information about the FSLIST procedure and about the commands available in the FSLIST window. To get information about a specific FSLIST window command, follow the HELP command with the name of the desired command.

KEYS
opens the KEYS window for browsing and editing function key definitions for the FSLIST window. The default key definitions for the FSLIST window are stored in the FSLIST.KEYS entry in the Sashelp.Fsp catalog.

If you change any key definitions in the KEYS window, then a new FSLIST.KEYS entry is created in your personal PROFILE catalog (Sasuser.Profile, or Work.Profile if the Sasuser library is not allocated).

When the FSLIST procedure is initiated, it looks for function key definitions first in the FSLIST.KEYS entry in your personal PROFILE catalog. If that entry does not exist, then the default entry in the Sashelp.Fsp catalog is used.

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GROOVY Procedure

Overview: GROOVY Procedure

What Does the GROOVY Procedure Do?

Groovy is a dynamic language that runs on the Java Virtual Machine (JVM). PROC GROOVY enables SAS code to execute Groovy code on the JVM.

PROC GROOVY can run Groovy statements that are written as part of your SAS code, and it can run statements that are in files that you specify with PROC GROOVY commands. It can parse Groovy statements into Groovy Class objects,

and it can run these objects or make them available to other PROC GROOVY statements or Java DATA Step Objects. You can also use PROC GROOVY to update your CLASSPATH environment variable with additional CLASSPATH strings or filerefs to JAR files.

Special Considerations

Groovy code that is submitted with PROC GROOVY runs as the process owner, and has the same access to resources (file system, network, and so on) as any process owner. Groovy code access to resources can cause problems when SAS code is running inside multiuser servers like the Stored Process Server. To give administrators some control over this functionality, PROC GROOVY runs only if the NOXCMD option is turned off. All SAS servers are shipped with the NOXCMD option turned on.

The use of a percent character (%) in the first byte of the text that is written by Java to the SAS log is reserved by SAS. If you need to write a percent character in the first byte of a Java text line, then you must immediately follow it with another percent character (%%).

PROC GROOVY does not support the THREADS | NOTHREADS SAS system option. However, Groovy code that you submit with PROC GROOVY can use threaded processing in the JVM.

Syntax: GROOVY Procedure

Restrictions: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

PROC GROOVY does not run if the NOXCMD option is turned on.

Interaction: When a SAS server is in a locked-down state, PROC GROOVY will not execute. For more information, see "SAS Processing Restrictions for Servers in a Locked-Down State" in *SAS Language Reference: Concepts*.

PROC GROOVY <*classpath options*>;

ADD *classpath options*;

EVALUATE <(LOAD | PARSEONLY | NORUN)>
"*Groovy statement string*" <*argument(s)*>;

EXECUTE <(LOAD | PARSEONLY | NORUN)>
Groovy filename | *fileref* <*argument(s)*>;

SUBMIT <(LOAD | PARSEONLY | NORUN)> <*argument(s)*>;
Groovy statement(s)

ENDSUBMIT;

CLEAR;

QUIT;

Statement	Task	Example
PROC GROOVY	Enable SAS code to run Groovy code on the JVM	Ex. 1
ADD	Append the given classpath to the current CLASSPATH environment variable	
EVALUATE	Parse the Groovy statement in the quoted string and call the Run method on the Script	
EXECUTE	Read the contents of the file that is specified as either a quoted string path or as a fileref and call the Run method on the Script	
SUBMIT	Parse the Groovy statements between the SUBMIT and ENDSUBMIT commands and call the Run method on the Script	
ENDSUBMIT	End the Groovy statements that begin with the SUBMIT command	
CLEAR	Empty the binding and unload the Groovy classloader	

PROC GROOVY Statement

Enables SAS code to run Groovy code on the JVM.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Syntax

PROC GROOVY <*classpath options*>;

Optional Argument

classpath options
can be one of the following:

CLASSPATH=
specifies a quoted CLASSPATH string or a fileref to a specific JAR file that is to be added to the current classpath. This path is searched after the paths that are in the user's CLASSPATH environment variable.

Alias PATH=

SASJAR=<*version*=> | <*range*=>
specifies a quoted string that identifies a JAR in the Versioned JAR Repository (VJR) that should be added to the current classpath. The VERSION and RANGE values are optional. RANGE takes precedence over VERSION, as in the following example:

```
ADD SASJAR="sas.core";
ADD SASJAR="sas.core" version="903000.9.0.20100810190000_v930";
ADD SASJAR="sas.core" range="[0,909000]";
```

Note: SAS JAR files do not have a source compatibility guarantee across versions of SAS. Future versions of this JAR can change without notice. To ensure continued functionality, contact SAS Technical Support.

Details

PROC GROOVY uses the current user's CLASSPATH environment variable as the base for building its classpath. You can use the CLASSPATH and SASJAR options to add paths to the current classpath.

When a class is loaded, the paths are searched in the following order:

1. CLASSPATH environment variable when process started
2. paths added with the ADD CLASSPATH and ADD SASJAR statements in the order in which they were executed

ADD Statement

Appends the given classpath to the current CLASSPATH environment variable.

Syntax

ADD *classpath options*;

Required Argument

classpath options
can be one of the following:

CLASSPATH=
specifies a quoted CLASSPATH string or a fileref to a specific JAR file that is to be added to the current classpath. This path is searched after the paths that are in the user's CLASSPATH environment variable.

Alias PATH=

SASJAR=<*version*=> | <*range*=>
specifies a quoted string that identifies a JAR file in the Versioned JAR Repository (VJR) that should be added to the current classpath. The VERSION and RANGE values are optional. RANGE takes precedence over VERSION, as in the following example:

```
ADD SASJAR="sas.core";
ADD SASJAR="sas.core" version="903000.9.0.20100810190000_v930";
ADD SASJAR="sas.core" range="[0,909000]";
```

Note: SAS JAR files do not have a source compatibility guarantee across versions of SAS. Future versions of this JAR file can change without notice. To ensure continued functionality, contact SAS Technical Support.

Details

The ADD statement appends the given classpath to the current CLASSPATH environment variable.

You must specify at least one CLASSPATH or one SASJAR. You can specify multiple CLASSPATHs or SASJARs.

EVALUATE Statement

Parses the Groovy statement that is provided in the quoted string into a groovy.lang.Script object and calls the Run method on the Script.

Syntax

EVALUATE <(LOAD | PARSEONLY | NORUN)>
"*Groovy statement string*" <*argument(s)*>;

Required Argument

Groovy statement string
specifies a Groovy statement string that is to be parsed by the EVALUATE statement.

Optional Arguments

LOAD | PARSEONLY | NORUN
parses the Groovy statement into a groovy.lang.Script object, but does not run it. The arguments are aliases for each other.

argument(s)
specifies arguments that are passed to the code that is being evaluated.

Details

The EVALUATE statement parses the Groovy statement that is provided in the quoted string into a groovy.lang.Script object and calls the Run method on the Script. If one of the LOAD, PARSEONLY, or NORUN options is present, then this statement parses the Groovy statement into a Class object but does not run it. Any classes that are defined by the Groovy code are then available for use by PROC GROOVY statements or by Java DATA Step Objects.

EVAL is an alias for the EVALUATE statement.

EXECUTE Statement

Reads the contents of the file that is specified as either a quoted string path or as a fileref.

Syntax

EXECUTE <(LOAD | PARSEONLY | NORUN)>
Groovy filename | fileref <*argument(s)*>;

Required Arguments

Groovy filename
specifies the name of the Groovy file that is to be parsed by the EXECUTE statement.

fileref
specifies the name of a fileref that is to be parsed by the EXECUTE statement.

Optional Arguments

LOAD | PARSEONLY | NORUN
parses the Groovy statement in the specified Groovy file or fileref into a groovy.lang.Script object, but does not run it. The arguments are aliases for each other.

argument(s)
specifies arguments that are passed to the code that is being executed.

Details

The EXECUTE statement reads the contents of the file that is specified as either a quoted string path or as a fileref. The contents are then parsed into a groovy.lang.Script object, and the Run method is called on the Script. If one of the LOAD, PARSEONLY, or NORUN options is present, then this statement parses the file contents into a Class object but does not run it. Any classes that are defined by the Groovy code are then available for use by PROC GROOVY statements or by Java DATA Step Objects.

EXEC is an alias for the EXECUTE statement.

Note: If you used an EXEC PARSEONLY statement to compile a file into a Class, then you must submit a CLASS statement so that changes to that file are honored by future EXEC PARSEONLY commands. If you do not submit the CLEAR statement, then any changes that you made to the file after you issued the EXEC PARSEONLY statement are not included by subsequent submissions of the EXEC PARSEONLY statement. You can use the GroovyScriptEngine Class if you need to use reloadable scripts.

SUBMIT Statement

Parses the Groovy statements that are between the SUBMIT and ENDSUBMIT commands into a groovy.lang.Script object and calls the Run method on the Script.

Syntax

SUBMIT <(LOAD | PARSEONLY | NORUN)> <*argument(s)*>;
Groovy statement(s)

ENDSUBMIT;

Required Argument

Groovy statement(s)
specifies Groovy statements that are to be parsed by the SUBMIT statement into a groovy.lang.Script object.

Optional Arguments

LOAD | PARSEONLY | NORUN
parses the Groovy statements into a groovy.lang.Script object, but does not run it. The arguments are aliases for each other.

argument(s)
specifies arguments that are passed to the code that is being submitted.

Details

The SUBMIT statement parses the Groovy statements that are between the SUBMIT and ENDSUBMIT commands into a groovy.lang.Script object and calls the Run method on the Script. If one of the LOAD, PARSEONLY, or NORUN options is present, then this statement parses the Groovy statements into a Class object but does not run it. Any classes that are defined by the Groovy code are then available for use by PROC GROOVY statements or by Java DATA Step Objects.

Note:

- The ENDSUBMIT statement must be on a line by itself and preceded by only blank space.
- Macro substitution is disabled between the SUBMIT and ENDSUBMIT commands.
- PROC GROOVY with multi-line submit commands cannot be used inside a macro.

ENDSUBMIT Statement

Ends the Groovy statements that begin with the SUBMIT command.

Syntax

ENDSUBMIT;

Details

Ends the Groovy statements that begin with the SUBMIT statement.

Note: The ENDSUBMIT statement must be on a line by itself and preceded by only blank space.

CLEAR Statement

Empties the binding and unloads the Groovy classloader.

Syntax

CLEAR;

Details

The CLEAR statement empties the binding and unloads the Groovy classloader. When this statement is executed, any variables that are saved in the binding are rendered unavailable. Any classes that are loaded into the Groovy classloader are also rendered unavailable.

RESET is an alias for the CLEAR statement.

Note: Neither the CLEAR statement nor the RESET statement resets the System.Properties collection or the CLASSPATH.

Usage: GROOVY Procedure

Special Variables

PROC GROOVY has four special variables: BINDING, ARGS, EXPORTS, and SHELL. It makes these variables available to any Groovy code that it is running.

BINDING

The BINDING special variable is used to share the state of objects between executions of PROC GROOVY. It is populated by any variables that are created without scope or that are explicitly stored in the binding. BINDING also holds all of the other special variables that are discussed in this section. The binding can be cleared with the CLEAR statement.

Note: The BINDING special variable is available to any Groovy code that PROC GROOVY is running.

```
proc groovy;
  eval "a = 42";
  eval "binding.b = 84";
```

```
  eval "binding.setProperty( 'c', 168 )";
quit;
proc groovy;
  eval "println ""----> ${binding.getProperty('a')}""";
  eval "println ""----> ${b}""";
  eval "println ""----> ${binding.c}""";
quit;
```

ARGS

Arguments are passed to Groovy code in the ARGS special variable in the binding.

Note: The ARGS special variable is available to any Groovy code that PROC GROOVY is running.

```
proc groovy;
  eval "args.each{ println ""----> ev ${it}"" }" "arg1" "arg2" "arg3";

  exec "args.groovy" "arg1" "arg2" "arg3";

  submit "arg1" "arg2" "arg3";
    args.each{
      println "----> su ${it}"
    }
  endsubmit;
quit;
```

EXPORTS

The EXPORTS special variable contains a map in the binding. Adding a key or value pair to this map will create a SAS macro variable when PROC GROOVY ends. Groovy is case sensitive, but macros are not. If two keys exist in the map that differ only by their case, then the one that is exported into a SAS macro is not determined. You can also replace the EXPORTS variable in the binding with any object that inherits from java.util.Map. If you replace the variable, all of the key or value pairs in that object will be exported.

Note: The EXPORTS special variable is available to any Groovy code that PROC GROOVY is running.

```
proc groovy;
  eval "exports.fname = ""first name""";
  eval "binding.exports.lname = ""last name""";
  eval "exports.put('state', 'NC')";
quit;

data _NULL_;
  put "----> &fname &lname: &state";
```

```
run;

proc groovy;
  submit;
    exports = [fname:"first name", lname: "last name", state: "NC"]
  endsubmit;
quit;

data _NULL_;
  put "----> &fname &lname: &state";
run;
```

SHELL

The SHELL special variable in the binding is set to the groovy.lang.GroovyShell that was used to compile the current script. You must submit a CLEAR statement before changes that were made to the execution.groovy file in this example are reflected in subsequent runs of the code.

Note: The SHELL special variable is available to any Groovy code that PROC GROOVY is running.

```
proc groovy;
  eval "shell.run(
              new File(""execution.groovy""),
              [] as String[] )";
quit;
```

Note: If you need Groovy scripts that will be reloaded automatically when they are modified, then create a new instance of the GroovyScriptEngine class.

Examples: GROOVY Procedure

Example 1: Define Classes

Features:

PROC GROOVY statement option
    CLASSPATH

SUBMIT statement option
    PARSEONLY

SUBMIT Statement

ENDSUBMIT Statement

The following three examples show how to use PROC GROOVY to define a class.

Program

Groovy code is run by default. If your script does not have any executable code, then an error is returned. The following example defines a class, but it does not have any executable code, and an error is returned.

```
proc groovy classpath=cp;
  submit;
    class Speaker {
      def say( word ) {
        println "----> \"${word}\""
      }
    }
  endsubmit;
quit;
```

Program

The following example shows how to define a class that can be run by including a `main` method.

```
proc groovy classpath=cp;
  submit;
    class Speaker {
      def Speaker() {
        println "----> ctor"
      }
      def main( args ) {
        println "----> main"
      }
    }
  endsubmit;
quit;
```

Program

The following example shows how to use the PARSEONLY option to avoid a run call. You can then use the new class in another execution of PROC GROOVY.

```
proc groovy classpath=cp;
  submit parseonly;
    class Speaker {
      def say( word ) {
        println "----> \"${word}\""
      }
```

```
    }
  endsubmit;
quit;

proc groovy classpath=cp;
  eval "s = new Speaker(); s.say( ""Hi"" )";
quit;
```

Example 2: Pass a Macro Variable to PROC GROOVY

Features: SUBMIT Statement
ENDSUBMIT Statement

The following example shows how to define a macro variable and pass it to PROC GROOVY.

```
%let _inzip = C:/path/example.zip;
proc groovy;
   submit "&_inzip.";
      def zipFile = new java.util.zip.ZipFile(new File(args[0]))
         zipFile.entries().each {
            println zipFile.getInputStream(it).text
         }

   endsubmit;
quit;
```

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HADOOP Procedure

Overview: HADOOP Procedure

What Does the HADOOP Procedure Do?

The HADOOP procedure enables SAS to interact with Hadoop data by running Apache Hadoop code. Apache Hadoop is an open-source framework, written in

Java, that provides distributed data storage and processing of large amounts of data.

PROC HADOOP interfaces with the Hadoop JobTracker. This is the service within Hadoop that controls tasks to specific nodes in the cluster. PROC HADOOP enables you to submit the following:

- Hadoop Distributed File System (HDFS) commands
- MapReduce programs
- Pig language code

The HADOOP procedure is supported in SAS 9.4 and in SAS Viya.

Syntax: HADOOP Procedure

Restrictions: This procedure is not supported in the z/OS operating environment.

This procedure is not supported on the CAS server.

When SAS is in a locked-down state, PROC HADOOP is not available. Your server administrator can re-enable this procedure so that it is accessible in the lockdown state. When the FILENAME Hadoop access method is re-enabled by using the LOCKDOWN ENABLE_AMS= statement, PROC HADOOP is automatically re-enabled. For more information, see "SAS Processing Restrictions for Servers in a Locked-Down State" in *SAS Programmer's Guide: Essentials*.

Requirement: Java Runtime Environment (JRE) 1.6 and higher

Interactions: Beginning with SAS 9.4M3, to connect to the Hadoop cluster, the Hadoop cluster configuration files must be accessible to the SAS client machine. You can copy the configuration files to a physical location that is accessible to the SAS client machine and then set the SAS environment variable SAS_HADOOP_CONFIG_PATH to the location. Or, you can create a single configuration file by merging the properties from the multiple Hadoop cluster configuration files and then identify the configuration file with the PROC HADOOP statement CFG= argument. For more information, see the *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*.

To submit HDFS commands, MapReduce programs, and Pig language code using the Java API, the Hadoop distribution JAR files must be copied to a physical location that is accessible to the SAS client machine. The SAS environment variable SAS_HADOOP_JAR_PATH must be set to the location of the Hadoop JAR files. For more information, see the *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*.

To submit HDFS commands through WebHDFS, the SAS environment variable SAS_HADOOP_RESTFUL must be set to 1. In addition, the Hadoop configuration file hdfs-site.xml must include the properties for the WebHDFS location. For more information, see the *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*.

Beginning with SAS 9.4M3, to submit MapReduce programs and Pig language code through the Apache Oozie RESTful API, the SAS environment variable

SAS_HADOOP_RESTFUL must be set to 1. You must also set the SAS environment variable SAS_HADOOP_CONFIG_PATH to the location where the hdfs-site.xml and core-site.xml configuration files exist. The hdfs-site.xml must include the property for the WebHDFS location. You also need to specify Oozie specific properties in a configuration file and identify the configuration file with the PROC HADOOP statement CFG= argument. The Oozie specific properties include oozie_http_port, fs.default.name, and mapred.job.tracker. For more information, see the *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*. PROC HADOOP does not support running an Oozie job (MAPREDUCE or PIG) on a server that has Kerberos enabled.

Note: For a list of Hadoop distributions that are supported in SAS 9.4, see SAS 9.4 Supported Hadoop Distributions. For a list of Hadoop distributions that are supported in SAS Viya, see *SAS Viya: Deployment Guide*. For information about configuration, see SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS.

PROC HADOOP <*hadoop-server-options*>;

HDFS <*hadoop-server-options*> <*hdfs-command-options*>;

MAPREDUCE <*hadoop-server-options*> <*mapreduce-options*>;

PIG <*hadoop-server-options*> <*pig-code-options*>;

PROPERTIES <*configuration-properties*>;

Statement	Task	Example
PROC HADOOP	Control access to the Hadoop server	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5
HDFS	Submit Hadoop Distributed File System (HDFS) commands	Ex. 1, Ex. 2
MAPREDUCE	Submit MapReduce programs into a Hadoop cluster	Ex. 3
PIG	Submit Pig language code into a Hadoop cluster	Ex. 4
PROPERTIES	Submit configuration properties	Ex. 5

PROC HADOOP Statement

Controls access to the Hadoop server.

Examples:
"Example 1: Submitting HDFS Commands" on page 1250
"Example 2: Submitting HDFS Commands with Wildcard Characters" on page 1251
"Example 3: Submitting a MapReduce Program" on page 1253
"Example 4: Submitting Pig Language Code" on page 1255
"Example 5: Submitting Configuration Properties" on page 1256

Syntax

PROC HADOOP <*hadoop-server-options*>;

Summary of Optional Arguments

AUTHDOMAIN='*authentication-domain*'
: specifies the name of an authentication domain metadata object in order to connect to the Hadoop server.

CFG=*fileref* | '*external-file*'
: identifies the Hadoop configuration file to use in order to connect to the Hadoop server.

MAXWAIT=*wait-interval*
: specifies the HTTP status response time when using WebHDFS.

PASSWORD='*password*'
: is the password for the user ID on the Hadoop server.

USERNAME='*ID*'
: is an authorized user ID on the Hadoop server.

VERBOSE
: enables additional messages that are displayed on the SAS log.

Hadoop Server Options

These options control access to the Hadoop server and can be specified in all HADOOP procedure statements.

AUTHDOMAIN='*authentication-domain*'
specifies the name of an authentication domain metadata object in order to connect to the Hadoop server. The authentication domain references credentials (user ID and password) without your explicitly specifying the credentials.

An administrator creates authentication domain definitions while creating a user definition with the User Manager in SAS Management Console. The authentication domain is associated with one or more login metadata objects that provide access to the Hadoop server. The metadata objects are resolved by SAS calling the SAS Metadata Server and returning the authentication credentials.

Restriction
: This option is not valid in SAS Viya.

Requirements
: Enclose the *authentication-domain* name in single or double quotation marks.

: The authentication domain and the associated login definition must be stored in a metadata repository, and the metadata server must be running to resolve the metadata object specification.

Interaction If you specify AUTHDOMAIN=, do not specify USERNAME= and PASSWORD=.

See For more information about creating and using authentication domains, see the discussion about credential management in the *SAS Intelligence Platform: Security Administration Guide*.

CFG=*fileref* | '*external-file*'
identifies the Hadoop configuration file to use in order to connect to the Hadoop server. The configuration file contains entries for Hadoop system information, including file system properties such as fs.defaultFS. The configuration file can be a copy of the Hadoop core-site.xml file. However, if your Hadoop cluster is running with HDFS failover enabled, you need to create a file that combines the properties of the Hadoop core-site.xml and hdfs-site.xml. The configuration file must specify the name and JobTracker addresses for the specific server.

fileref
specifies the SAS fileref that is assigned to the Hadoop configuration file. To assign a fileref, use the FILENAME statement.

'***external-file***'
is the physical location of the XML document. Include the complete pathname and the filename. The maximum length is 200 characters.

Requirement Enclose the physical name in single or double quotation marks.

Alias OPTIONS=

Requirement The file must be an XML document.

Interaction The CFG= option is required for a configuration file that is specific to Apache Oozie. You must also set the SAS environment variable SAS_HADOOP_CONFIG_PATH. For more information, see *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*. For other uses, specify the location of configuration files by setting the SAS_HADOOP_CONFIG_PATH environment variable only. The environment variable is used by several SAS components.

Note For more information about Hadoop configuration, see SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS.

MAXWAIT=*wait-interval*
specifies the HTTP status response time when using WebHDFS.

Default 40000 milliseconds

Requirement The environment variable SAS_HADOOP_RESTFUL must be set to 1.

Tip If you receive a time-out message in the log, use MAXWAIT= to increase the wait period.

PASSWORD='*password*'
is the password for the user ID on the Hadoop server. The user ID and password are added to the set of options that are identified by CFG=.

Alias PASS=

Interaction To specify PASSWORD=, you must also specify USERNAME=.

USERNAME='*ID*'
is an authorized user ID on the Hadoop server. The user ID and password are added to the set of options that are identified by CFG=.

Alias USER=

VERBOSE
enables additional messages that are displayed on the SAS log. VERBOSE is a good error diagnostic tool. If you receive an error message when you invoke SAS, you can use this option to see whether you have an error in your system option specifications.

HDFS Statement

Submits Hadoop Distributed File System (HDFS) commands.

Restrictions: The HDFS statement supports only one operation per invocation.

The CAT, CHMOD, and LS commands are available only when submitting HDFS commands through webHDFS.

The RECURSE option and use of wildcards are permitted only when submitting HDFS commands through webHDFS.

Requirements: To submit HDFS commands through WebHDFS, the SAS environment variable SAS_HADOOP_RESTFUL must be set to 1. In addition, the Hadoop configuration file must include the properties for the WebHDFS location. For more information, see the *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*.

To submit HDFS commands using the Java API, the Hadoop distribution JAR files must be copied to a physical location that is accessible to the SAS client machine. The SAS environment variable SAS_HADOOP_JAR_PATH must be set to the location of the Hadoop JAR files. For more information, see the *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*.

Note: For more information about Hadoop configuration, see SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS.

Examples: "Example 1: Submitting HDFS Commands" on page 1250

"Example 2: Submitting HDFS Commands with Wildcard Characters" on page 1251

Syntax

HDFS <*hadoop-server-options*> <*hdfs-command-options*>;

Summary of Optional Arguments

CAT='*HDFS-file*' <ONLY=*n*> <OUT='*output-location*'> <RECURSE> <SHOW_FILENAME>
: displays the contents of the specified file or files.

CHMOD='*HDFS-file*' PERMISSION=<'>*value*<'> <RECURSE>
: changes file access permissions for one or more HDFS files.

COPYFROMLOCAL='*local-file*' OUT='*output-location*' <DELETESOURCE> <OVERWRITE> <RECURSE>
: copies the specified local file to an HDFS output location.

COPYTOLOCAL='*HDFS-file*' OUT='*output-location*' <DELETESOURCE> <KEEPCRC> <OVERWRITE> <RECURSE>
: copies the specified HDFS file to a local output location.

DELETE='*HDFS-file*' <NOWARN>
: deletes the specified HDFS file.

LS='*HDFS-pathname*' <OUT=*output-location*><RECURSE>
: lists the files in the specified HDFS pathname.

MKDIR='*HDFS-pathname*'
: creates the specified HDFS pathname. Specify the complete HDFS pathname.

RENAME='*HDFS-file*' OUT='*output-location*'
: renames the specified HDFS file.

HDFS Command Options

These options support commands that interact with the HDFS. Include only one operation per HDFS statement.

CAT='*HDFS-file*' <ONLY=*n*> <OUT='*output-location*'> <RECURSE> <SHOW_FILENAME>
: displays the contents of the specified file or files.

'HDFS-file'
: specifies a pathname or a pathname and a filename. You can use wildcard characters to substitute for any other character or characters in the pathname or the filename. Use * to match one or more characters, or ? to match a single character.

ONLY=*n*
: displays only the specified number of lines from the beginning of the file. For example, `only=10` displays the first ten lines of a file. This option is helpful to determine the contents of a file.

OUT='*output-location*'
: specifies the output location for the contents, which can be an external file for your machine or a fileref that is assigned with the FILENAME statement. By default, the output location is the SAS log.

RECURSE
: specifies to display the contents for all files in the specified pathname and all files that are in subdirectories. RECURSE has no effect if the specified HDFS file is not a directory.

SHOW_FILENAME
includes the name of the file in the output. For example, `hdfs cat='/tmp/*.txt' show_filename only=10 recurse;` displays in the SAS log the name of the file and the first ten lines of all .txt files that are found in the /tmp directory and all of its subdirectories.

Note The CAT= option is supported beginning with SAS 9.4M3.

CHMOD='*HDFS-file*' PERMISSION=<'>*value*<'> <RECURSE>
changes file access permissions for one or more HDFS files.

'HDFS-file'
specifies a pathname or a pathname and a filename. You can use a wildcard character to substitute for any character or characters in the pathname or filename. Use * to match any number of characters, or ? to match a single character.

PERMISSION=*value*
specifies a value that represents three levels of permissions, which are owner, group, and user. All three permission levels are required. You can specify the permissions in read, write, and execute (rwx) symbolic notation or octal notation.

- For the rwx symbolic notation, use nine characters. The first set of three characters represents what the owner can do, the second set represents what a group can do, and the third set represents what a user can do. For each set of three characters, the first position must be r or - (for read), the second position must be w or - (for write), and the third position must be x or - (for execute). For example, `permission=rwxr-xr-x` specifies that the owner has Read, Write, and Execute permission, group members have Read and Execute permission, and users have Read and Execute permission.
- For octal notation, use three digits. Each digit represents the permissions for owner, group, and user. Each digit must be from 0 to 7. The octal notation represents the same numeric value as the rwx symbolic notation. That is, 4 is r, 2 is w, 1 is x, and 0 is -. For example, `permission=755;` specifies that the owner has Read, Write, and Execute permission, group members have Read and Execute permission, and users have Read and Execute permission.

RECURSE
specifies to change the access permissions to all files and directories in the specified pathname and all files and directories that are in subdirectories. RECURSE has no effect if the specified HDFS file is not a directory. For example, `hdfs chmod='/tmp' permission=755 recurse;` changes the permissions to the specified directory and all files and subdirectories within the directory.

Note The CHMOD= option is supported beginning with SAS 9.4M3.

COPYFROMLOCAL='*local-file*' OUT='*output-location*' <DELETESOURCE> <OVERWRITE> <RECURSE>
copies the specified local file to an HDFS output location.

'local-file'
specifies the complete pathname and the filename. Beginning with SAS 9.4M3, you can use a wildcard character to substitute for any other character or characters in the pathname or the filename. Use * to match any number of characters, or ? to match a single character.

OUT='*output-location*'
specifies the output location for the copied file, which is a complete HDFS pathname and the filename.

DELETESOURCE
deletes the input source file after a copy command.

OVERWRITE
specifies to overwrite an existing output location.

RECURSE
specifies to copy all the files in the specified pathname and all files that are in subdirectories. RECURSE has no effect if the specified file is not a directory.

Note The RECURSE option is supported beginning with SAS 9.4M3.

COPYTOLOCAL='*HDFS-file*' OUT='*output-location*' <DELETESOURCE> <KEEPCRC> <OVERWRITE> <RECURSE>
copies the specified HDFS file to a local output location.

'HDFS-file'
specifies the complete pathname and the filename. Beginning with SAS 9.4M3, you can use a wildcard character to substitute for any other character or characters in the pathname or the filename. Use * to match any number of characters, or ? to match a single character.

OUT='*output-location*'
specifies the output location for the copied file, which is an external file for your machine.

DELETESOURCE
deletes the input source file after a copy command.

KEEPCRC
saves the Cyclic Redundancy Check (CRC) file after the copy command to a local output location. The CRC file is saved to the same location that is specified in the OUT= option. The CRC file is used to ensure the correctness of the file being copied. By default, the CRC file is deleted.

OVERWRITE
specifies to overwrite an existing output location.

RECURSE
specifies to copy all the files in the specified pathname and all files that are in subdirectories. RECURSE has no effect if the specified HDFS file is not a directory.

Note The RECURSE option is available beginning with SAS 9.4M3.

DELETE='*HDFS-file*' <NOWARN>
deletes the specified HDFS file.

HDFS-file
specifies a pathname or a pathname and a filename. If you include the filename, then only that file is deleted. If you do not include a filename, then all the files in the specified pathname and all the files that are in subdirectories are deleted. Beginning with SAS 9.4M3, you can use a wildcard character to substitute for any other character or characters in the pathname or the filename. Use * to match any number of characters, or ? to match a single character.

NOWARN
suppresses the warning message when there is an attempt to delete a file that does not exist.

LS='*HDFS-pathname*' <OUT=*output-location*><RECURSE>
lists the files in the specified HDFS pathname. The output for each file consists of its permissions, User ID, User ID group, file size, creation date, creation time, and the filename.

HDFS-pathname
specifies a pathname. You can use a wildcard character to substitute for any character or characters in the pathname. Use * to match any number of characters, or ? to match a single character.

OUT=*output-location*
specifies the output location for the list of files, which can be an external file for your machine or a fileref that is assigned with the FILENAME statement. By default, the output location is the SAS log.

RECURSE
specifies to list the files in the specified pathname and all files that are in subdirectories. RECURSE has no effect if the specified file is not a directory.

Default The default output location is the SAS log.

Note The LS= option is supported beginning with SAS 9.4M3.

MKDIR='*HDFS-pathname*'
creates the specified HDFS pathname. Specify the complete HDFS pathname.

RENAME='*HDFS-file*' OUT='*output-location*'
renames the specified HDFS file.

'*HDFS-file*'
specifies the pathname and the filename to rename.

OUT='*output-location*'
specifies the new HDFS pathname and filename.

MAPREDUCE Statement

Submits MapReduce programs into a Hadoop cluster.

Requirement: To submit MapReduce programs to a Hadoop server, the Hadoop configuration file must include the properties to run MapReduce (MR1) or MapReduce 2 (MR2) and YARN.

Interactions: To submit MapReduce programs using the Java API, the Hadoop distribution JAR files must be copied to a physical location that is accessible to the SAS client machine. The SAS environment variable SAS_HADOOP_JAR_PATH must be set to the location of the Hadoop JAR files. For more information, see the *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*.

Beginning with SAS 9.4M3, to submit MapReduce programs through the Apache Oozie RESTful API, the SAS environment variable SAS_HADOOP_RESTFUL must be set to 1. You must also set the SAS environment variable SAS_HADOOP_CONFIG_PATH to the location where the hdfs-site.xml and core-site.xml configuration files exist. The hdfs-site.xml file must include the property for the WebHDFS location. You also need to specify Oozie specific properties in a configuration file and identify the configuration file with the PROC HADOOP statement CFG= argument. The Oozie specific properties include oozie_http_port, fs.default.name, and mapred.job.tracker. For more information, see the *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*.

Note: For more information about Hadoop configuration, see SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS.

Example: "Example 3: Submitting a MapReduce Program" on page 1253

Syntax

MAPREDUCE<*hadoop-server-options*> <*mapreduce-options*>;

Summary of Optional Arguments

COMBINE='*class-name*'
: specifies the name of the combiner class in dot notation.

DELETERESULTS
: specifies to delete the output directory, if it exists, before starting the MapReduce job.

GROUPCOMPARE='*class-name*'
: specifies the name of the grouping comparator (GroupComparator) class in dot notation.

INPUT='*HDFS-pathname*'
: specifies the HDFS pathname to the MapReduce input file.

INPUTFORMAT='*class-name*'
: specifies the name of the input format class in dot notation.

JAR='*external-file(s)*'
: specifies the locations of the JAR files that contain the MapReduce program and named classes.

MAP='*class-name*'
: specifies the name of the map class in dot notation.

OUTPUT='*HDFS-pathname*'
: when connecting to the Hadoop server, specifies a new HDFS pathname for the MapReduce output.

OUTPUTFORMAT='*class-name*'
: specifies the name of the output format class in dot notation.

OUTPUTKEY='*class-name*'
: specifies the name of the output key class in dot notation.

OUTPUTVALUE='*class-name*'
: is the name of the output value class in dot notation.

PARTITIONER='*class-name*'
: specifies the name of the partitioner class in dot notation.

REDUCE='*class-name*'
: specifies the name of the reducer class in dot notation.

REDUCETASKS=*integer*
: specifies the number of reduce tasks.

REPLACE
: when connecting to Hadoop through the Oozie RESTful API, specifies to delete any existing workflow and JAR file(s) in the Oozie application before copying new files to the working directory.

SORTCOMPARE='*class-name*'
: specifies the name of the sort comparator class in dot notation.

WORKINGDIR='*HDFS-pathname*'
: specifies the name of the HDFS working directory pathname.

MapReduce Options

COMBINE='*class-name*'
specifies the name of the combiner class in dot notation.

DELETERESULTS
specifies to delete the output directory, if it exists, before starting the MapReduce job.

Note This option is supported beginning with SAS 9.4M3.

GROUPCOMPARE='*class-name*'
specifies the name of the grouping comparator (GroupComparator) class in dot notation.

INPUT='*HDFS-pathname*'
specifies the HDFS pathname to the MapReduce input file.

INPUTFORMAT='*class-name*'
specifies the name of the input format class in dot notation.

JAR='*external-file(s)*'
specifies the locations of the JAR files that contain the MapReduce program and named classes. Include the complete pathname and the filename.

Requirement Enclose each location in single or double quotation marks.

MAP='*class-name*'
specifies the name of the map class in dot notation. A map class contains elements that are formed by the combination of a key value and a mapped value.

OUTPUT='*HDFS-pathname*'
when connecting to the Hadoop server, specifies a new HDFS pathname for the MapReduce output.

Requirements You must specify the MapReduce output location.

Enclose the physical name in single or double quotation marks.

OUTPUTFORMAT='*class-name*'
specifies the name of the output format class in dot notation.

OUTPUTKEY='*class-name*'
specifies the name of the output key class in dot notation.

OUTPUTVALUE='*class-name*'
is the name of the output value class in dot notation.

PARTITIONER='*class-name*'
specifies the name of the partitioner class in dot notation. A partitioner class controls the partitioning of the keys of the intermediate map outputs.

REDUCE='*class-name*'
specifies the name of the reducer class in dot notation. The reduce class reduces a set of intermediate values that share a key to a smaller set of values.

REDUCETASKS=*integer*
specifies the number of reduce tasks.

REPLACE
when connecting to Hadoop through the Oozie RESTful API, specifies to delete any existing workflow and JAR file(s) in the Oozie application before copying new files to the working directory.

Note The REPLACE option is supported beginning with SAS 9.4M3.

SORTCOMPARE='*class-name*'
specifies the name of the sort comparator class in dot notation.

WORKINGDIR='*HDFS-pathname*'
specifies the name of the HDFS working directory pathname.

Requirements Beginning with SAS 9.4M3, when connecting to Hadoop through the Oozie RESTful API, this argument is required and specifies the HDFS pathname for the Oozie workflow application directory.

Enclose the *HDFS-pathname* name in single or double quotation marks.

PIG Statement

Submits Pig language code into a Hadoop cluster.

Interactions: To submit Pig language code using the Java API, the Hadoop distribution JAR files must be copied to a physical location that is accessible to the SAS client machine. The SAS environment variable SAS_HADOOP_JAR_PATH must be set to the location of the Hadoop JAR files. For more information, see the *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*.

Beginning with SAS 9.4M3, to submit Pig language code through the Apache Oozie RESTful API, the SAS environment variable SAS_HADOOP_RESTFUL must be set to 1. You must also set the SAS environment variable SAS_HADOOP_CONFIG_PATH to the location where the hdfs-site.xml and core-site.xml configuration files exist. The hdfs-site.xml file must include the property for the WebHDFS location. You also need to specify Oozie specific properties in a configuration file and identify the configuration file with the PROC HADOOP statement CFG= argument. The Oozie specific properties include oozie_http_port, fs.default.name, and mapred.job.tracker. For more information, see the *SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS*.

Note: For more information about Hadoop configuration, see SAS Hadoop Configuration Guide for Base SAS and SAS/ACCESS.

Example: "Example 4: Submitting Pig Language Code" on page 1255

Syntax

PIG <*hadoop-server-options*> <*pig-code-options*>;

Summary of Optional Arguments

CODE=*fileref* | '*external-file*'
: specifies the source that contains the Pig language code to execute.

DELETERESULTS
: when connecting to the Hadoop server through the Oozie RESTful API, specifies to delete the existing output location before starting the Oozie job.

OUTPUT='*HDFS-pathname*'
: when connecting to the Hadoop server through the Oozie RESTful API, specifies the existing output location to delete before starting the Oozie job.

PARAMETERS=*fileref* | '*external-file*'
: specifies the source that contains parameters to be passed as arguments when the Pig code executes.

REGISTERJAR='*external-file(s)*'
specifies the locations of the JAR files that contain the Pig scripts to execute.

REPLACE
when connecting to Hadoop through the Oozie RESTful API, specifies to delete any existing workflow and JAR file(s) in the Oozie application before copying new files to the working directory.

WORKINGDIR='*HDFS-pathname*'
when connecting to Hadoop through the Oozie RESTful API, specifies the HDFS pathname for the Oozie workflow application directory.

Pig Code Options

CODE=*fileref* | '*external-file*'
specifies the source that contains the Pig language code to execute.

fileref
is a SAS fileref that is assigned to the source file. To assign a fileref, use the FILENAME statement.

'external-file'
is the physical location of the source file. Specify the complete pathname and the filename.

Requirement Enclose the physical name in single or double quotation marks.

DELETERESULTS
when connecting to the Hadoop server through the Oozie RESTful API, specifies to delete the existing output location before starting the Oozie job.

Interaction Use the DELETERESULTS option with the OUTPUT= option.

Note The DELETERESULTS option is supported beginning with SAS 9.4M3.

OUTPUT='*HDFS-pathname*'
when connecting to the Hadoop server through the Oozie RESTful API, specifies the existing output location to delete before starting the Oozie job.

Requirement Enclose the physical name in single or double quotation marks.

Interaction Use the OUTPUT= option with the DELETERESULTS option.

Note The OUTPUT= option is supported beginning with SAS 9.4M3.

PARAMETERS=*fileref* | '*external-file*'
specifies the source that contains parameters to be passed as arguments when the Pig code executes.

fileref
is a SAS fileref that is assigned to the source file. To assign a fileref, use the FILENAME statement.

'external-file'
is the physical location of the source file. Specify the complete pathname and the filename.

Requirement Enclose the physical name in single or double quotation marks.

REGISTERJAR='*external-file(s)*'
specifies the locations of the JAR files that contain the Pig scripts to execute. Specify the complete pathname and the filename.

Requirement Enclose each location in single or double quotation marks.

REPLACE
when connecting to Hadoop through the Oozie RESTful API, specifies to delete any existing workflow and JAR file(s) in the Oozie application before copying new files to the working directory.

Note The REPLACE option is supported beginning with SAS 9.4M3.

WORKINGDIR='*HDFS-pathname*'
when connecting to Hadoop through the Oozie RESTful API, specifies the HDFS pathname for the Oozie workflow application directory.

Requirements When connecting to Hadoop through the Oozie RESTFUL API, this argument is required.

Enclose the *HDFS-pathname* name in single or double quotation marks.

Note The WORKINGDIR= option is supported beginning with SAS 9.4M3.

PROPERTIES Statement

Submits configuration properties to the Hadoop server.

Alias: PROP

Example: "Example 5: Submitting Configuration Properties" on page 1256

Syntax

PROPERTIES '*configuration-property-1*' <'*configuration-property-2*'> ...;

Required Argument

configuration-property
specifies any property that can be specified in a Hadoop configuration file.

Requirement Enclose each property in single or double quotation marks, and enclose each value in single or double quotation marks. For example, `prop 'mapred.job.tracker'='xxx.us.company.com:8021' 'fs.default.name'='hdfs://xxx.us.company.com:8020';`

Usage: HADOOP Procedure

Submitting Hadoop Distributed File System Commands

The Hadoop Distributed File System (HDFS) is a distributed, scalable, and portable file system for the Hadoop framework. HDFS is designed to hold large amounts of data that is distributed across a network and to provide access to the data by many clients.

The PROC HADOOP HDFS statement submits HDFS commands to the Hadoop server. HDFS commands are like the Hadoop shell commands that interact with HDFS and manipulate files. For the list of HDFS commands, see "HDFS Statement" on page 1238.

Submitting MapReduce Programs

MapReduce is a parallel processing framework that enables developers to write programs to process vast amounts of data. There are two types of key functions in the MapReduce framework:

- map function that separates the data to be processed into independent chunks
- reduce function that performs analysis on that data

The PROC HADOOP MAPREDUCE statement submits a MapReduce program into a Hadoop cluster. For more information, see "MAPREDUCE Statement" on page 1242.

Submitting Pig Language Code

The Apache Pig language is a high-level programming language that creates MapReduce programs that are used with Hadoop.

The PROC HADOOP PIG statement submits Pig language code into a Hadoop cluster. For more information, see "PIG Statement" on page 1246.

Submitting Configuration Properties

Rather than specifying a Hadoop configuration file, you can submit configuration properties with the PROC HADOOP PROPERTIES statement. For more information, see "PROPERTIES Statement" on page 1248.

Examples: HADOOP Procedure

Example 1: Submitting HDFS Commands

Features:

SAS_HADOOP_CONFIG_PATH environment variable
SAS_HADOOP_JAR_PATH environment variable
PROC HADOOP statement
HDFS statement
OPTIONS statement
SET system option

Details

This PROC HADOOP example submits HDFS commands to a Hadoop server. The statements create a directory, delete a directory, and copy a file from HDFS to a local output location.

Program

```
options set=SAS_HADOOP_CONFIG_PATH="\\sashq\root\u\abcdef\cdh45p1";
options set=SAS_HADOOP_JAR_PATH="\\sashq\root\u\abcdef\cdh45";

proc hadoop username='sasabc' password='sasabc' verbose;

   hdfs mkdir='/user/sasabc/new_directory';

   hdfs delete='/user/sasabc/temp2_directory';
```

```
   hdfs copytolocal='/user/sasabc/testdata.txt'
        out='C:\Users\sasabc\Hadoop\testdata.txt' overwrite;
run;
```

Program Description

Define the SAS_HADOOP_CONFIG_PATH environment variable and the SAS_HADOOP_JAR_PATH environment variable. The OPTIONS statements include the SET system option to define the environment variables. The environment variables set the location of the Hadoop cluster configuration files and the Hadoop JAR files so that the required files are available to the SAS session.

```
options set=SAS_HADOOP_CONFIG_PATH="\\sashq\root\u\abcdef\cdh45p1";
options set=SAS_HADOOP_JAR_PATH="\\sashq\root\u\abcdef\cdh45";
```

Execute the PROC HADOOP statement. The PROC HADOOP statement controls access to the Hadoop server by identifying the user ID and password on the Hadoop server. The statement specifies the VERBOSE option, which enables additional messages to be written to the SAS log.

```
proc hadoop username='sasabc' password='sasabc' verbose;
```

Create an HDFS pathname. The first HDFS statement specifies the MKDIR= option to create an HDFS pathname.

```
   hdfs mkdir='/user/sasabc/new_directory';
```

Delete an HDFS file. The second HDFS statement specifies the DELETE= option to delete an HDFS file.

```
   hdfs delete='/user/sasabc/temp2_directory';
```

Copy an HDFS file. The third HDFS statement specifies the COPYTOLOCAL= option to specify the HDFS file to copy, the OUT= option to specify the output location on the local machine, and the OVERWRITE option to specify that if the output location exists, write over it.

```
   hdfs copytolocal='/user/sasabc/testdata.txt'
        out='C:\Users\sasabc\Hadoop\testdata.txt' overwrite;
run;
```

Example 2: Submitting HDFS Commands with Wildcard Characters

Features:

SAS_HADOOP_CONFIG_PATH environment variable
SAS_HADOOP_JAR_PATH environment variable
SAS_HADOOP_RESTFUL environment variable
PROC HADOOP statement
HDFS statement
Wildcard characters

OPTIONS statement
SET system option

Details

This PROC HADOOP example submits HDFS commands to a Hadoop server. The statements display the contents of the specified files, change the permissions for one HDFS file, and list the files in a specified HDFS pathname.

Program

```
options set=SAS_HADOOP_CONFIG_PATH="\\sashq\root\u\abcdef\cdh45p1";
options set=SAS_HADOOP_JAR_PATH="\\sashq\root\u\abcdef\cdh45";
options set=SAS_HADOOP_RESTFUL 1;

proc hadoop username='sasabc' password='sasabc' verbose;

   hdfs cat='/user/sasabc/*';

   hdfs chmod='/user/sasabc/' permission=rwxr-xr-x;

   hdfs ls='/user/sasabc/*';
run;
```

Program Description

Define the SAS_HADOOP_CONFIG_PATH environment variable, the SAS_HADOOP_JAR_PATH environment variable, and the SAS_HADOOP_RESTFUL environment variable. The OPTIONS statements include the SET system option to define the environment variables. The first two environment variables set the location of the Hadoop cluster configuration files and the Hadoop JAR files so that the required files are available to the SAS session. The SAS_HADOOP_RESTFUL environment variable specifies to connect to the Hadoop server by using the WebHDFS REST API.

```
options set=SAS_HADOOP_CONFIG_PATH="\\sashq\root\u\abcdef\cdh45p1";
options set=SAS_HADOOP_JAR_PATH="\\sashq\root\u\abcdef\cdh45";
options set=SAS_HADOOP_RESTFUL 1;
```

Execute the PROC HADOOP statement. The PROC HADOOP statement controls access to the Hadoop server by identifying the user ID and password on the Hadoop server. The statement specifies the VERBOSE option, which enables additional messages to be written to the SAS log.

```
proc hadoop username='sasabc' password='sasabc' verbose;
```

Display the contents of HDFS files. The first HDFS statement specifies the CAT= option to display the contents of HDFS files. The wildcard character * specifies to

match one or more characters. All files that are contained in the directory /user/sasabc/ are displayed in the SAS log.

```
hdfs cat='/user/sasabc/*';
```

Change the file access permissions. The second HDFS statement specifies the CHMOD= option to change the file access permissions for the specified HDFS pathname. The file access permissions provide the owner with Read, Write, and Execute permission, group members with Read and Execute permission, and users with Read and Execute permission.

```
hdfs chmod='/user/sasabc/' permission=rwxr-xr-x;
```

List the files in an HDFS pathname. The third HDFS statement specifies the LS= option to list the files in the specified HDFS pathname to the SAS log. The wildcard character * specifies to match one or more characters. All files that are contained in the directory /user/sasabc/ are displayed in the SAS log. The output for each file consists of its permissions, User ID, User ID group, file size, creation date, creation time, and the filename.

```
   hdfs ls='/user/sasabc/*';
run;
```

Example 3: Submitting a MapReduce Program

Features:

SAS_HADOOP_CONFIG_PATH environment variable

SAS_HADOOP_JAR_PATH environment variable

PROC HADOOP statement

MAPREDUCE statement

FILENAME statement

Details

This PROC HADOOP example submits a MapReduce program to a Hadoop server. This code runs the MapReduce job by using the Java API. To run the job by using the Apache Oozie RESTful API would require additional setup.

The example uses the Hadoop MapReduce application WordCount that reads a text input file, breaks each line into words, counts the words, and then writes the word counts to the output text file.

Program

```
options set=SAS_HADOOP_CONFIG_PATH="pathname";
options set=SAS_HADOOP_JAR_PATH="pathname";
```

```
proc hadoop username='sasabc' password='sasabc' verbose;
   mapreduce input='/user/sasabc/architectdoc.txt'
      output='/user/sasabc/outputtest'
      jar='pathname/WordCount.jar'
      outputkey='org.apache.hadoop.io.Text'
      outputvalue='org.apache.hadoop.io.IntWritable'
      reduce='org.apache.hadoop.examples.WordCount$IntSumReducer'
      combine='org.apache.hadoop.examples.WordCount$IntSumReducer'
      map='org.apache.hadoop.examples.WordCount$TokenizerMapper';
run;
```

Program Description

Define the SAS_HADOOP_CONFIG_PATH environment variable and the SAS_HADOOP_JAR_PATH environment variable. The OPTIONS statements include the SET system option to define the environment variables. The environment variables set the location of the Hadoop cluster configuration files and the Hadoop JAR files so that the required files are available to the SAS session.

```
options set=SAS_HADOOP_CONFIG_PATH="pathname";
options set=SAS_HADOOP_JAR_PATH="pathname";
```

Execute the PROC HADOOP statement. The PROC HADOOP statement controls access to the Hadoop server by identifying the user ID and password on the Hadoop server. The statement specifies the VERBOSE option, which enables additional messages to be written to the SAS log.

```
proc hadoop username='sasabc' password='sasabc' verbose;
```

Submit a MapReduce program. The MAPREDUCE statement includes several options. INPUT= specifies the HDFS pathname and the filename of the input Hadoop file named ArchitectDoc.txt.

```
   mapreduce input='/user/sasabc/architectdoc.txt'
```

Create an HDFS pathname. OUTPUT= creates the HDFS pathname for the program output location named OutputTest.

```
      output='/user/sasabc/outputtest'
```

Specify the JAR file. JAR= specifies the location of the JAR file that contains the MapReduce program named WordCount.jar.

```
      jar='pathname/WordCount.jar'
```

Specify an output key class. OUTPUTKEY= specifies the name of the output key class org.apache.hadoop.io.Text.

```
      outputkey='org.apache.hadoop.io.Text'
```

Specify an output value class. OUTPUTVALUE= specifies the name of the output value class org.apache.hadoop.io.IntWritable.

```
      outputvalue='org.apache.hadoop.io.IntWritable'
```

Specify a reducer class. REDUCE= specifies the name of the reducer class org.apache.hadoop.examples.WordCount$IntSumReducer.

```
        reduce='org.apache.hadoop.examples.WordCount$IntSumReducer'
```

Specify a combiner class. COMBINE= specifies the name of the combiner class org.apache.hadoop.examples.WordCount$IntSumReducer.

```
        combine='org.apache.hadoop.examples.WordCount$IntSumReducer'
```

Specify a map class. MAP= specifies the name of the map class org.apache.hadoop.examples.WordCount$TokenizerMapper.

```
        map='org.apache.hadoop.examples.WordCount$TokenizerMapper';
run;
```

Example 4: Submitting Pig Language Code

Features:

SAS_HADOOP_CONFIG_PATH environment variable

SAS_HADOOP_JAR_PATH environment variable

PROC HADOOP statement

PIG statement

FILENAME statement

Details

This PROC HADOOP example submits Pig language code into a Hadoop cluster. This code runs the Pig job by using the Java API. To run the job by using the Apache Oozie RESTful API would require additional setup.

Here is the Pig language code, which is stored in a text file named sample_pig.txt.

```
A = LOAD '/user/sasabc/class.txt' USING PigStorage(' ')
AS (name,grade,age,height,weight);
B = FOREACH A GENERATE name, grade, some.custom.class.promotionDecision(grade) as promote;
store B into '/user/sasabc/pigout' USING PigStorage(',');
```

The Pig code references a data file named class.txt. The Pig code also calls a user-defined Java function named some.custom.class.promotionDecision() to manipulate the data. The user has created that function and made it available in a JAR file.

Program

```
options set=SAS_HADOOP_CONFIG_PATH="pathname";
options set=SAS_HADOOP_JAR_PATH="pathname";
```

```
filename mycode 'pathname/sample_pig.txt';

proc hadoop username='sasabc' password='sasabc' verbose;

   pig code=mycode registerjar='pathname/gradeAnalysis.jar';
run;
```

Program Description

Define the SAS_HADOOP_CONFIG_PATH environment variable and the SAS_HADOOP_JAR_PATH environment variable. The OPTIONS statements include the SET system option to define the environment variables. The environment variables set the location of the Hadoop cluster configuration files and the Hadoop JAR files so that the required files are available to the SAS session.

```
options set=SAS_HADOOP_CONFIG_PATH="pathname";
options set=SAS_HADOOP_JAR_PATH="pathname";
```

Assign a file reference to the Pig language code. The FILENAME statement assigns the file reference MYCODE to the physical location of the file that contains the Pig language code that is named Sample_Pig.txt, which is shown above.

```
filename mycode 'pathname/sample_pig.txt';
```

Execute the PROC HADOOP statement. The PROC HADOOP statement controls access to the Hadoop server by identifying the user ID and password on the Hadoop server with the USERNAME= and PASSWORD= options. The statement specifies the VERBOSE option, which enables additional messages to be written to the SAS log.

```
proc hadoop username='sasabc' password='sasabc' verbose;
```

Execute the PIG statement. The CODE= option specifies the SAS fileref MYCODE, which is assigned to the physical location of the file that contains the Pig language code. The REGISTERJAR= option specifies the JAR file gradeAnalysis.jar, which the user has created, to provide user-defined functions.

```
   pig code=mycode registerjar='pathname/gradeAnalysis.jar';
run;
```

Example 5: Submitting Configuration Properties

Features: PROC HADOOP statement
PROPERTIES statement
MAPREDUCE statement

Details

This PROC HADOOP example submits a MapReduce program to a Hadoop server. Rather than specifying a Hadoop configuration file in the PROC HADOOP statement, the configuration properties are submitted in the PROPERTIES statement.

Program

```
proc hadoop username='sasabc' password='sasabc' verbose;

   prop 'mapred.job.tracker'='xxx.us.company.com:8021'
      'fs.default.name'='hdfs://xxx.us.company.com:8020';

   mapreduce jar="&mapreducejar."
      input="&inputfile."
      output="&outdatadir."
      deleteresults;
run;
```

Program Description

Execute the PROC HADOOP statement. The PROC HADOOP statement controls access to the Hadoop server by identifying the user ID and password on the Hadoop server. The statement specifies the VERBOSE option, which enables additional messages to be written to the SAS log.

```
proc hadoop username='sasabc' password='sasabc' verbose;
```

Submit configuration properties. The PROPERTIES statement submits properties to specify the name and JobTracker addresses in order to connect to the Hadoop server.

```
   prop 'mapred.job.tracker'='xxx.us.company.com:8021'
      'fs.default.name'='hdfs://xxx.us.company.com:8020';
```

Submit a MapReduce program. The MAPREDUCE statement includes several options.

```
   mapreduce jar="&mapreducejar."
      input="&inputfile."
      output="&outdatadir."
      deleteresults;
run;
```

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HDMD Procedure

Overview: HDMD Procedure

What Does the HDMD Procedure Do?

Use PROC HDMD to generate XML-based metadata that describes the contents of files that are stored in HDFS. This metadata enables SAS/ACCESS Interface to Hadoop, SAS/ACCESS Interface to Spark, and SAS high-performance procedures to

read Hadoop data directly without an intermediate metadata repository such as Hive.

File Readers

You can use PROC HDMD to describe tabular HDFS files for these formats:

- fixed-record length (binary) data
- delimited text
- XML-encoded text

PROC HDMD can also associate a custom MapReduce reader (one that is based in Java) with a file. The custom reader is able to produce delimited text or fixed length binary records that can be described using the PROC HDMD syntax. You can use custom MapReduce readers only with SAS high-performance procedures for Hadoop. SAS/ACCESS Interface to Hadoop does not currently use custom readers.

Concepts: HDMD Procedure

Accessing Data Independently from Hive

When you specify the HDFS_METADIR= connection option, SAS/ACCESS does not connect to Hive. It instead accesses data through HDFS. SAS can create and use XML-based metadata descriptions of HDFS files and tables. You can create XML-based metadata with PROC HDMD. The filetype for an XML-based metadata description that PROC HDMD produces is SASHDMD (for example, product_table.sashdmd). Another name for this metadata is a *SASHDMD descriptor*.

Similar to HiveQL data definition language (DDL), SASHDMD descriptors describe the columns in an HDFS file or table, and it contains the file or table location. If it describes one file, a SASHDMD descriptor contains a complete HDFS file path.

```
/corp/files/product_codes.dat
```

When it describes a table, the SASHDMD descriptor contains an HDFS directory:

```
/corp/tables/purchases/franchise_201
```

Similar to Hive, it is expected that the directory contains identically structured files. These files have identical column layout:

```
/corp/tables/purchases/franchise_201/income_2012-01-02.dat
```

```
/corp/tables/purchases/franchise_201/income_2012-01-03.dat
```

/corp/tables/purchases/franchise_201/income_2012-01-04.dat

In this example, PROC HDMD creates a SASHDMD descriptor for this income table data. The income table has four comma-separated columns, a product code, the quantity purchased, the price, and the total purchase amount including tax.

```
libname hdplib hadoop server=mysrv1
   user=myusr1 pass=mypwd1
   hdfs_metadir="/corp/metadata"
   hdfs_datadir="/corp/tables/purchases/franchise_201";

proc hdmd hdplib.meta_income
   file_format=delimited encoding=utf8 sep=','
   data_file='file01.ebcd'
;

column product_code int;
column quantity_purchased int;
column price real;
column total_purchase_amount real;
run;
```

Working with Hive 3.0

Overview

Apache Hive 3.0 provides better support for transactional data. Changes to improve transaction support for Hive *managed tables* also mean that PROC HDMD users must perform extra steps to create and use metadata descriptions (.HDMD files) for existing Hive tables.

Managed and External Tables

Hive has two types of tables: *managed* and *external*. By default, a table that you create in Hive is always a *managed table*, which means that Hive manages its life cycle. To create an *external table*, you specify the EXTERNAL keyword in the CREATE TABLE query and include the LOCATION.

The difference between the two tables is what Hive deletes when you drop the table.

- *managed:* table metadata from the Hive MetaStore and physical data from the Hadoop file system
- *external:* only table metadata; table data from the Hadoop file system is retained

Managed Tables and Transactional Support

By default in Apache 3.0, all new tables are created with *transactional support*. Apache 3.0 also introduces a new restriction that Hive managed tables must be transactional. However, you can override this by setting the hive.strict.managed.tables Hive property to FALSE.

Therefore, in Apache Hive 3.0, by default a new table is both *managed* and *transactional*.

This example shows how to create the CLASS managed, transactional table.

```
0: jdbc:hive2:> create table class (name varchar(8), sex varchar(1),
   age double, weight double);
INFO  : OK
No rows affected (0.045 seconds)
0: jdbc:hive2:> describe formatted class;
INFO  : OK
```

```
+----------------------+----------------------------------------------------+--------------------+
|       col_name       |                     data_type                      |       comment      |
+----------------------+----------------------------------------------------+--------------------+
| # col_name           | data_type                                          |                    |
| name                 | varchar(8)                                         |                    |
| sex                  | varchar(1)                                         |                    |
| age                  | double                                             |                    |
| height               | double                                             |                    |
| weight               | double                                             |                    |
|                      | NULL                                               | NULL               |
| # Detailed Table     |                                                    |                    |
| # Information        | NULL                                               | NULL               |
| Database:            | default                                            | NULL               |
| OwnerType:           | USER                                               | NULL               |
| Owner:               | hadoop                                             | NULL               |
| CreateTime:          | Fri Sep 28 09:30:10 EDT 2018                       | NULL               |
| LastAccessTime:      | UNKNOWN                                            | NULL               |
| Retention:           | 0                                                  | NULL               |
| Location:            | hdfs://server16.corp.com:8020/warehouse            |                    |
|                      |    /tablespace/managed/hive/class                  | NULL               |
| Table Type:          | MANAGED_TABLE                                      | NULL               |
| Table Parameters:    | NULL                                               | NULL               |
|                      | SAS OS Name                                        | Linux              |
|                      | SAS Version                                        | 9.04.01M6D09272018 |
|                      | bucketing_version                                  | 2                  |
|                      | numFiles                                           | 1                  |
|                      | numRows                                            | 0                  |
|                      | rawDataSize                                        | 0                  |
|                      | totalSize                                          | 496                |
|                      | transactional                                      | true               |
|                      | transactional_properties                           | insert_only        |
|                      | transient_lastDdlTime                              | 1538141416         |
|                      | NULL                                               | NULL               |
| # Storage            |                                                    |                    |
| # Information        | NULL                                               | NULL               |
| SerDe Library:       | org.apache.hadoop.hive.serde2.lazy.LazySimpleSerDe | NULL               |
| InputFormat:         | org.apache.hadoop.mapred.TextInputFormat           | NULL               |
| OutputFormat:        | org.apache.hadoop.hive.ql.io.HiveIgnoreKeyTextOutputFormat | NULL               |
| Compressed:          | No                                                 | NULL               |
| Num Buckets:         | -1                                                 | NULL               |
| Bucket Columns:      | []                                                 | NULL               |
| Sort Columns:        | []                                                 | NULL               |
| Storage Desc Params: | NULL                                               | NULL               |
|                      | field.delim                                        | \u0001             |
|                      | line.delim                                         | \n                 |
|                      | serialization.format                               | \u0001             |
+----------------------+----------------------------------------------------+--------------------+
40 rows selected (0.163 seconds)
```

Transactional, Managed, and PROC HDMD

When a text file is created with transactional support, the on-disk structure of the file is different from a non-transactional table. When PROC HDMD creates metadata about a Hive transactional table, it stores metadata in the .HDMD file such that the table cannot be directly read by downstream operations. For example, attempting to run PROC PRINT using an HDMD table reference to a transactional table fails and generates this error message:

```
ERROR:  Cannot read the HDMD-defined data file NLSCARS in CUSTOM
        format.  The table is managed by Hive and is either a Hive
        transactional table or represented in a "non-native" HDMD format.
```

To resolve this issue, you must create the table as *non-transactional*. Because of the restriction that managed tables must be *transactional*, the table must also be created as *external*.

Here is an example using the Beeline client. Note that DESCRIBE FORMATTED does not show transactional in the table parameters.

```
0: jdbc:hive2:> create external table class
   (name varchar(8), sex varchar(1), age double, weight double)
      location '/tmp' tblproperties ("transactional"="false");
INFO  : OK
No rows affected (0.267 seconds)
0: jdbc:hive2://server18.corp.com:2181,srv> describe formatted class;
INFO  : OK
```

```
+---------------------+-------------------------------------------------------------+-------------------+
|      col_name       |                          data_type                          |      comment      |
+---------------------+-------------------------------------------------------------+-------------------+
| # col_name          | data_type                                                   |                   |
| name                | varchar(8)                                                  |                   |
| sex                 | varchar(1)                                                  |                   |
| age                 | double                                                      |                   |
| weight              | double                                                      |                   |
|                     | NULL                                                        | NULL              |
| # Detailed Table    |                                                             |                   |
| # Information       | NULL                                                        | NULL              |
| Database:           | default                                                     | NULL              |
| OwnerType:          | USER                                                        | NULL              |
| Owner:              | hadoop                                                      | NULL              |
| CreateTime:         | Tue Oct 02 13:10:11 EDT 2018                                | NULL              |
| LastAccessTime:     | UNKNOWN                                                     | NULL              |
| Retention:          | 0                                                           | NULL              |
| Location:           | hdfs://server16.corp.com:8020/tmp                           | NULL              |
| Table Type:         | EXTERNAL_TABLE                                              | NULL              |
| Table Parameters:   | NULL                                                        | NULL              |
|                     | EXTERNAL                                                    | TRUE              |
|                     | bucketing_version                                           | 2                 |
|                     | numFiles                                                    | 0                 |
|                     | totalSize                                                   | 0                 |
|                     | transient_lastDdlTime                                       | 1538500211        |
|                     | NULL                                                        | NULL              |
| # Storage           |                                                             |                   |
| # Information       | NULL                                                        | NULL              |
| SerDe Library:      | org.apache.hadoop.hive.serde2.lazy.LazySimpleSerDe          | NULL              |
| InputFormat:        | org.apache.hadoop.mapred.TextInputFormat                    | NULL              |
| OutputFormat:       | org.apache.hadoop.hive.ql.io.HiveIgnoreKeyTextOutputFormat  | NULL              |
| Compressed:         | No                                                          | NULL              |
| Num Buckets:        | -1                                                          | NULL              |
| Bucket Columns:     | []                                                          | NULL              |
| Sort Columns:       | []                                                          | NULL              |
| Storage Desc Params:| NULL                                                        | NULL              |
|                     | serialization.format                                        | 1                 |
+---------------------+-------------------------------------------------------------+-------------------+
32 rows selected (0.055 seconds)
```

Creating External, Non-Transactional Tables with SAS

To use PROC HDMD to describe a Hive source table, you must create the table as both managed and non-transactional. You can create it readily with PROC SQL using explicit SQL.

Here is an example that uses a LIBNAME statement.

```
options sastrace=',,,d' sastraceloc=saslog nostsuffix
   sql_ip_trace=(note,source) msglevel=i;
options set=SAS_HADOOP_JAR_PATH=
   "/u/corpadmin/viya/hadoopjars/hdp30/prod";
options set=SAS_HADOOP_CONFIG_PATH=
   "/u/corpadmin/viya/hadoopcfg/hdp30d1/test";
options set=SAS_HADOOP_JAR_PATH=
   "\\newwinsrc\u\corpadmin\viya\hadoopjars\hdp30\prod";
options set=SAS_HADOOP_CONFIG_PATH=
   "\\newwinsrc\u\corpadmin\viya\hadoopcfg\hdp30d1\test";

libname x hadoop user=abc pwd=abc;
libname nohive hadoop hdfs_tempdir='/tmp/'
   hdfs_datadir='/tmp' hdfs_metadir='/tmp' server=server18;

proc delete data=x.class;run;

proc sql;
connect using x;
execute (create external table if not exists default.class
   (name varchar(8), sex varchar(1), age double, weight double)
      location '/tmp/class' tblproperties ("transactional"="false")
   ) by x;
quit;

proc delete data=nohive.classhdmd;run;
proc hdmd from=x.class nohive.classhdmd;run;
proc print data=nohive.classhdmd;run;
```

Summary

When you know how to use PROC HDMD to create a metadata description of a Hive table, you can use PROC PRINT and other SAS tools to reference the table. The example shows how to specify the EXTERNAL and LOCATION keywords along with the table properties set to FALSE to create the source Hive table.

Syntax: HDMD Procedure

Restriction: This procedure is not supported on the CAS server.

Requirements: To be able to work with Hive 3.0 data, you must first set external table properties. For details, see "Working with Hive 3.0" on page 1261.

At least one COLUMN statement is required in a PROC HDMD procedure step.

Supports: Hadoop, Spark

See: "LIBNAME Statement for the Hadoop Engine" in *SAS/ACCESS for Relational Databases: Reference*

PROC HDMD <*hadoop-metadata-options*;>

COLUMN <*column-specifications*>;

Statement	Task	Example
PROC HDMD	Generate and use metadata descriptions of HDFS files and tables.	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 8, Ex. 9
COLUMN	Specifies the columns of HDFS files and tables with which to work.	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 8, Ex. 9

PROC HDMD Statement

Generates the XML metadata for tables or files that are not registered in Hive.

Syntax

PROC HDMD
<BYTE_ORDER=LITTLEENDIAN | BIGENDIAN>
<DATA_FILE='*input-filename*'>
<ENCODING=*encoding*>
<FILE_FORMAT=*file-format*>
<FILE_TYPE='*custom-input-file-type*'>
<FROM=*Hive-table*>

<HEADER_LINES=*n*>
<INPUT_CLASS='*java.class*'>
<MANAGED>
<NAME=*libref.filename* <hadoop | spark>>
<RECORD_LENGTH=*record-length*>
<ROW_TAG='*row-tag*'>
<SEP='*character-separator*'>
<TEXT_QUALIFIER='*character-qualifier*'>;

COLUMN *column-specifications*;

run;

Optional Hadoop Metadata Options

These options control how metadata is generated.

BYTE_ORDER=< LITTLEENDIAN | BIGENDIAN >
specifies how numeric data is stored. If LITTLEENDIAN, it is stored with the least significant byte first, such as a PC. If BIGENDIAN,, it is stored with the most significant byte first.

Type optional

Default client

Applies to BINARY

DATA_FILE='*input-filename*'
specifies the path to the input data file relative to the HDFS_DATADIR= option in the Hadoop engine LIB statement.

Type required

Default none

Applies to BINARY, DELIMITED, XML

ENCODING=*encoding*
specifies the encoding for text for the input data file or folder.

Type optional

Default UTF8 (if you do not specify a value)

Applies to BINARY

FILE_FORMAT=*file-format*
specifies the format of the input data that is passed to the SAS Embedded Process for Hadoop.

file-format can be one of the following values:

BINARY
specifies a file with fixed length records where numeric data is stored in machine-specific binary form.

DELIMITED
specifies a file that contains only text-based data where fields are separated by a specific delimiter. Delimited records can vary in length.

See "SEP='*character-separator*'" on page 1270

XML
specifies a text-based data file in XML format.

Type required

Alias FILE_FMT=

Default none

Applies to BINARY, DELIMITED, XML

FILE_TYPE='*custom-input-file-type*'
specifies the file type that is used in the MapReduce framework to load the data into the SAS Embedded Process. The file type maps to a SAS provided MapReduce input format classes name. The input format classes that is provided by SAS for a particular file type creates specific input readers. For example, the DELIMITED file type is mapped to the MapReduce input format class, com.sas.access.hadoop.ep.delimited.DelimitedInputFormat.

Type optional

Default none

Applies to BINARY, DELIMITED, XML

Requirement To use a custom-sequence file type, you must specify INPUT_CLASS= and also FILE_TYPE=CUSTOM_SEQUENCE.

Interaction If you specify an input class, FILE_TYPE= defaults to CUSTOM.

FROM=*Hive-table*
specifies the name of a Hive table that you want to use for in-database scoring. SAS creates the metadata file *Hive-table*.sashdmd in the target's metadata directory.

Example
```
proc hdmd hdfs.&modelnm. from=hive.&modelnm.; run;
```

HEADER_LINES=*n*
specifies the number of lines that are skipped when parsing delimited files.

Type optional

Default none

Applies to DELIMITED

INPUT_CLASS='*java.class*'
specifies the fully qualified class name that implements the Java custom MapReduce reader to use.

Type optional

Default none

Applies to BINARY, DELIMITED, XML

Requirement The class must be in the class path of the Hadoop server.

Interaction The DBCREATE_EXTERNAL_TABLE= LIBNAME option ignores this option.

MANAGED
specifies that the file is deleted when its metadata is deleted (for example, by using PROC DELETE).

Type optional

Default By default, data files are not managed—namely, they are not deleted when the metadata is deleted..

Applies to BINARY, DELIMITED, XML

Interaction The DBCREATE_EXTERNAL_TABLE= LIBNAME option ignores this option.

NAME=*libref.filename* <hadoop | spark>
specifies the name of the metadata file to create. The HDFS_METADIR= connection option specifies where metadata is located.

Type required

Default none

Applies to BINARY, DELIMITED, XML

Requirement The *libref* must be a valid Hadoop or Spark engine libref for which HDFS_METADIR= and HDFS_DATADIR= options have been specified.

Data source Hadoop, Spark

RECORD_LENGTH=*record-length*
specifies the record length of the BINARY file.

Type required

Default none

Applies to BINARY

ROW_TAG='*row-tag*'
specifies the XML tag that identifies records in the input XML.

Type required

Default none

Applies to XML

Restriction This option is case sensitive.

SEP='*character-separator*'
specifies the character to separate the columns for the records in the delimited input file. Here is how you can specify values.

- SEP=^A
- SEP=','
- SEP=TAB
- SEP=^Z
- SEP='09'x
- SEP=32

Type required

Default ^A (if you do not specify a value)

Range You can specify only a single character between the Unicode range of U+0001 to U+007F.

Applies to DELIMITED

Restriction The value of this option cannot be the same character as for TEXT_QUALIFIER= and cannot be a newline ('0a'x).

TEXT_QUALIFIER='*character-qualifier*'
specifies the text qualifier for the input data file or folder. Here is how you can specify values.

Type optional

Default none

Range You can specify only a single character between the Unicode range of U+0001 to U+007F.

Applies to DELIMITED

Restriction The value of this option cannot be the same character as for SEP= and cannot be a newline ('0a'x).

Requirement You must specify either a double quotation mark enclosed in single quotation marks(' " ') or a single quotation mark enclosed in double quotation marks (" ' ").

COLUMN Statement

Provides specifications for one or more columns.

Requirement: One or more of these statements is required.

Syntax

COLUMN <*column-options*> <*data-type*> <*name*>;

Column Specifications

column-options
specifies one or more column options.

BYTES=*byte-length*
for BINARY files, specifies the number of bytes that the data occupies in the record.

Type required

Default none

Applies to BINARY

CTYPE=*ctype*
for BINARY files, specifies the actual binary type of data that to be stored in the record. Here are the valid binary data types:

- CHAR
- DOUBLE
- FLOAT
- INT8
- INT16
- INT32
- INT64
- UINT8
- UINT16
- UINT32
- UINT64

Type optional

Default none

Applies to BINARY

ENCODING=*encoding*
for BINARY files, specifies the encoding for the character data if it differs from the overall file encoding.

Type optional

Default none

Applies to BINARY

FORMAT=*format-specification*
specifies the format that is associated with the column.

Type optional

Default none

Applies to BINARY, DELIMITED, XML

See *SAS Formats and Informats: Reference*

INFORMAT=*informat-specification*
specifies the informat to use to read the input data.

Type optional

Default none

Applies to BINARY, DELIMITED, XML

See *SAS Formats and Informats: Reference*

OFFSET=*bytes*
specifies the offset of the column data in the record.

Type required

Default none

Applies to BINARY

TAG='*tag*'
specifies the XML element that encloses the column data.

Type required

Default none

Applies to XML

data-type
specifies a valid data type:

- BIGINT

- CHAR(*n*)
- DATE
- DOUBLE
- INT
- REAL
- SMALLINT
- TIME[(prec)]
- TIMESTAMP[(prec)]
- TINYINT
- VARCHAR(*n*)

Type required

Default none

Applies to BINARY, DELIMITED, XML

Interaction The Hadoop engine converts all numeric types to DOUBLE.

name
specifies a name for the column.

Type required (when specified)

Default none

Applies to BINARY, DELIMITED

Examples: HDMD Procedure

Example 1: Create Hadoop Metadata from a Delimited File

You can use the HDMD procedure to create metadata in a Hadoop file or directory of files. This example starts with a comma-delimited file with three columns.

```
Name,Age,Weight
```

```
John,32,180
Jane,27,112
Tim,54,210
```

By assigning a data type for each column that is retrieved, here is how you can create the metadata.

```
libname hdplib hadoop server=mysrv1_cluster1
user=myusr1 pass=mypwd1
/* connection options */
config='/user/configs/hadoop_cluster1.xml'
hdfs_tempdir='/corp/tempdir'
hdfs_metadir='/corp/metadata'
hdfs_datadir='/corp/tables/purchases';

proc hdmd hdplib.people
   file_format=delimited sep=',' encoding=utf8
   data_file='people.csv' header_lines=1;
column name char(8);
column age int;
column weight int;
run;
```

Example 2: Define Metadata for a Delimited File

This example uses the Hadoop LIBNAME statement to define metadata for a delimited file. The file contains this data:

```
12.34 23f45 "This shows quotes" 4.5 2013-05-05
unquoted 11:12:13 09:05:12.2345 "2013-03-04
12:13:12.12345678" 3 10240 1298378438743
```

A blank character and a double quotation mark are used to parse the file.

```
libname hdplib hadoop server=mysrv1_cluster1
user=myusr1 pass=mypwd1
/* connection options */
config='/user/configs/hadoop_cluster1.xml'
hdfs_tempdir='/corp/tempdir'
hdfs_metadir='/corp/metadata'
hdfs_datadir='/corp/tables/purchases';

proc hdmd hdp.foo file_format=delimited
encoding=utf8 sep='20'x text_qualifier='"'
data_dir='franchise_201';
column col1 double file_format=dollar6.2;
column col2 int informat=hex5.;
column 'col3 has a blank'n char(20) file_format=$revers20.;
column col4 real;
column col5 date;
column col5 varchar(42);
column col6 time;
```

```
column col7 time(4);
column col8 timestamp(8);
column col9 tinyint;
column col10 smallint;
column col11 bigint;
run;
```

Example 3: Define Metadata for a Delimited File with Column Headings

This example starts with a comma-delimited file with two columns.

```
ID,Full Name
1,"Doe, John"
2,"Smith, Sally"
```

Here is the syntax for the HDMD procedure.

```
proc hdmd hdplib.text_qualifer_example
   file_format=delimited sep=',' text_qualifier='"'
   header_lines=1 input_dir="text_qualifier.csv";

column id double;
column fullname char(32);
run;
```

Here is the resulting PROC PRINT output.

```
proc print data=hdplib.text_qualifer_example;run;
```

```
The SAS System

Obs    id    fullname
1      1     Doe, John
2      2     Smith, Sally
```

Example 4: Extract Columns from Binary Data

In this example, two columns are extracted from a binary file.

```
proc hdmd hdp.foo file_format=binary
record_length=80
data_file='foo.bin';
column size double ctype=double bytes=8;
column id bigint ctype=int64 offset=8;
column name char(42) ctype=char offset=16 bytes=42;
run;
```

Example 5: Extract Columns from MVS Binary Data

This example is similar to the previous one. However, because the data was extracted from MVS, it contains DOUBLE data types and EBCDIC characters.

```
proc hdmd hdp.foo file_format=binary
record_length=80 encoding=ebcdic037
data_file='foo.bin';
column size double ctype=double bytes=8 informat=s370frb8.;
column name char(42) ctype=char offset=8 bytes=42 encoding=ebcdic037;
run;
```

Example 6: Extract Columns from a Binary File with Chinese Encoding

In this example, two columns are extracted from the beginning of a binary 80 ASCII file. The character column is encoded in Chinese.

```
proc hdmd hdp.foo file_format=binary
record_length=80 encoding=utf8
data_file='foo.bin';
column size double ctype=double bytes=8;
column name char(42) ctype=char offset=8 bytes=42 encoding='euc-cn';
run;
```

Example 7: Extract Columns from XML Data

In this example, two columns are extracted from an XML file that contains these XML tags:

```
<row><Size>42.5</Size><Name>Julius Caesar</Name></row>
```

Here is the syntax for the HDMD procedure.

```
proc hdmd hdp.foo file_format=xml
row_tag='row'data_file='foo.xml';
column size double tag='Size';
column name char(42) tag='Name';
run;
```

Example 8: Use the DESCRIBE Option

This example uses the HDMD procedure to describe the syntax and output.

```
proc hdmd libname.data
   file_format=delimited sep=','
   input_dir="mydata.csv"
;

column I   double;
column J   double;
column W   double;
run;

proc hdmd libname.data describe;
run;
```

Here is the resulting log file.

```
1103  proc hdmd libname.data
1104  describe;
1105  run;
```

Here is the resulting output.

```
PROC HDMD HDPLIB.REAL2
    FILE_FORMAT=DELIMITED ENCODING=UTF8 SEP=',' BYTE_ORDER=LITTLEENDIAN
    FILE_TYPE=DELIMITED
    DATA_DIR='/user/data/csv/data/mydasta.csv'
    META_DIR='/user/data/csv/meta';
COLUMN /* 1 */ I DOUBLE OFFSET=0 BYTES=8 CTYPE=DOUBLE;
COLUMN /* 2 */ J DOUBLE OFFSET=0 BYTES=8 CTYPE=DOUBLE;
COLUMN /* 3 */ W DOUBLE OFFSET=0 BYTES=8 CTYPE=DOUBLE;
```

Example 9: Define a Custom Reader and Use a Data File

Before PROC HDMD runs, this example starts by defining the SAS_HADOOP_JAR_PATH environment variable within SAS by entering this OPTION SET statement. The variable points to folders with all Hadoop JAR files.

```
option set=SAS_HADOOP_JAR_PATH="/users/SAS/JARS:/users/SAS/JARS/
cdh420";
```

It then defines a LIBNAME statement to point to Hadoop.

```
libname hdplib hadoop
   user=myusr1 pw=mypwd1 server="mysrv1"
   HDFS_TEMPDIR="/user/hdmddemo/temp"
   HDFS_DATADIR="/user/hdmddemo/data"
   HDFS_METADIR="/user/hdmddemo/meta"
   DBCREATE_TABLE_EXTERNAL=NO
   CONFIG="/user/mycfg1.xml";
```

Last, it creates the HDMD file.

```
proc hdmd hdplib.peopleseq
   file_format=delimited sep=tab
   file_type=custom_sequence
   input_class=

'com.abc.hadoop.ep.inputformat.sequence.PeopleCustomSequenceInputFormat
'
   data_file='people.seq';

column name varchar(20);
column sex varchar(1);
column age int;
column height double;
column weight double;
run;
```

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HTTP Procedure

Overview: HTTP Procedure

What Does the HTTP Procedure Do?

The HTTP procedure issues Hypertext Transfer Protocol (HTTP) requests. The procedure is supported in both SAS 9.4 and SAS Viya.

PROC HTTP allows an open-ended set of methods. In addition to standard HTTP methods, PROC HTTP accepts any method that conforms to the HTTP/1.1 standard and that is recognized by the target web server. PROC HTTP also implements HTTP/1.1 features such as persistent connections, cookie caching, EXPECT_100_CONTINUE support, and it provides authentication type specification.

For web servers that support it, PROC HTTP uses connection caching and cookie caching by default. You can toggle the behavior of both types of caching and clear the caches within the procedure by specifying procedure arguments. Or you can turn cookie caching off by using a macro variable.

The authentication specification feature enables you to specify one or multiple authentication types for a request.

Beginning with the November 2019 release of SAS 9.4M6 and SAS Viya 3.5, you can easily post form data as well as perform HTTP multipart requests. A new QUERY= procedure option simplifies the process of submitting query parameters for the URL= argument. For more information, see "Using the FORM and QUERY Options with PROC HTTP" on page 1298 and "Using the MULTI Option" on page 1299.

The procedure includes a DEBUG statement, response status macro variables, and the ability to specify a time-out period for requests. Beginning with SAS 9.4M6 and SAS Viya 3.5, a new statement, SSLPARMS, enables you to override global SAS system options for encryption with local options for a specific PROC HTTP request.

Syntax: HTTP Procedure

Restrictions: This procedure is not supported on the CAS server.

When SAS is in a locked-down state, the HTTP procedure is not available. Your server administrator can re-enable this procedure so that it is accessible in the lockdown state. When the FILENAME, URL access method is re-enabled by using the LOCKDOWN ENABLE_AMS= statement, the HTTP procedure is automatically

re-enabled. For more information, see "SAS Processing Restrictions for Servers in a Locked-Down State" in *SAS Programmer's Guide: Essentials*

Tip: PROC HTTP sets up macro variables with certain values after it executes each statement. These macro variables can be used inside a macro to test for HTTP errors. For more information, see "PROC HTTP Response Status Macro Variables" on page 1301.

PROC HTTP URL="*URL-to-target*" <*options*>;

DEBUG *options*;

HEADERS "*HeaderName*"="*HeaderValue*"
<"*HeaderName-n*"="*HeaderValue-n*">;

SSLPARMS *encryption-options*;

Statement	Task	Example
PROC HTTP	Issue HTTP requests	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 9, Ex. 10, Ex. 11, Ex. 12
DEBUG	Display debugging messages	Ex. 13
HEADERS	Specify request headers for the HTTP request	Ex. 8
SSLPARMS	Set encryption options for the PROC HTTP request	Ex. 14

PROC HTTP Statement

Invokes a web service that issues requests.

Examples:

"Example 13: Use the DEBUG Statement with the LEVEL= Option" on page 1316
"Example 14: Specify Local Options for Two-Way Encryption in Windows" on page 1319

Syntax

PROC HTTP URL="*URL-to-target*</redirect/*n*>"
<METHOD=<">*http-method*<">>
<*authentication-type-options*>
<*caching-options*>
<*header-options*>
<*proxy-server-connection-options*>
<*web-server-authentication-options*>
<EXPECT_100_CONTINUE>
<FOLLOWLOC | NOFOLLOWLOC>
<HTTP_TOKENAUTH>
<IN=<*fileref* | FORM (*arguments*) | MULTI <options> (*parts*) | "*string*">>
<MAXREDIRECTS=*n*>
<OUT=*fileref*>
<QUERY=("*parm1*"="*value1*" "*parm2*="*value2*" ...)>
;

Summary of Optional Arguments

EXPECT_100_CONTINUE
: enables a client to determine whether the target server is willing to accept the request.

FOLLOWLOC
: enables write methods to automatically follow URL redirections.

HTTP_TOKENAUTH
: generates a one-time password from the metadata server that can be used to access the SAS Content Server.

IN=*fileref* | FORM (*arguments*) | MULTI <*options* > | "*string*"
: specifies the input data.

MAXREDIRECTS=*n*
: specifies the maximum number of redirects that are allowed.

METHOD=<">*http-method*<">
: specifies an HTTP method.

NOFOLLOWLOC
: prevents the GET method from following URL redirections.

OUT=*fileref-to-response-data*
: specifies a fileref where output is written.

QUERY=(<NOENCODE>*"parm1"="value1" "parm2"="value2"*)
: provides an alternate method for submitting query parameters for the URL= argument.

TIMEOUT=*integer*
: specifies the number of seconds of inactivity to wait before canceling an HTTP request.

Authenticate to Web Server

WEBAUTHDOMAIN="*web-credentials-from-metadata*"
: specifies the web authentication domain.

WEBPASSWORD="*basic-authentication-password*"
: specifies a password for basic authentication.

WEBUSERNAME="*basic-authentication-name*"
: specifies a user name for basic authentication.

Connect to Proxy Server

PROXYHOST="*proxy-host-name*"
: specifies the Internet host name of an HTTP proxy server.

PROXYPASSWORD="*proxy-passwd*"
: specifies an HTTP proxy server password.

PROXYPORT=*proxy-port-number*
: specifies an HTTP proxy server port.

PROXYUSERNAME="*proxy-user-name*"

Disable Shared Connection and Cookie Caching

CLEAR_CACHE
: specifies to clear both the shared connection and cookie caches before the HTTP request is executed.

CLEAR_CONN_CACHE
: specifies to clear the shared connection cache before the HTTP request is executed.

CLEAR_COOKIES
: specifies to clear the shared cookie cache before the HTTP request is executed.

NO_CONN_CACHE
: disables connection caching for this procedure execution.

NO_COOKIES
: specifies cached cookies will not be used for this procedure execution.

Specify Authentication Type

AUTH_ANY
: specifies that any type of authentication can be used to authenticate to the connected server.

AUTH_BASIC
: specifies to use user identity authentication to authenticate to the connected server.

AUTH_NEGOTIATE
: specifies to use NTLM, Kerberos. or some other type of HTTP authentication to authenticate to the connected server.

AUTH_NONE
: specifies not to use basic authentication, NTLM authentication, or to negotiate authentication, even when authentication with one of these methods is possible.

AUTH_NTLM
: specifies to use NTLM authentication to authenticate to the connected server.

OAUTH_BEARER=*token*
: sends an OAuth access token along with the HTTP call.

PROXY_AUTH_BASIC
: specifies to perform user identity authentication through a proxy server.

PROXY_AUTH_NEGOTIATE
: specifies to perform NTLM, Kerberos, or some other type of HTTP authentication through a proxy server.

PROXY_AUTH_NTLM
: specifies to perform NTLM authentication through a proxy server.

Specify HTTP Headers

CT="*content-type*"
: specifies the HTTP content-type to be set in the request headers.

HEADERIN=*fileref-to-request-header-file*
: specifies a fileref to a text file that contains one line per request header in the format *key:value*.

HEADEROUT_OVERWRITE
: causes the response header to record only the last header block sent by the web server when a redirect occurs.

HEADEROUT=*fileref-to-response-header-file*
: specifies a fileref to a text file to which the response headers are written in the format *key:value*.

Required Argument

URL="*URL-to-target*"
specifies a fully qualified URL path that identifies the endpoint for the HTTP request.

Note The URL that is passed to PROC HTTP is assumed to be URL encoded. To ensure correct encoding, use an appropriate connection class for the target web server. For example, use the AWSV4Signer class for Amazon Web Services. Or, encode reserved characters as described in RFC3986.

Tip Beginning with SAS 9.4M3, you do not have to specify the protocol. If you set just the path (for example, `"httpbin.org"`), the actual URL used is `http://httpbin.org`.

Optional Arguments

AUTH_ANY
When a user name and password are supplied, they are used to authenticate the connected server. Otherwise, any other form of authentication that is available

is used. Specifying AUTH_ANY is equivalent to specifying AUTH_NEGOTIATE, AUTH_NTLM, and AUTH_BASIC on the procedure statement.

Default This is the default authentication type if an authentication type is not specified.

Note This option is supported beginning with SAS 9.4M3.

Tip Since there is a chance of more than one trip to the HTTP server, specify EXPECT_100_CONTINUE to prevent data from being uploaded multiple times.

AUTH_BASIC
specifies to use user identity authentication to authenticate the connected server. The user name and password are supplied with the WEBUSERNAME and WEBPASSWORD arguments.

Note This option is supported beginning with SAS 9.4M3.

AUTH_NTLM
specifies to use NTLM authentication to authenticate to the connected server. As long as your current user identity has permissions, authentication is established.

Restriction NTLM is currently available only on Windows clients.

Note This option is supported beginning with SAS 9.4M3.

Example “Example 10: A Request That Specifies an Authentication Type” on page 1310

AUTH_NEGOTIATE
specifies to use NTLM, Kerberos. or some other type of HTTP authentication to authenticate to the connected server. As long as your current user identity has permissions, authentication is established.

Note This option is supported beginning with SAS 9.4M3.

Example “Example 10: A Request That Specifies an Authentication Type” on page 1310

AUTH_NONE
specifies not to use basic authentication, NTLM authentication, or to negotiate authentication, even when authentication with one of these methods is possible. The OAUTH_BEARER= procedure option can be used with NO_AUTH.

Note This option is supported beginning with SAS 9.4M3.

CLEAR_CACHE
specifies to clear both the shared connection and cookie caches before the HTTP request is executed.

Note This option is supported beginning with SAS 9.4M3.

CLEAR_CONN_CACHE
specifies to clear the shared connection cache before the HTTP request is executed.

Note This option is supported beginning with SAS 9.4M3.

CLEAR_COOKIES
specifies to clear the shared cookie cache before the HTTP request is executed.

Note This option is supported beginning with SAS 9.4M3.

CT="*content-type*"
used in conjunction with the HEADERIN= argument, specifies the HTTP content-type to be set in the request headers. The content-type describes the data contained in the body fully enough that the receiving user agent can present the data to the user.

Examples of content-type specifications are:

```
CT="Text/HTML; charset=ISO-8859-4"

CT="Text/plain; charset=us-ascii"

CT="Application/x-www-form-urlencoded"
```

Note Beginning with SAS 9.4M3, this option is supported for compatibility with previous versions of SAS software. Use the "HEADERS Statement" on page 1294 instead of CT= .

EXPECT_100_CONTINUE
enables a client that is sending a request message with a request body to determine whether the target server is willing to accept the request, based on the request headers. Use EXPECT_100_CONTINUE when you are sending large amounts of data and want to make sure that no unnecessary transfers of the data occur. For more information, see http://www.w3.org/Protocols/rfc2616/rfc2616-sec8.html#sec8.2.3.

Valid in HTTP requests that specify the IN= argument, most commonly with PUT.

Interaction This option is used in conjunction with the HEADEROUT= argument.

Note This option is supported beginning with SAS 9.4M3.

Example "Example 11: A PUT That Specifies EXPECT_100_CONTINUE" on page 1311

FOLLOWLOC
enables write methods to automatically follow URL redirections. By default, PROC HTTP methods that write data, like POST and PUT, terminate processing when they are redirected to an alternate location. When FOLLOWLOC is specified, PROC HTTP initially returns a 300-level response, then submits the POST or PUT again to the redirected location.

FOLLOWLOC is the default behavior for the GET method.

Note This option is supported beginning with SAS 9.4M5.

See "NOFOLLOWLOC" on page 1289

HEADERIN=*fileref-to-request-header-file*
specifies a fileref to a text file that contains one line per request header in the format *key:value*.

z/OS Specifics: In the z/OS operating environment, HEADERIN= files must be created with a variable record length.

Note Beginning with SAS 9.4M3, this option is supported for compatibility with previous versions of SAS software. Use the "HEADERS Statement" on page 1294 instead of HEADERIN=

CAUTION **Do not specify both the HEADERS statement and the HEADERIN= argument.** The behavior that results from specifying both options together is not defined.

HEADEROUT=*fileref-to-response-header-file*
specifies a fileref to a text file to which the response headers are written in the format *key:value*.

Examples "Example 6: A POST That Captures the Response Headers" on page 1306

"Example 11: A PUT That Specifies EXPECT_100_CONTINUE" on page 1311

HEADEROUT_OVERWRITE
used in conjunction with the HEADEROUT= argument, causes the response header to record only the last header block sent by the web server when a redirect occurs.

Example "Example 7: A GET That Specifies HEADEROUT_OVERWRITE" on page 1307

HTTP_TOKENAUTH
generates a one-time password from the metadata server that can be used to access the SAS Content Server.

IN=*fileref* | FORM (*arguments*) | MULTI <*options* > | *"string"*
specifies the input data. There are multiple ways to submit input data:

fileref
specifies a fileref. The fileref is a pointer to data that exists in another location. A fileref is assigned with the FILENAME statement.

Example "Example 2: A Simple POST Request" on page 1303

FORM (*"name1"="value1" "name2"="value2" ...*)
sends input data as a standard HTML form.

The data is input as name=value pairs. The FORM option URL-encodes and delimits the pairs with an & (ampersand) as is standard for form submissions. If a name=value pair should not be URL-encoded, you can specify a NOENCODE flag before the name=value pair.

Note The FORM option is available beginning with the November 2019 release of SAS 9.4M6 and SAS Viya 3.5.

See "Using the FORM and QUERY Options with PROC HTTP" on page 1298

MULTI <FORM | "*type*" > (*parts*)
specifies the upload is performed as a multipart request.

You can specify form data or generic data as input. These options do not include support for nested multipart uploads. See https://www.w3.org/Protocols/rfc1341/7_2_Multipart.html for more information about the multipart content-type.

When the FORM option is used, the upload is performed using the specialized multipart type known as multipart/form-data. More information can be found at https://tools.ietf.org/html/rfc7578#section-4.

Note The MULTI option is available beginning with the November 2019 release of SAS 9.4M6 and SAS Viya 3.5.

See "Using the MULTI Option" on page 1299

"*string*"
specifies input data in a quoted string.

Note This method of submission is available beginning with SAS 9.4M3.

Example "Example 4: Specifying Input Data as a String" on page 1304

Requirement The IN= option is required when the POST and PUT methods are used.

MAXREDIRECTS=*n*
specifies the maximum number of redirects that are allowed. PROC HTTP automatically follows redirects coming from a 300-level response code, as long as the NOFOLLOWLOC option is not specified. This option enables you to limit the number of redirects that are performed.

Default 5

Note The MAXREDIRECTS= option is available beginning with the November 2019 release of SAS 9.4M6 and SAS Viya 3.5.

METHOD=<">*http-method*<">
specifies an HTTP method. Standard methods include HEAD, TRACE, GET, POST, PUT, and DELETE. Beginning with SAS 9.4M3, the method is open-ended. Any method that conforms to the HTTP/1.1 standard and is recognizable by the target web server is acceptable. For information, see the HTTP/1.1 specification at www.w3.org.

Default Beginning with SAS 9.4M3, if you omit the METHOD argument and do not specify the IN argument, the default method is GET. If you omit METHOD and do specify the IN argument — and in SAS releases prior to SAS 9.4M3 — the default method is POST.

Restriction Software releases prior to SAS 9.4M3 support only the standard methods.

Requirement Quotation marks continue to be required around *http-method* in SAS versions before the November 2019 release of SAS 9.4M6 and SAS Viya versions before SAS Viya 3.5.

Examples "Example 1: A Simple GET Request" on page 1302

"Example 2: A Simple POST Request" on page 1303

"Example 9: A Nonstandard Method" on page 1310

NO_CONN_CACHE
disables connection caching for this HTTP request. The connection will be made with the specified connection parameters.

Notes This option is supported beginning with SAS 9.4M3.

When you enable NO_CONN_CACHE, you forgo all benefits of cached connections, including cached authentication. Each call that uses authentication must re-authenticate, which can take time.

NO_COOKIES
specifies that cached cookies will not be used for this HTTP request. This option does not prevent cookies from being sent manually with the "Cookie" header.

Note This option is supported beginning with SAS 9.4M3.

NOFOLLOWLOC
prevents the GET method from following URL redirections.

NOFOLLOWLOC is the default behavior for HTTP methods that write data.

Note This option is supported beginning with SAS 9.4M5.

See "FOLLOWLOC" on page 1286

OAUTH_BEARER=*token*
sends an OAuth access token along with the HTTP call. Valid token values are a string, a fileref, or the constant SAS_SERVICES. String values must be quoted. For all token types, the argument sends an authorization header in the form: `Authorization: Bearer Value`.

In addition to adding a header, OAUTH_BEARER= disables other types of HTTP authentication. Any HTTP-Authenticate headers that come back will be ignored.

Notes This option is supported beginning with SAS 9.4M5 and SAS Viya 3.3.

The SAS_SERVICES constant is supported only in SAS Viya.

OUT=*fileref-to-response-data*
specifies a fileref that indicates where output is written.

Example "Example 2: A Simple POST Request" on page 1303

PROXY_AUTH_BASIC
specifies to perform user identity authentication through a proxy server. The user name and password are supplied with the PROXYUSERNAME and PROXYPASSWORD arguments.

Note This option is supported beginning with SAS 9.4M3.

PROXY_AUTH_NTLM
specifies to perform NTLM authentication through a proxy server. As long as your current user identity has permissions, authentication is established.

Restriction NTLM is currently available only on Windows clients.

Note This option is supported beginning with SAS 9.4M3.

PROXY_AUTH_NEGOTIATE
specifies to perform NTLM, Kerberos, or some other type of HTTP authentication through a proxy server. As long as your current user identity has permissions, authentication is established.

Note This option is supported beginning with SAS 9.4M3.

PROXYHOST="*proxy-host-name*"
specifies the Internet host name of an HTTP proxy server. Beginning with SAS 9.4M3, you can specify both the host name and the port number in the PROXYHOST argument in the form:

```
host-name:port-number
```

When this syntax is used, there is no need to specify the PROXYPORT argument.

Earlier SAS versions require you to specify both the PROXYHOST and PROXYPORT arguments. For the earlier releases, specify PROXYHOST= as:

```
host-name
```

Example "Example 3: Specify a Proxy In the HTTP Request" on page 1303

PROXYPASSWORD="*proxy-passwd*"
specifies an HTTP proxy server password.

Tips The password is required only if your proxy server requires credentials.

Encodings that are produced by PROC PWENCODE are supported.

PROXYPORT=*proxy-port-number*
specifies an HTTP proxy server port. Beginning with SAS 9.4M3, PROXYPORT is an optional argument. You are not required to specify PROXYPORT if you specified both the HTTP proxy server host name and port number in the PROXYHOST argument.

Note Earlier SAS releases require that the HTTP proxy server host name and port number are specified separately in the PROXYHOST and PROXYPORT arguments. See "Example 3: Specify a Proxy In the HTTP Request" on page 1303.

PROXYUSERNAME="*proxy-user-name*"
specifies an HTTP proxy server user name.

Tip The user name is required only if your proxy server requires credentials.

QUERY=(<NOENCODE>"*parm1*"="*value1*" "*parm2*"="*value2*")
provides an alternate method for submitting query parameters for the URL= argument.

Typically, query strings are placed on the URL in the URL= option. This can be cumbersome when a value must be URL-encoded and arguments need to be separated with an & (ampersand). You must encode the values in advance. SAS interprets values preceded by an & as a macro. The QUERY= option enables you to specify query arguments as name=value pairs in a list, which is automatically URL-encoded and added to the query string on the URL.

When QUERY= is specified, if the input URL already has an existing query string, the entire generated replacement string uses an & instead of a ?.

The keyword NOENCODE can be specified before a name=value pair to indicate the pair should not be URL-encoded. NOENCODE applies only to the pair that it precedes. Other characters that normally are encoded are still encoded, like spaces.

Note The QUERY= option is available beginning with the November 2019 release of SAS 9.4M6 and SAS Viya 3.5.

See "Using the FORM and QUERY Options with PROC HTTP" on page 1298

TIMEOUT=*integer*
specifies the number of seconds of inactivity to wait before canceling an HTTP request. Use this option to prevent hangs if there is a chance that the server will not respond. The default value, 0 (zero), means no time-out period.

WEBAUTHDOMAIN="*web-credentials-from-metadata*"
specifies the web authentication domain. If specified, a user name and password are retrieved from metadata for the specified authentication domain.

Restriction This option applies to SAS 9 only.

WEBPASSWORD="*basic-authentication-password*"
specifies a password for basic authentication.

Alias PASSWORD

Tip Encodings that are produced by PROC PWENCODE are supported.

WEBUSERNAME="*basic-authentication-name*"
specifies a user name for basic authentication.

Alias USERNAME

DEBUG Statement

Writes debugging information to the SAS log.

Supports: All HTTP methods

Notes: This statement is supported beginning with SAS 9.4M5 and SAS Viya 3.3.

The OUTPUT_TEXT, REQUEST_BODY, RESPONSE_BODY, REQUEST_HEADERS, RESPONSE_HEADERS, NO_REQUEST_BODY, NO_RESPONSE_BODY, NO_REQUEST_HEADERS, and NO_RESPONSE_HEADERS options are new in SAS 9.4M6. SAS 9.4M6 enhancements are currently not supported in SAS Viya.

Example: "Example 13: Use the DEBUG Statement with the LEVEL= Option" on page 1316

Syntax

DEBUG *options*;

Optional Arguments

Level= 0 | 1 | 2 | 3

0 no debugging. This is the same as specifying PROC HTTP without the DEBUG statement.

1 displays request and response headers in the log. Setting a debug level of 1 equates to setting the REQUEST_HEADERS and RESPONSE_HEADERS options in the DEBUG statement.

2 displays request data as well as level 1 messages in the log. Setting a debug level of 2 equates to setting the REQUEST_HEADERS, RESPONSE_HEADERS, and REQUEST_BODY options in the DEBUG statement.

3 displays response data as well as level 2 messages in the log. Setting a debug level of 3 equates to setting the REQUEST_HEADERS, RESPONSE_HEADERS, REQUEST_BODY, and RESPONSE_BODY options in the DEBUG statement.

CAUTION

Use level 3 with care in SAS 9.4M5 and SAS Viya. The system may become unstable when the response is binary data.

NO_REQUEST_BODY

suppresses the request body from the information displayed when a debug level of 2 or greater is specified.

NO_REQUEST_HEADERS
suppresses the request header from the information displayed when a debug level of 1 or greater is specified.

NO_RESPONSE_BODY
suppresses the response body from the information displayed when a debug level of 3 is specified.

NO_RESPONSE_HEADERS
suppresses the response header from the information displayed when a debug level of 1 or greater is specified.

OUTPUT_TEXT
displays the request body and response body as if they are text.

REQUEST_BODY
displays the request body in the log.

REQUEST_HEADERS
displays the request header in the log.

RESPONSE_BODY
displays the response body in the log.

RESPONSE_HEADERS
displays the response header in the log.

Details

You must specify at least one option in the DEBUG statement for debugging information to be written to the log.

In SAS 9.4M5 and in SAS Viya, you control the amount of information that is printed with the LEVEL= option. A value of 1 or greater in the LEVEL= option is required to display debugging information. All DEBUG statement output in these software versions is written as text.

Beginning with SAS 9.4M6:

- the HTTP request body and response body are written as binary by default. You can set the OUTPUT_TEXT option to print the information as text.
- you have a choice of options, in addition to LEVEL=, which can be specified alone or in combination. For example, you can specify RESPONSE_HEADERS to display debugging information for response headers only, or RESPONSE_HEADERS and RESPONSE_BODY to display response information only. Or, you can specify LEVEL=3 to display all debugging information, and also to specify NO_RESPONSE_BODY to omit the response body. The options that control individual components can be used to limit or expand the information displayed for a particular LEVEL= value.

HEADERS Statement

Specifies request headers for the HTTP request.

Supports: All HTTP methods

Notes: This statement is supported beginning with SAS 9.4M3.

Use the HEADERS statement instead of the PROC HTTP CT= and HEADERIN= arguments.

Example: "Example 8: A GET That Uses the HEADERS Statement" on page 1309

Syntax

HEADERS *"HeaderName"="HeaderValue"* <*"HeaderName-n"="HeaderValue-n"*>;

Required Argument

"HeaderName"="HeaderValue"

is a name and value pair that represents a header name and its value. The HeaderName can be a standard header name or a custom header name. For information about header field definitions, see the HTTP/1.1 specification at www.w3.org.

Note: Do not specify a colon (:) in the header name. The name=value pairs are automatically translated into the following form:

```
HeaderName : HeaderValue
```

Details

The HEADERS statement enables you to specify header values easily within the procedure request, instead of having to provide a fully formatted input file via a fileref. Use the HEADERS statement to specify the content-type and character set of the document that you are uploading when the values are different from the default values for the method.

Table 35.1 *Default Content-Type for the POST and PUT Methods*

HTTP Method	Default Content-Type
POST	application/x-www-form-urlencoded

HTTP Method	Default Content-Type
PUT	application/octet-stream

SSLPARMS Statement

Sets encryption options for the PROC HTTP request.

Supports: All HTTP methods

Note: Support for this statement starts in SAS 9.4M6 and SAS Viya 3.5.

See: "Using Hypertext Transfer Protocol Secure (HTTPS) " on page 1296

Example: "Example 14: Specify Local Options for Two-Way Encryption in Windows" on page 1319

Syntax

SSLPARMS *encryption-options*;

Required Argument

encryption-options
specifies SAS system options for encryption that enable a secure client-server connection with the target server. For a listing of available system options, see "SAS System Options for Encryption" in *Encryption in SAS*.

Note: Only system options for encryption that begin with "SSL" are supported.

The SAS system options for encryption can be specified in either of the following ways:

```
"SystemOption"="OptionValue"
SystemOption="OptionValue"
```

Note SAS system options for encryption are host-specific.

Details

Use the SSLPARMS statement to apply a SAS system option for encryption locally instead of globally.

Usage: HTTP Procedure

Using Hypertext Transfer Protocol Secure (HTTPS)

HTTP Security: TLS and Data Encryption

Transport Layer Security (TLS) and its predecessor, Secure Sockets Layer (SSL), enables web browsers and web servers to communicate over a secured connection by encrypting data. Both browsers and servers encrypt data before the data is transmitted. The receiving browser or server then decrypts the data before it is processed.

Note: All discussion of TLS is also applicable to the predecessor protocol, SSL.

Using HTTPS with PROC HTTP

For both SAS 9.4 (beginning with SAS 9.4M3) and the full SAS Viya deployment, secure communication over HTTP (HTTPS) is provided globally by default. HTTPS is controlled by a Trusted Root CA bundle. A default Trusted Root CA bundle is laid down at installation and pointed to by the SSLCALISTLOC= system option. The SSLCALISTLOC= system option sets secure communications globally for the SAS system. Do not change the value of the SSLCALISTLOC= system option unless you are instructed to do so by SAS Technical Support. "SSLCALISTLOC=" in *Encryption in SAS*.

Some UNIX installations require the Server Name Indicator (SNI) to be set so that they can serve up the proper certificate. Beginning with SAS 9.4M5, the SNI is also set by default. Earlier SAS 9.4 releases and SAS Viya require you to set the SNI with environment variables. For information about setting environment variables for a SAS 9.4 installation, see *Encryption in SAS*. For information about setting environment variables for SAS Viya, see *Encryption in SAS Viya: Data in Motion*.

Beginning with SAS 9.4M6 and SAS Viya 3.5, PROC HTTP enables you to override the global communication security settings with local communication security settings with the SSLPARMS statement. In the SSLPARMS statement, specify SAS system options for encryption. The options that are set in the SSLPARMS

statement apply only to the PROC HTTP request in which they are specified. For more information, see "SSLPARMS Statement" on page 1295 and "Example 14: Specify Local Options for Two-Way Encryption in Windows" on page 1319.

Using Authentication Other Than Basic

Beginning with SAS 9.4M3, PROC HTTP enables you to specify the authentication type. The ability to specify the authentication type is useful when you know which authentication type is required for a request to succeed in advance. Specifying the correct type, rather than requiring the procedure to negotiate it, optimizes procedure execution. For example, if you know that the server supports only Kerberos authentication, it is a good idea to specify the AUTH_NEGOTIATE argument. If you know that the server supports only NTLM authentication, then specify AUTH_NTLM.

If you do not specify the authentication type, the default type (which is the type of authentication that is available in SAS releases prior to the third maintenance release), is AUTH_ANY. AUTH_ANY is equivalent to specifying AUTH_NTLM, AUTH_NEGOTIATE, and AUTH_BASIC together in the request. AUTH_NTLM authentication is attempted first (for Windows only), then AUTH_NEGOTIATE, and so on, although the server ultimately determines which authentication type is used. If the server that you are connecting to supports the NTLM authentication protocol or the Kerberos authentication protocol, it usually is not necessary to specify a user name and password. As long as your current user identity has permissions, authentication is established.

EXPECT_100_CONTINUE support is provided to optimize requests that must make more than one trip to the server. This option prevents the data from being uploaded multiple times.

Note: When using authentication, do not enable NO_CONN_CACHE. When NO_CONN_CACHE is enabled, each call that uses authentication must re-authenticate, which can take time.

HTTP_TOKENAUTH enables you to access SAS Content Servers from PROC HTTP without having to supply a user name and password.

WEBAUTHDOMAIN is also used in lieu of a user name and password. However, you must set up a metadata entry that stores the user name and password for the specified web authentication domain.

Wire Logging

Wire logging logs packets of information as they appear on the network. This information is normally referred to as a dump. Wire dumps enable you to see what information is being sent to the server and what information the server is sending

back. Because you can see the raw data, wire dumps can be useful in debugging your programs.

Beginning with SAS 9.4M3, logger APP.TK.HTTPC is used to log HTTP-specific messages. The wire dumps that the logger generates can be enabled by setting logger APP.TK.HTTPC to the DEBUG level or higher. In earlier versions of SAS 9.4, logger HTTP is used to log HTTP-specific messages. Set logger HTTP to the DEBUG level or higher. At the DEBUG level, the first 64 bytes of incoming and outgoing data is logged. At the TRACE level, all of the data is written to the log. Note that at the TRACE level, performance can be greatly diminished.

For more information, see “SAS Logging” in *SAS Logging: Configuration and Programming Reference*.

Using Encodings with PROC HTTP

Responses are not encoded to session encodings. You must supply the request with the encoding that you want to use, and set the content type.

Beginning with the November 2019 release of SAS 9.4M6 and SAS Viya 3.5, you can send post URL-encoded data with the FORM parameter in the IN= argument. The QUERY= procedure option enables you to submit URL-encoded query parameters.

Using the FORM and QUERY Options with PROC HTTP

Beginning with the November 2019 release of SAS 9.4M6 and SAS Viya 3.5, uploading standard URL encoded form data has been made more convenient. The FORM option enables you to submit a single-part form with PROC HTTP. For example, in order to post values to this form in previous SAS releases, you had to prepare your PROC HTTP request as follows:

```
%let firstname=Mickey;
%let lastname=Mouse;

data _null_;
      firstname = urlencode("&firstname");
      lastname = urlencode("&lastname");
      call symputx("firstname",firstname,'G');
      call symputx("lastname",lastname,'G');
run;

proc http url="http://httpbin.org/post"
in="firstname=&firstname.%nrstr(&lastname)=&lastname";
run;
```

The URLENCODE function and the SYMPUTX call routine were necessary to encode the data before submitting the PROC HTTP request.

With the new FORM option, the same request can now be submitted as follows:

```
%let firstname=Mickey;
%let lastname=Mouse;
proc http url="http://httpbin.org/post"
in = form ("firstname"="&firstname"
           "lastname"="&lastname");
run;
```

The QUERY= option makes adding query parameters to a URL easier. You can still add query parameters to a URL manually as shown below. However, when you modify the URL manually you are responsible for URL encoding any special characters and making sure that the & (ampersand) appears correctly and is not mistaken for a macro variable.

```
url="http://httpbin.org/GET?firstname=&firstname
%nrstr(&lastname)=&lastname";
```

With the new QUERY= procedure option, the above request can now be submitted as follows:

```
%let firstname=Mickey;
%let lastname=Mouse;
proc http url="http://httpbin.org/get"
query = ("firstname"="&firstname"
           "lastname"="&lastname");
run;
```

Both options URL-encode the input data by default unless you specify the NOENCODE option before a name=value pair.

Using the MULTI Option

A multipart upload enables you to upload multiple entities in a single request. The PROC HTTP MULTI option provides support for sending multipart form data as well as generic multipart uploads. The multipart feature is useful for uploading files to an HTTP server. For example, you might use it to upload a JSON file that contains the metadata about a file followed by the binary code of the file.

Note: The new functionality does not include support for nested multipart uploads.

Here is an example of a multipart form post:

```
filename input1 "input1.txt";
filename input2 "input2.txt";
filename resp "multi_resp.json";

proc http
url="httpbin.org/post"
in = MULTI FORM ( "Name1" = "Raw Input 1" ,
                  "Name2" = input1 header="Foo: Bar" header="Foo2: Bar2" ,
                  "Name3" = input2 FILENAME="Different Filename"
                    header="Content-Type: text/plain")
```

```
out=resp
;
run;
```

This HTTP request sends a three-part form.

In a multipart form post:

- the MULTI keyword is specified in the IN= statement. The keyword must follow the equal sign.
- the FORM keyword indicates that this upload is of type multipart/form-data.
- the parts of the form are submitted within parenthesis
- Each part of the form includes the following components:
  - a unique identifier that indicates the beginning of the part. In this example, that is "Name*n*".
  - one or more optional HTTP headers. The HTTP headers must be specified before the input data. For a form, it is a good idea to specify a content-type header to indicate the type of content that will follow. The Content-Disposition header is derived from Name= and FILENAME= values. If the input is a fileref, and a FILENAME value is not specified, the FILENAME= value is derived from the fileref.
  - input data, supplied as a string or a fileref.

Here is an example of a generic multipart request:

```
proc http
   url="httpbin.org/post"
   method=POST
   in = MULTI "related" ( input1 header="content-type: text/plain",
         "some text data with no header");
run;
```

In a generic multipart request:

- The quoted value after the MULTI keyword is used to derive the Content-Disposition header. For this request, a header of Content-Type: multipart/related is sent.
- The input data for each part can come from a fileref or be specified in a quoted string.
- Headers are optional on each part. When a header is specified, the specification must contain a full header in proper form.
- Parts are separated by commas.

The preceding example uploads two entities.

Using HEADERS= to Send Chunked Data

To force chunked data to be sent, specify a header as follows:

```
proc http url="httpbin.org/post"
 in="hello";
 headers "Transfer-Encoding"="chunked";
 debug level=3;
run;
```

PROC HTTP Response Status Macro Variables

Beginning with SAS 9.4M5, PROC HTTP sets up macro variables with certain values after it executes each statement. These macro variables can be used inside a macro to test for HTTP errors. An HTTP error is an error that is encountered after a successful host connection has been made and the HTTP request has been successfully parsed by the HTTP procedure. The macro variables do not store values for host connection errors or for PROC HTTP syntax errors. The macro variables are reset on each invocation of PROC HTTP.

SYS_PROCHTTP_STATUS_CODE
: stores the status code of the HTTP request.

SYS_PROCHTTP_STATUS_PHRASE
: stores the descriptive phrase that is associated with the status code.

Consider this example:

```
HTTP/1.1 200 OK
```

The SYS_PROCHTTP_STATUS_CODE macro variable stores the value 200. The SYS_PROCHTTP_STATUS_PHRASE macro variable stores OK, which indicates that this HTTP request was successful.

For more information, see "Example 12: Create A Program That Captures Status Response Values" on page 1312.

Macro Variables for Setting Global Values

Beginning with SAS 9.4M3, PROC HTTP produces two automatic macro variables to enable you to set or change default PROC HTTP settings.

PROCHTTP_PROXY=*proxy-server-name-and-port-number*;
: sets a default proxy server for PROC HTTP requests. Once set, the specified proxy server establishes a proxy for all PROC HTTP requests in the SAS session, unless you specify the PROXYHOST= argument in the PROC HTTP request. The value that is specified in the procedure argument overrides the value that is specified in the macro variable. Specify the PROXYHOST= argument with a value that is different from the macro variable to use a different proxy server for a request. Specify PROXYHOST= without a value to disable proxy use for a request. For more information, see "Example 5: Specify A Proxy In a Macro Variable" on page 1305.

PROCHTTP_NOCOOKIES= blank | *integer*;
provides global control of cookie caching for PROC HTTP requests. Omitting the macro variable or specifying the macro variable without a value enables cookie caching (cookie caching is on by default). To globally disable cookie caching, specify a nonzero value in the macro variable. Cookie caching can be disabled for a specific PROC HTTP request by specifying the NO_COOKIES procedure option in the PROC HTTP request along with the CLEAR_COOKIES or CLEAR_CACHE arguments.

The macro variables are set with the %LET statement. In the event that you disable cookie caching, you can delete the macro variable from the symbol table with the %SYMDEL statement.

Examples: HTTP Procedure

Example 1: A Simple GET Request

Features: METHOD= argument
URL= Argument
OUT= Argument

Details

This example makes a GET request to a server on the local network. GET is the simplest and most common request that you can make with PROC HTTP. Beginning with SAS 9.4M3, GET is the default METHOD value when the IN argument is omitted for a PROC HTTP request, making the argument optional. A GET request must specify METHOD=GET in earlier releases of SAS software.

Program

```
filename resp TEMP;

proc http
   url="http://httpbin.org/get"
   out=resp;
run;
```

Example 2: A Simple POST Request

Features: METHOD= Argument
IN= Argument
OUT= Argument

Details

This example makes a simple POST request to a server on the local network. The file to upload is identified by a fileref in the IN argument. When the IN argument is specified, the default METHOD= value in all SAS releases is POST. The response and the output headers are written to filerefs.

Program

```
filename resp TEMP;
filename headout TEMP;
filename input TEMP;

data _null_;
   file input;
   put "this is some sample text";
run;

proc http
   url="http://httpbin.org/post"
   in=input
   out=resp
   headerout=headout;
run;
```

Example 3: Specify a Proxy In the HTTP Request

Features: PROXYHOST= Argument
PROXYPORT= Argument

Note: The PROXYHOST and PROXYPORT arguments are the only way to specify a proxy server in software releases before SAS 9.4M3.

Details

This example makes the same request as in “Example 2: A Simple POST Request” on page 1303, except the call is sent to an external server and therefore requires the use of a proxy server. This example uses the PROXYHOST argument to specify the name of the external server and the PROXYPORT argument to specify the port number.

Program

```
filename out "u:\prochttp\Testware\ProxyTest_out.txt";
filename input TEMP;

data _null_;
   file input;
   put "this is some sample text";
run;

proc http
   url="http://httpbin.org/post"
   method=post
   in=input
   out=out
   proxyhost="proxyhost.company.com"
   proxyport=889;
run;
```

Example 4: Specifying Input Data as a String

Features: IN= *"string"*

Note: The ability to specify input text as a string is supported beginning with SAS 9.4M3.

Details

The PROC HTTP IN= argument accepts a quoted input string or a fileref to submit input data. Specifying input in a string makes it easier to send text posts and form-based posts. This example submits the form that can be found at http://httpbin.org/forms/post. The response is written to a response file.

Program

```
filename resp TEMP;

proc http
   method=post
   url="http://httpbin.org/post"
   in='custname=Sas+User&custtel=919-555-5555&custemail=sas.user%40
   sas.com&size=medium&topping=cheese&delivery=12%3A00&comments=Dont
+Drop+It'
   out=resp;
run;

data _null_;
   infile resp;
   input;
   put _infile_;
run;
```

This is the content of the Resp file:


```
{
  "args": {},
  "data": "",
  "files": {},
  "form": {
    "comments": "Dont Drop It",
    "custemail": "sas.user@sas.com",
    "custname": "Sas User",
    "custtel": "919-555-5555",
    "delivery": "12:00",
    "size": "medium",
    "topping": "cheese"
  },
  "headers": {
    "Accept": "*/*",
    "Content-Length": "133",
    "Content-Type": "application/x-www-form-urlencoded",
    "Host": "httpbin.org",
    "User-Agent": "SAS/9",
  },
  "json": null,
  "origin": "149.173.1.80, 104.129.194.85",
  "url": "http://httpbin.org/post"
}
```


Example 5: Specify A Proxy In a Macro Variable

Features: PROCHTTP_PROXY= Macro Variable
IN="*string*"

Note: The PROCHTTP_PROXY= macro variable and the ability to specify input text as a string are supported beginning with SAS 9.4M3.

Details

This example makes the same request as in "Example 3: Specify a Proxy In the HTTP Request" on page 1303, except the proxy server is specified in a macro variable and the input text is specified as a string in the IN argument. The PROCHTTP_PROXY macro variable specifies the proxy server's Internet host name and port number as one value. Because the proxy is set in the macro variable, it is available to all subsequent HTTP requests that are made in the SAS session. In this request, parameters to the POST are read from a string that is specified in the IN argument.

Program

```
%let PROCHTTP_PROXY=proxyhost.company.com:889;

filename out "u:\prochttp\Testware\ProxyTest_out.txt";
filename input TEMP;

proc http
   url="http://httpbin.org/post"
   method=post
   in="text to write out"
   out=out;
run;
```

Example 6: A POST That Captures the Response Headers

Features: IN="*string*"
HEADEROUT= Argument

Details

This example makes the same POST request as in "Example 5: Specify A Proxy In a Macro Variable" on page 1305 but captures the response headers in a file called headerOut.txt.

Program

```
%let PROCHTTP_PROXY=proxyhost.company.com:889;

filename out "u:\prochttp\Testware\ProxyTest_out.txt";
filename hdrout "u:\prochttp\Testware\headerOut.txt";

 proc http
   url="http://httpbin.org/post"
   method=post
   in="text to write out"
   out=out
   headerout=hdrout;
run;
```

Example 7: A GET That Specifies HEADEROUT_OVERWRITE

Features: HEADEROUT argument
HEADEROUT_OVERWRITE argument

Note: The HEADEROUT_OVERWRITE argument is supported beginning with SAS 9.4M3.

Details

This example shows the effects of the HEADEROUT_OVERWRITE argument. The GET requests redirect twice before reaching their destination. HEADEROUT_OVERWRITE causes only the last output header to be recorded.

Example of Normal HEADEROUT Output after a Redirect

```
filename hdrs "u:\prochttp\Testware\GetHdr_out.txt";
filename out "u:\prochttp\Testware\GetTest_out.txt";

proc http
   url="http://httpbin.org/redirect/2"
   method=GET
   headerout=hdrs
   out=out;
run;
```

This is the content of GetHdr_out.txt:

```
HTTP/1.1 302 FOUND
Server: nginx
Date: Mon, 20 Apr 2015 14:19:52 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 247
Connection: keep-alive
Location: /relative-redirect/1
Access-Control-Allow-Origin: *
Access-Control-Allow-Credentials: true

HTTP/1.1 302 FOUND
Server: nginx
Date: Mon, 20 Apr 2015 14:19:53 GMT
Content-Type: text/html; charset=utf-8
Content-Length: 0
Connection: keep-alive
Location: /get
Access-Control-Allow-Origin: *
Access-Control-Allow-Credentials: true

HTTP/1.1 200 OK
Server: nginx
Date: Mon, 20 Apr 2015 14:19:53 GMT
Content-Type: application/json
Content-Length: 195
Connection: keep-alive
Access-Control-Allow-Origin: *
Access-Control-Allow-Credentials: true
```

Example of HEADEROUT Request with HEADEROUT_OVERWRITE

```
filename hdrs "u:\prochttp\Testware\GetHdr2_out.txt";
filename out "u:\prochttp\Testware\GetTest2_out.txt";

proc http
 url="http://httpbin.org/redirect/2"
method=GET
headerout=hdrs
out=out
HEADEROUT_OVERWRITE;
run;
```

This is the content of GetHdr2_out.txt:

```
HTTP/1.1 200 OK
Server: nginx
Date: Mon, 20 Apr 2015 14:22:48 GMT
Content-Type: application/json
Content-Length: 195
Connection: keep-alive
Access-Control-Allow-Origin: *
Access-Control-Allow-Credentials: true
```

Example 8: A GET That Uses the HEADERS Statement

Features: HEADERS Statement
GET Method

Note: The HEADERS statement is supported beginning with SAS 9.4M3.

Details

The following is an example of a GET method request that specifies the HEADERS statement. As of SAS 9.4M3, GET is also the default method when the IN argument is not specified.

Program

```
filename resp TEMP;

proc http
   url="http://httpbin.org/headers"
   out=resp;
 headers
   "Accept"="application/json";
run;

data _null_;
   infile resp;
   input;
   put _infile_;
run;
```

The output looks like this:

```
  "headers": {
    "Accept": "*/*,application/json",
    "Host": "httpbin.org",
    "User-Agent": "SAS/9",
  }
}
```

Example 9: A Nonstandard Method

Features: METHOD Argument

Note: Nonstandard methods are supported in SAS 9.4M3 and later releases.

Details

This example submits the MKCOL WEBDAV http method. Output is written to a temporary file named Resp. There are no input and output requirements for nonstandard methods. As long as the target server returns data and you have specified a valid OUT, data will be written to your OUT fileref. Here, output is written to Resp.

Program

```
filename resp TEMP;

proc http
   url="http://hostname/directory/"
   method=MKCOL
   out=resp;
run;
```

Example 10: A Request That Specifies an Authentication Type

Features: AUTH_NEGOTIATE Argument

AUTH_NTLM Argument

Note: The ability to specify an authentication type is supported beginning with SAS 9.4M3.

Details

This example specifies an authentication type for a PROC HTTP request. Two authentication types are specified, indicating that only Negotiate or NTLM authentication are allowed.

Program

```
proc http
   url="http://securesite.com"
   AUTH_NEGOTIATE
   AUTH_NTLM;
run;
```

Example 11: A PUT That Specifies EXPECT_100_CONTINUE

Features: EXPECT_100_CONTINUE Argument
HEADEROUT= Argument

Note: The EXPECT_100_CONTINUE argument is supported beginning with SAS 9.4M3.

Details

This example specifies the EXPECT_100_CONTINUE header.

Program

```
filename resp TEMP;
filename hdrs TEMP;

proc http
   url="http://httpbin.org/put"
   method=PUT
   in='Some Put Data'
   out=resp
   headerout=hdrs
   EXPECT_100_CONTINUE;
```

```
run;

data _null_;
   infile hdrs;
   input;
   put _infile_;
run;

data _null_;
   infile resp;
   input;
   put _infile_;
run;
```

The output in the HDRS looks like this:

```
HTTP/1.1 100 Continue

HTTP/1.1 200 OK
Server: myserver/18.0
Date: Mon, 24 Nov 2014 20:18:29 GMT
Content-Type: application/json
Content-Length: 652
Access-Control-Allow-Origin: *
Access-Control-Allow-Credentials: true
X-Cache: MISS from transproxy
Via: 1.1 vegur, 1.1 transproxy (squid)
Connection: keep-alive
```

The output in the Resp file looks like this:

```
{
  "args": {},
  "data": "Some Put Data",
  "files": {},
  "form": {},
  "headers": {
    "Accept": "*/*",
    "Content-Length": "13",
    "Content-Type": "application/octet-stream",
    "Host": "httpbin.org",
    "User-Agent": "SAS/9",
    "Xxpect": "100-continue",
  },
  "json": null,
  "origin": "149.173.1.80, 104.129.194.85",
  "url": "http://httpbin.org/put"
}
```

Example 12: Create A Program That Captures Status Response Values

Features: SYS_PROCHTTP_STATUS_CODE macro variable
SYS_PROCHTTP_STATUS_PHRASE macro variable

Details

This example creates a simple macro program that tests the value set in the SYS_PROCHTTP_STATUS_CODE macro variable. The program specifies to print an error message when the result code does not match a specified value for the SYS_PROCHTTP_STATUS_CODE macro variable. The program also specifies to print the actual values returned by the SYS_PROCHTTP_STATUS_CODE and SYS_PROCHTTP_STATUS_PHRASE macro variables in any error messages.

The macro program is then invoked after various PROC HTTP requests to illustrate the results that you can expect under various circumstances. The macro program is invoked with a value of 200 in each execution. A value of 200 indicates successful completion of the HTTP request.

Program

The following code creates the macro program.

```
%macro prochttp_check_return(code);
%if %symexist(SYS_PROCHTTP_STATUS_CODE) ne 1 %then %do;
  %put ERROR: Expected &code., but a response was not received from
 the HTTP Procedure;
  %abort;
  %end;
%else %do;
  %if &SYS_PROCHTTP_STATUS_CODE. ne &code. %then %do;
   %put ERROR: Expected &code., but received &SYS_PROCHTTP_STATUS_CODE.
 &SYS_PROCHTTP_STATUS_PHRASE.;
   %abort;%end;
%end;
%mend;
```

Result for a Successful HTTP Request

Here is an example of a successful PROC HTTP request. The macro program specifies to print an error message and the return code and status values for any HTTP request that does not return the code value 200.

```
proc http url="httpbin.org/get";
run;
%prochttp_check_return(200);
```

Here is the log for the request. The request returned 200. For PROC HTTP requests whose return code matches the code value specified in the macro program, the values of the macro variables are ignored. There is no error message; therefore, no need to print the value of the status reporting macro variables.

```
173  proc http url="httpbin.org/get";
174  run;

NOTE: PROCEDURE HTTP used (Total process time):
      real time           3.40 seconds
      cpu time            0.03 seconds

NOTE: 200 OK

175
176  %prochttp_check_return(200);
177
178
```

Result for Failed Host Connection

The following is an example of a PROC HTTP request that cannot establish a host connection:

```
proc http url="foo.bar";
run;
%prochttp_check_return(200);
```

When a server connection cannot be made, the procedure returns an error message. However, the error message does not include a return code or a status phrase.

```
179  proc http url="foo.bar";
180  run;

ERROR: Host name resolution failed
NOTE: PROCEDURE HTTP used (Total process time):
      real time           2.28 seconds
      cpu time            0.00 seconds

NOTE: The SAS System stopped processing this step because of errors.
181
182  %prochttp_check_return(200);
ERROR: Expected 200, but a response was not received from the HTTP Procedure
ERROR: Execution terminated by an %ABORT statement.
183
```

Result for a Valid HTTP Error

The following is an example of a PROC HTTP request that connects but specifies an invalid secondary path:

```
proc http url="httpbin.org/get2";
run;
%prochttp_check_return(200);
```

When a server connection is made, but the HTTP request fails, the error message prints the actual return code and its corresponding status phrase.

```
184  proc http url="httpbin.org/get2";
185  run;

NOTE: PROCEDURE HTTP used (Total process time):
      real time           0.04 seconds
      cpu time            0.00 seconds

NOTE: 404 Not Found

186
187  %prochttp_check_return(200);
ERROR: Expected 200, but received 404 Not Found
ERROR: Execution terminated by an %ABORT statement.
188
```

Results for a Parsing Error

The following is an example of a PROC HTTP request that specifies an invalid argument:

```
proc http url="httpbin.org/get" foo;
run;
%prochttp_check_return(200);
```

When a server connection is made, but the PROC HTTP request cannot be parsed, the macro returns an error message. The message does not include a return code or status phrase.

```
189  proc http url="httpbin.org/get" foo;
                                     ---
                                     22
                                     202
ERROR 22-322: Syntax error, expecting one of the following: ;, AUTH_ANY, AUTH_BASIC,
              AUTH_NEGOTIATE, AUTH_NONE, AUTH_NTLM, CLEAR_CACHE, CLEAR_CONN_CACHE,
              CLEAR_COOKIES, CT, EXPECT_100_CONTINUE, FOLLOWLOC, HEADERIN, HEADEROUT,
              HEADEROUT_OVERWRITE, HTTP_TOKENAUTH, IN, METHOD, NOFOLLOW, NOFOLLOWLOC,
              NO_CONN_CACHE, NO_COOKIES, OAUTH_BEARER, OUT, PASSWORD, PROXYHOST,
              PROXYPASSWORD, PROXYPORT, PROXYUSERNAME, PROXY_AUTH_BASIC,
PROXY_AUTH_NEGOTIATE,
              PROXY_AUTH_NONE, PROXY_AUTH_NTLM, TIMEOUT, URL, USERNAME, VERBOSE,
              WEBAUTHDOMAIN, WEBPASSWORD, WEBUSERNAME.
ERROR 202-322: The option or parameter is not recognized and will be ignored.
190  run;
191
192  %prochttp_check_return(200);
ERROR: Expected 200, but a response was not received from the HTTP Procedure
NOTE: PROCEDURE HTTP used (Total process time):
      real time           0.07 seconds
      cpu time            0.07 seconds

ERROR: Execution terminated by an %ABORT statement.
NOTE: The SAS System stopped processing this step because of errors.
```

Example 13: Use the DEBUG Statement with the LEVEL= Option

Features: DEBUG statement
LEVEL= statement option
Statement output

Details

This example shows the information returned by the DEBUG statement Level= option.

Debug Level 1

A debug level of 1 displays the HTTP request and response headers.

```
proc http
   in = "*************testing prochttp****************"
   method=POST
   url="http://httpbin.org/post";
   debug level = 1;
run;
```

The following information is displayed in the log:

```
> POST /post HTTP/1.1
> User-Agent: SAS/9
> Host: httpbin.org
> Accept: */*
> Connection: Keep-Alive
> Content-Length: 45
> Content-Type: application/x-www-form-urlencoded
>
< HTTP/1.1 200 OK
< Connection: keep-alive
< Server: myserver/19.9.0
< Date: Tue, 07 Aug 2018 19:12:34 GMT
< Content-Type: application/json
< Content-Length: 418
< Access-Control-Allow-Origin: *
< Access-Control-Allow-Credentials: true
< Via: 1.1 vegur
<
```

Debug Level 2

A debug level of 2 displays the HTTP request and response headers and the HTTP request body.

```
proc http
   in = "**************testing prochttp****************"
   method=POST
   url="http://httpbin.org/post";
   debug level = 2;
run;
```

Beginning with SAS 9.4M6, the following information is displayed in the log. The request body is written as binary by default. Use the OUTPUT_TEXT DEBUG statement option if you want to write the information as text.

```
> POST /post HTTP/1.1
> User-Agent: SAS/9
> Host: httpbin.org
> Accept: */*
> Connection: Keep-Alive
> Content-Length: 45
> Content-Type: application/x-www-form-urlencoded
>
> 000000000A9FC4C0: 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 74 65 73
**************tes
> 000000000A9FC4D0: 74 69 6E 67 20 70 72 6F 63 68 74 74 70 2A 2A 2A ting
prochttp***
> 000000000A9FC4E0: 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A          *************
< HTTP/1.1 200 OK
< Connection: keep-alive
< Server: myserver/19.9.0
< Date: Thu, 06 Sep 2018 14:21:26 GMT
< Content-Type: application/json
< Content-Length: 418
< Access-Control-Allow-Origin: *
< Access-Control-Allow-Credentials: true
< Via: 1.1 vegur
<
```

Debug Level 3

A debug level of 3 displays the request header, response header, request body, and response body.

```
proc http
   in = "**************testing prochttp*****************"
   method=POST
   url="http://httpbin.org/post";
   debug level = 3;
run;
```

Beginning with SAS 9.4M6, the following information is displayed in the log. The request and response body are written as binary by default.

```
> POST /post HTTP/1.1
> User-Agent: SAS/9
> Host: httpbin.org
> Accept: */*
> Connection: Keep-Alive
> Content-Length: 45
> Content-Type: application/x-www-form-urlencoded
>
> 000000000A9FC4C0: 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 74 65 73 **********tes
> 000000000A9FC4D0: 74 69 6E 67 20 70 72 6F 63 68 74 74 70 2A 2A 2A ting prochttp***
> 000000000A9FC4E0: 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A          **********
< HTTP/1.1 200 OK
< Connection: keep-alive
< Server: myserver/19.9.0
< Date: Thu, 06 Sep 2018 14:25:41 GMT
< Content-Type: application/json
< Content-Length: 418
< Access-Control-Allow-Origin: *
< Access-Control-Allow-Credentials: true
< Via: 1.1 vegur
<
< 000000000A9FC5B6: 7B 0A 20 20 22 61 72 67 73 22 3A 20 7B 7D 2C 20 {.  "args": {},
< 000000000A9FC5C6: 0A 20 20 22 64 61 74 61 22 3A 20 22 22 2C 20 0A .  "data": "", .
< 000000000A9FC5D6: 20 20 22 66 69 6C 65 73 22 3A 20 7B 7D 2C 20 0A   "files": {}, .
< 000000000A9FC5E6: 20 20 22 66 6F 72 6D 22 3A 20 7B 0A 20 20 20 20   "form": {.
< 000000000A9FC5F6: 22 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 74 65 "**********te
< 000000000A9FC606: 73 74 69 6E 67 20 70 72 6F 63 68 74 74 70 2A 2A sting prochttp**
< 000000000A9FC616: 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 2A 22 3A **********":
< 000000000A9FC626: 20 22 22 0A 20 20 7D 2C 20 0A 20 20 22 68 65 61  "".  }, .  "hea
< 000000000A9FC636: 64 65 72 73 22 3A 20 7B 0A 20 20 20 20 22 41 63 ders": {.    "Ac
< 000000000A9FC646: 63 65 70 74 22 3A 20 22 2A 2F 2A 22 2C 20 0A 20 cept": "*/*", .
< 000000000A9FC656: 20 20 20 22 43 6F 6E 6E 65 63 74 69 6F 6E 22 3A    "Connection":
< 000000000A9FC666: 20 22 63 6C 6F 73 65 22 2C 20 0A 20 20 20 20 22  "close", .    "
< 000000000A9FC676: 43 6F 6E 74 65 6E 74 2D 4C 65 6E 67 74 68 22 3A Content-Length":
< 000000000A9FC686: 20 22 34 35 22 2C 20 0A 20 20 20 20 22 43 6F 6E  "45", .    "Con
< 000000000A9FC696: 74 65 6E 74 2D 54 79 70 65 22 3A 20 22 61 70 70 tent-Type": "app
< 000000000A9FC6A6: 6C 69 63 61 74 69 6F 6E 2F 78 2D 77 77 77 2D 66 lication/x-www-f
< 000000000A9FC6B6: 6F 72 6D 2D 75 72 6C 65 6E 63 6F 64 65 64 22 2C orm-urlencoded",
< 000000000A9FC6C6: 20 0A 20 20 20 20 22 48 6F 73 74 22 3A 20 22 68  .    "Host": "h
< 000000000A9FC6D6: 74 74 70 62 69 6E 2E 6F 72 67 22 2C 20 0A 20 20 ttpbin.org", .
< 000000000A9FC6E6: 20 20 22 55 73 65 72 2D 41 67 65 6E 74 22 3A 20   "User-Agent":
< 000000000A9FC6F6: 22 53 41 53 2F 39 22 0A 20 20 7D 2C 20 0A 20 20 "SAS/9".  }, .
< 000000000A9FC706: 22 6A 73 6F 6E 22 3A 20 6E 75 6C 6C 2C 20 0A 20 "json": null, .
< 000000000A9FC716: 20 22 6F 72 69 67 69 6E 22 3A 20 22 31 32 2E 37  "origin": "12.7
< 000000000A9FC726: 30 2E 31 30 31 2E 31 31 34 22 2C 20 0A 20 20 22 0.101.114", .  "
< 000000000A9FC736: 75 72 6C 22 3A 20 22 68 74 74 70 3A 2F 2F 68 74 url": "http://ht
< 000000000A9FC746: 74 70 62 69 6E 2E 6F 72 67 2F 70 6F 73 74 22 0A tpbin.org/post".
< 000000000A9FC756: 7D 0A                                         }.
```

Example 14: Specify Local Options for Two-Way Encryption in Windows

Features: SSLPARMS statement
SSLCERTISS= system option
SSLCERTSERIAL= system option

Details

The following is an example of a PROC HTTP request that specifies local encryption options to send a client certificate for two-way TLS authentication on Windows. The name of the Certificate Authority (CA) that issued the client certificate is named Glenn's CA.

The system options used are host dependent. For more information about the system options in a SAS 9.4 installation, see *Encryption in SAS*. For more information about system options in SAS Viya, see *Encryption in SAS Viya: Data in Motion*.

This request specifies the Windows system options SSLCERTISS and SSLCERTSERIAL.

```
proc http
  method=GET
  url="https://internal.site.com/";
  sslparms
    sslcertiss="Glenn's CA"
    sslcertserial="0a1dcfa3000000000015"
  ;
run;
```

Example 15: Specify Local Options for Two-Way Encryption in UNIX

Features:

SSLPARMS statement

SSLCERTLOC= system option

SSLPVTKEYLOC= system option

SSLPVTKEYPASS= system option

SSLPKCS12LOC= system option

SSLPKCS12PASS= system option

Details

The following is an example of a PROC HTTP request that specifies local encryption options to send a client certificate for two-way TLS authentication on UNIX. On UNIX, the encryption options that you use depend on whether the certificate is in PEM or DER format. This example shows how to specify the location of PEM and DER certificates for user John Doe.

Note: The paths to the certificates are relative to the location where the web server is running. Therefore, the certificates must be accessible on disk.

For more information about the system options, see *Encryption in SAS*.

SSLPARMS Arguments for a PEM Certificate

The SSLCERTLOC= and SSLPVTKEYLOC= system options specify the location of a PEM certificate. SSLPVTKEYPASS= is specified only if needed.

```
proc http
  method=GET
  url="https://internal.site.com/";
  sslparms
    sslcertloc="/users/johndoe/certificates/server.pem"
    sslpvtkeyloc="/users/johndoe/certificates/serverkey.pem"
    sslpvtkeypass="password"
  ;
run;
```

SSLPARMS Arguments for a DER Certificate

The SSLPKCS12LOC= and SSLPKCS12PASS= system options specify the location of a DER certificate.

Example Code 35.1 *System Options for a DER-Encoded Certificate*

```
proc http
  method=GET
  url=https://internal.site.com/;
  sslparms
    sslpkcs12loc="/users/server/certificates/server.p12"
    sslpkcs12pass="password"
  ;
run;
```

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IMPORT Procedure

Overview: IMPORT Procedure

What Does the IMPORT Procedure Do?

The IMPORT procedure reads data from an external data source and writes it to a SAS data set. In Base SAS 9.4, you can import JMP files and delimited files.

In delimited files, a delimiter (such as a blank, comma, or tab) separates columns of data values. If you license SAS/ACCESS Interface to PC Files, additional external data sources can include Microsoft Access database files, Microsoft Excel files, and Lotus spreadsheets. For more information, see *SAS/ACCESS Interface to PC Files: Reference*.

Starting in SAS 9.4, you can import data from JMP 7 or later files, and JMP variables can be up to 255 characters long. You can also import value labels to a SAS format catalog. Extended attributes are now used automatically, and the META= statement is no longer supported. For more information, see "JMP Files" in *SAS/ACCESS Interface to PC Files: Reference*.

When you run the IMPORT procedure, it reads the input file and writes the data to the specified SAS data set. By default, IMPORT procedure expects the variable names to appear in the first row. The procedure scans the first 20 rows to count the variables, and it attempts to determine the correct informat and format for each variable. You can use the IMPORT procedure's statements to do the following:

- indicate how many rows SAS scans for variables to determine the type and length (GUESSINGROWS=)
- indicate at which row SAS begins to read the data (DATAROW=)
- modify whether SAS extracts the variable names (GETNAMES=).

You can also use these same statements to change the default values.

When the IMPORT procedure reads a delimited file, it generates a DATA step to import the data. You control the results with options and statements that are specific to the input data source. The IMPORT procedure generates the specified output SAS data set and writes information about the import to the SAS log. The log displays the DATA step code that is generated by the IMPORT procedure.

If you need to revise your code after the procedure runs, issue the RECALL command (or press F4) to recall the generated DATA step. At this point, you can add or remove options from the INFILE statement and customize the INFORMAT, FORMAT, and INPUT statements to your data.

If you use this method and modify an informat, also modify the format for that same variable. The informat and format for a given variable also must be of the same type (either character or numeric). In addition, if the type is character, the assigned format should be as long as the variable to avoid truncation when the data is displayed. For example, if a character variable is 400 characters long but has a format of `$char50`, then only the first 50 characters are shown when the data is displayed.

To recall your PROC IMPORT code, issue a second RECALL command (or press F4 again).

Note: By default, the IMPORT procedure reads delimited files as varying record-length files. If your external file has a fixed-length format, use a SAS DATA step with an INFILE statement that includes the RECFM=F and LRECL= options. For more information, see the INFILE statement, RECFM= option in *SAS DATA Step Statements: Reference*.

The **Import Wizard** or the **External File Interface** (EFI) can also be used to import data. They can guide you through the steps to import an external data source. You can use the Import Wizard to generate IMPORT procedure statements, which you can save to a file for subsequent use.

To open the Import Wizard or EFI from the SAS windowing environment, select **File** ⇨ **Import Data**. For more information about the Import Wizard or EFI, see the Base SAS online Help and documentation. For more detail and an example, see "Using SAS Import and Export Wizards" in *SAS/ACCESS Interface to PC Files: Reference*.

Note: EFI does not recognize non-ASCII characters when SAS Registry contains "UseDateStyle"="Yes".

CAUTION
Sequential access is not allowed when you use EFI.

TIP **Sharing Delimited Files Across Hosts:** When a delimited file is read into SAS using the IMPORT procedure, each row must end with a host-specific, end-of-line delimiter. If you share delimited files that were created on one host with another host, the default end-of-line delimiters will not match. When this occurs, you must specify the new host's end-of-line delimiter for your files.

- Microsoft Windows: The default newline delimiter is Carriage Return/Linefeed (CRLF). To read a file that is native to UNIX or Linux, use a FILENAME statement with the TERMSTR=LF option. For more information, see the FILENAME statement in*SAS DATA Step Statements: Reference*.
- UNIX or Linux: The default end-of-row delimiter is Linefeed (LF). To read a file that is native to Windows, use a FILENAME statement with the TERMSTR=CRLF option. For more information, see the FILENAME statement in *SAS DATA Step Statements: Reference*.

Beginning with SAS 9.4M3, PROC IMPORT uses the NLNUM informat instead of the COMMA informat. When you import a file that contains values such as 14,000.01 that have commas, the COMMA informat removes the commas and other non-numeric characters from the numerical values. Removing these characters can cause interpretation errors in the values. NLNUM prevents these errors by using the specified value of the LOCALE system option to interpret numerical values that have commas.

For example, to enter the numerical equivalent of fourteen thousand and one hundredth, a person specifying LOCALE=English_UnitedStates would enter 14,000.01. A person specifying LOCALE=French_France would enter 14.000,01. NLNUM interprets either input value correctly and writes the correct value based on the specified locale. If you read in 14.000,01 with NLNUM and LOCALE=French_France, store it in a data set, and then write it with NLNUM and LOCALE=English_UnitedStates, it is displayed as 14,000.01.

If you want to import a character value such as AAFFGG_ 06JAN2016:10:04:26 into a SAS data set, SAS might try to read it as a date. You can use the Registry Editor window to ensure that SAS imports such values as character values.

1 Type REGEDIT in the SAS command line to open the Registry Editor.

2 Click on **Products** ⇨ **Base** ⇨ **EFI**.

3 Change the value of AllChars to Yes.

For more information, see:

- "COMMAw.d" in *SAS Formats and Informats: Reference*
- "NLNUMw.d Informat" in *SAS National Language Support (NLS): Reference Guide*
- "Overview of Locale Concepts for NLS" in *SAS National Language Support (NLS): Reference Guide*

Format Catalog Encodings in SAS Viya

SAS Viya supports only the UTF-8 encoding.

For more information about the encodings of format catalogs, see *Migrating Data to UTF-8 for SAS Viya* and *SAS Viya FAQ for Processing UTF-8 Data*.

TIP

- Use the XLSX engine to read UTF−8 data. For more information, see "LIBNAME Statement: XLSX Engine" in *SAS/ACCESS Interface to PC Files: Reference*.
- Do not use the `DBMS=xls` option to import spreadsheets that contain UTF-8 data.
- Use Microsoft Excel to convert your .xls spreadsheets to .xlsx spreadsheets before you import them with the `DBMS=xlsx` option.

Support for the VARCHAR Data Type

PROC IMPORT supports the VARCHAR data type in CAS. VARCHAR stores a character variable that can have a varying length. The length that you specify for the variable represents the maximum number of characters that you want to store.

The VARCHAR data type is similar to the CHAR data type. CHAR variables have a length that is measured in terms of bytes. VARCHAR variables have a length that is measured in terms of characters rather than bytes. For information about using

VARCHAR, see “Data Types Supported in the CAS DATA Step” in *SAS Cloud Analytic Services: User’s Guide*.

In the following example, the CAS engine is used with the LENGTH statement to create a VARCHAR variable and a CHAR variable. The VARCHAR variable, X, has a length of 30 and the CHAR variable, Y, also has a length of 30.

```
libname mycas cas;
data mycas.string;
   length x varchar(30);
   length y $30;
   x = 'abc'; y = 'def';
run;
proc contents data=mycas.string; run;
```

Here is the output that the code produces.

The CONTENTS Procedure

Data Set Name	MYCAS.STRING	Observations	1
Member Type	DATA	Variables	2
Engine	CAS	Indexes	0
Created	09/11/2016 13:48:30	Observation Length	48
Last Modified	09/11/2016 13:48:30	Deleted Observations	0
Protection		Compressed	NO
Data Set Type		Sorted	NO
Label			
Data Representation	SOLARIS_X86_64, LINUX_X86_64, ALPHA_TRU64, LINUX_IA64		
Encoding	utf-8 Unicode (UTF-8)		

Engine/Host Dependent Information	
Data Limit	100MB

Alphabetic List of Variables and Attributes

#	Variable	Type	Len
1	x	Varchar	30
2	y	Char	30

External File Interface (EFI) Macro Variables

External File Interface (EFI) macro variables can be used to control how PROC IMPORT reads and interprets character values.

EFI_ALLCHARS=YES | NO

Default NO

Notes The value of EFI_ALLCHARS applies to all PROC IMPORT steps that follow.

The AllChars SAS Registry option has the same effect as the EFI_ALLCHARS macro variable.

Example %let EFI_ALLCHARS=YES;

specifies whether all columns default to a CHAR data type to avoid misinterpretation of a SAS datetime. Beginning in SAS 9.4TS1M4, you can specify the EFI macro variable, EFI_ALLCHARS, which causes PROC IMPORT to define all of the variables as character. Here is an example of how to use EFI_ALLCHARS with PROC IMPORT:

```
%let EFI_ALLCHARS=YES;
proc import datafile='c:\temp\class.csv' out=class dbms=csv replace;
run;
%let EFI_ALLCHARS=NO;
```

Reset the value of EFI_ALLCHARS after the PROC IMPORT step. Otherwise, all PROC IMPORT steps that follow EFI_ALLCHARS=YES define all variables as character.

EFI_MISSING_NUMERICS=YES | NO

Default NO

Note The MissingNumerics SAS Registry option has the same effect as the EFI_MISSING_NUMERICS macro variable.

Example %let EFI_MISSING_NUMERICS=YES;

specifies whether a single period is numeric or character. When MissingNumerics is set to No, the single period is interpreted as a character.

EFI_NOQUOTED_DELIMITER=YES | NO

Default NO

Note The QuotedDelimiter SAS Registry option has the same effect as the EFI_NOQUOTED_DELIMITER macro variable.

Example %let EFI_NOQUOTED_DELIMITER=YES;

specifies whether single quotation marks within a variable value are read as delimiters inside open quotation marks or as part of the variable value. If your variables contain delimiters, or to read in a single quotation mark as part of the variable value, set EFI_NOQUOTED_DELIMITER to Yes.

EFI_QUOTED_NUMERICS=YES | NO

Default NO

Note The QuotedNumerics SAS Registry option has the same effect as the EFI_QUOTED_NUMERICS macro variable.

Example %let EFI_QUOTED_NUMERICS=YES;

specifies whether to read numbers that are enclosed in quotation marks as character or numeric values. When PROC IMPORT reads an external file, values that are enclosed in quotation marks are automatically created as character values. Setting EFI_QUOTED_NUMERICS to Yes enables you to read quoted numbers as numeric. For example, "10MAY14" is a character value, but with

EFI_QUOTED_NUMERICS set to Yes, it becomes 10MAY14, which is a date value.

Syntax: IMPORT Procedure

Restrictions: The IMPORT procedure is available for the following operating environments:

- Microsoft Windows
- UNIX or Linux

A pathname for a file can have a maximum length of 201 characters.

Interaction: All data with the percent sign (%) is considered character data to avoid misinterpretation. Percentage data is considered character data because of the danger of misinterpretation.

Supports: PROC IMPORT supports the CSV, TAB, DLM, and JMP file types in CAS.

Note: You can use PROC IMPORT to import an external file to a SAS data set or to a CAS table.

Tips: Beginning with SAS 9.4M5, PROC IMPORT supports the VARCHAR data type for CAS tables. For more information, see "Support for the VARCHAR Data Type" on page 1326.

Use the XLSX engine to read UTF–8 data. For more information, see "LIBNAME Statement: XLSX Engine" in *SAS/ACCESS Interface to PC Files: Reference*.

Do not use the `DBMS=xls` option to import spreadsheets that contain UTF-8 data.

Use Microsoft Excel to convert your .xls spreadsheets to .xlsx spreadsheets before you import them with `DBMS=xlsx`.

See: "ANYDTDTMw." in *SAS Formats and Informats: Reference*

PROC IMPORT

DATAFILE="*filename*" | TABLE="*tablename*"

OUT=<*libref*.>*SAS data set* <(*SAS data set options*)>

<DBMS=*identifier*> <REPLACE>;

statements for importing from delimited files

DATAROW=*n*;

DELIMITER='*char*' | '*nn*x;

GETNAMES=YES | NO;

GUESSINGROWS=*n* | MAX;

statements for importing from JMP files

DBENCODING=*12-char SAS encoding-value*;

FMTLIB=<*libref*.>*format-catalog*;

META=*libref.member-data-set*;

Statement	Task	Example
PROC IMPORT	Import an external data file to a SAS data set	Ex. 1, Ex. 2, Ex. 3, Ex. 4
DATAROW	Start reading data from a specific row in the delimited text file	Ex. 3
DBENCODING	Indicate the encoding character set to use for the JMP file	
DELIMITER	Specify the delimiter that separates columns of data in the input file	Ex. 1, Ex. 3, Ex. 4
FMTLIB	Save value labels to the specified SAS format catalog	
GETNAMES	Generate SAS variable names from the data values in the first row in the input file	Ex. 1, Ex. 2
GUESSINGROWS	Specify the number of rows of the input file to scan to determine the appropriate data type and length for the variables	
META	Save JMP metadata information to the specified SAS data set	

PROC IMPORT Statement

Imports an external data file to a SAS data set.

Restriction: A pathname for a file can have a maximum length of 201 characters.

Tips: Beginning with SAS Viya 3.5, PROC IMPORT supports all access types that are available in the FILENAME statement.

Beginning with SAS 9.4M5, PROC IMPORT supports the VARCHAR data type for CAS tables. For more information, see "Support for the VARCHAR Data Type" on page 1326.

Use the XLSX engine to read UTF–8 data. For more information, see "LIBNAME Statement: XLSX Engine" in *SAS/ACCESS Interface to PC Files: Reference*.

Do not use the `DBMS=xls` option to import spreadsheets that contain UTF-8 data.

Use Microsoft Excel to convert your .xls spreadsheets to .xlsx spreadsheets before you import them with `DBMS=xlsx`.

Syntax

PROC IMPORT

DATAFILE="*filename* " | TABLE="*tablename* "

OUT=<*libref .>SAS data set* <(*SAS data set options*)>
<DBMS=*identifier*> <REPLACE>;

Summary of Optional Arguments

DBMS=*identifier*
: specifies the type of data to import.

REPLACE
: overwrites an existing SAS data set.

SAS data set options
: specifies SAS data set options.

Required Arguments

DATAFILE="*filename*" | "*fileref*"
specifies the complete path and filename or fileref for the input PC file, spreadsheet, or delimited external file. A fileref is a SAS name that is associated with the physical location of the output file. To assign a fileref, use the FILENAME statement. For more information about the FILENAME statement, see *SAS Global Statements: Reference*. For more information about PC file formats, see *SAS/ACCESS Interface to PC Files: Reference*

If you specify a fileref or if the complete path and filename does not include special characters such as the backslash in a path, lowercase characters, or spaces, then you can omit the quotation marks.

Alias
: FILE=

Restrictions
: The IMPORT procedure does not support device types or access methods for the FILENAME statement except for DISK. For example, the IMPORT procedure does not support the TEMP device type, which creates a temporary external file.

  The IMPORT procedure can import data only if SAS supports the data type. SAS supports numeric and character types of data but not (for example) binary objects. If the data that you want to import is a type that SAS does not support, the IMPORT procedure might not be able to import it correctly. In many cases, the procedure attempts to convert the data to the best of its ability. However, conversion is not possible for some types.

Interactions
: By default, the IMPORT procedure reads delimited files as varying record-length files. If your external file has a fixed-length format, use a SAS DATA step with an INFILE statement that includes the RECFM=F and LRECL= options. For more information, see the INFILE statement.

  When you use a *fileref* to specify a delimited file to import, the logical record length (LRECL) defaults to 256, unless you specify

the LRECL= option in the FILENAME statement. The maximum LRECL that the IMPORT procedure supports is 32767.

For delimited files, the first 20 rows are scanned to determine the variable attributes. You can increase the number of rows that are scanned by using the GUESSINGROWS= statement. All values are read in as character strings. If a Date and Time format or a numeric informat can be applied to the data value, the type is declared as numeric. Otherwise, the type remains character.

Examples "Example 1: Importing a Delimited File" on page 1339

"Example 2: Importing a Specific Delimited File Using a Fileref" on page 1342

"Example 3: Importing a Tab-Delimited File" on page 1345

"Example 4: Importing a Comma-Delimited File with a CSV Extension" on page 1349

OUT=<*libref.*>*SAS data set*

identifies the output SAS data set with either a one or two-level SAS name (library and member name). If the specified SAS data set does not exist, the IMPORT procedure creates it. If you specify a one-level name, by default the IMPORT procedure uses either the USER library (if assigned) or the WORK library (if USER is not assigned).

In the first maintenance release of SAS 9.4, a SAS data set name can contain a single quotation mark when the VALIDMEMNAME=EXTEND system option is also specified. Using VALIDMEMNAME= expands the rules for the names of certain SAS members, such as a SAS data set name. For more information, see "Rules for SAS Data Set Names, View Names, and Item Store Names" in *SAS Language Reference: Concepts*.

Examples "Example 1: Importing a Delimited File" on page 1339

"Example 2: Importing a Specific Delimited File Using a Fileref" on page 1342

"Example 3: Importing a Tab-Delimited File" on page 1345

"Example 4: Importing a Comma-Delimited File with a CSV Extension" on page 1349

TABLE="*tablename*"

specifies the name of the input DBMS table. If the name does not include special characters (such as question marks), lowercase characters, or spaces, you can omit the quotation marks. Note that the DBMS table name might be case sensitive.

Requirements You must have a license for SAS/ACCESS Interface to PC Files to import from a DBMS table.

When you import a DBMS table, you must specify the DBMS= option.

Optional Arguments

DBMS=*identifier*

specifies the type of data to import. You can import delimited files or JMP files (DBMS=JMP) in Base SAS. The JMP file format must be Version 7 or later, and JMP variable names can be up to 255 characters long. SAS supports importing JMP files that have more than 32,767 variables.

To import a tab-delimited file, specify TAB as the identifier. To import any other delimited file that does not end in .CSV, specify DLM as the identifier. For a comma-separated file with a .CSV extension, DBMS= is optional. The IMPORT procedure recognizes .CSV as an extension for a comma-separated file.

The DBMS argument is required if you are importing a file that does not have an extension, and the data is delimited by tabs. It is also required if you are importing a TXT file that has data that is delimited with a comma.

The following values are valid for the DBMS identifier.

Table 36.1 *DBMS Identifiers Supported in Base SAS*

Identifier	Output Data Source	Extension
CSV	Delimited file (comma-separated values)	.csv
DLM	Delimited file (default delimiter is a blank)	.dat or .txt
JMP	JMP files, Version 7 or later format	.jmp
TAB	Delimited file (tab-delimited values)	.txt

See Table 23.66 on page 855 for more information about identifiers for this option.

"LIBNAME Statement: Options for Excel and Access Engines" in *SAS/ACCESS Interface to PC Files: Reference* for a list of additional DBMS values when using SAS/ACCESS Interface to PC Files.

"DELIMITER Statement" on page 1335

Examples "Example 1: Importing a Delimited File" on page 1339

"Example 2: Importing a Specific Delimited File Using a Fileref" on page 1342

"Example 3: Importing a Tab-Delimited File" on page 1345

"Example 4: Importing a Comma-Delimited File with a CSV Extension" on page 1349

REPLACE

overwrites an existing SAS data set. If you omit REPLACE, the IMPORT procedure does not overwrite an existing data set.

CAUTION

Using the IMPORT procedure with the REPLACE option to write to an existing SAS generation data set causes the most recent (base) generation data set or group of generation data sets to be deleted.

If you write to an existing generation data set using the IMPORT procedure with the REPLACE option and you do one of the following:

- specify the GENMAX= data set option to increase or decrease the number of generations, then all existing generations are deleted and replaced with a single new base generation data set
- omit the GENMAX= data set option, then all existing generations are deleted and replaced with a single new data set by the same name, but it is not a generation data set

Instead, use a SAS DATA step with the REPLACE= data set option to replace a permanent SAS data set and to maintain the generation group for that SAS data set. For more information, see "Understanding Generation Data Sets" in *SAS Language Reference: Concepts*.

Examples "Example 1: Importing a Delimited File" on page 1339

"Example 2: Importing a Specific Delimited File Using a Fileref" on page 1342

"Example 3: Importing a Tab-Delimited File" on page 1345

"Example 4: Importing a Comma-Delimited File with a CSV Extension" on page 1349

SAS data set options

specifies SAS data set options. For example, to assign a password to the resulting SAS data set, you can use the ALTER=, PW=, READ=, or WRITE= data set option. To import only data that meets a specified condition, you can use the WHERE= data set option.

Restriction You cannot specify data set options when importing delimited, comma-separated, or tab-delimited external files.

See *SAS Data Set Options: Reference*

DATAROW Statement

Starts reading data from the specified row number in the delimited text file.

Default: When GETNAMES=NO: 1, when GETNAMES=YES: 2

Restriction: When GETNAMES=NO, DATAROW must be equal to or greater than 1. When GETNAMES=YES, DATAROW must be equal to or greater than 2.

Interaction: The DATAROW statement is valid only for delimited and XLSX files.

See: "GETNAMES Statement" on page 1337

Example: "Example 3: Importing a Tab-Delimited File" on page 1345

Syntax

DATAROW=*n*;

Required Argument

n
specifies the row number in the input file for the IMPORT procedure to start reading data.

DBENCODING Statement

Indicates the encoding character set to use for the JMP file.

Interaction: The DBENCODING statement is valid only when DBMS=JMP.

Syntax

DBENCODING=*12-char SAS encoding-value*;

Required Argument

12-char SAS encoding-value
indicates the encoding to use with JMP files. Encoding maps each character in a character set to a unique numeric representation, which results in a table of code points. A single character can have different numeric representations in different encodings. This value can be up to 12 characters long.

DELIMITER Statement

Specifies the delimiter that separates columns of data in the input file.

Defaults: Comma for .CSV files
Blank space for all other file types

Interaction: If you specify DBMS=DLM, you must also specify the DELIMITER= statement.

See: Table 36.77 on page 1333 for a list of DBMS identifiers supported in Base SAS.
"DBMS=*identifier*" on page 1333

Example: "Example 1: Importing a Delimited File" on page 1339

Syntax

DELIMITER=*char'' | 'nnx*;

Required Argument

***char* | *'nn'*x**

specifies the delimiter that separates columns of data in the input file. You can specify the delimiter as a single character or as a hexadecimal value. For example, if columns of data are separated by an ampersand, specify DELIMITER='&'.

Note: If you omit DELIMITER=, the IMPORT procedure assumes that the delimiter is a space.

The DELIMITER statement is required when you import a file that meets any of these criteria:

- a file that does not have a file extension
- a file that has a .TXT extension and contains data that is delimited by anything other than tabs
- a file that has a .TXT, .CSV, or .JMP extension and contains data that is delimited by blank spaces

This example shows how to use the DBMS argument and the DELIMITER statement to specify a comma delimiter for a file that has a .TXT extension.

```
proc import datafile="C:\temp\test.txt"
   out=test
   dbms=dlm
   replace;
   delimiter=',';
run;
```

FMTLIB Statement

Saves value labels to the specified SAS format catalog.

Interaction: The FMTLIB statement is valid only when DBMS=JMP.

Syntax

FMTLIB=<*libref.>format-catalog*;

Required Argument

<libref.>format-catalog
specifies the format catalog where the value labels are saved.

GETNAMES Statement

Specifies whether the IMPORT procedure generates SAS variable names from the data values in the first row in the input file.

Default: YES

Restrictions: Valid only with the IMPORT procedure.

If VALIDVARNAME=ANY is used, GETNAMES= might not prefix an underscore to the data value.

Interaction: The GETNAMES statement is valid only for delimited files.

Examples: "Example 1: Importing a Delimited File" on page 1339
"Example 2: Importing a Specific Delimited File Using a Fileref" on page 1342
"Example 4: Importing a Comma-Delimited File with a CSV Extension" on page 1349

Syntax

GETNAMES=YES | NO;

Required Argument

YES | NO

YES specifies that the IMPORT procedure generate SAS variable names from the data values in the first row of the imported delimited file.

NO specifies that the IMPORT procedure generate SAS variable names as VAR1, VAR2, and so on.

Note: If a data value in the first row in the input file is read and it contains special characters that are not valid in a SAS name, such as a blank, then SAS converts the character to an underscore. For example, the variable name `Occupancy Code` would become the SAS variable name `Occupancy_Code`. Because SAS variable names cannot begin with a number, GETNAMES= prefixes an underscore to a variable name rather than replace the value's first character. For example, `2014.CHANGES` becomes `_2014_CHANGES`.

GUESSINGROWS Statement

Specifies the number of rows of the file to scan to determine the appropriate data type and length for the variables.

Default: 20

Restriction: This value should be greater than the value specified for DATAROW.

Interaction: The GUESSINGROWS statement is valid only for delimited files.

Syntax

GUESSINGROWS=*n* | MAX;

Required Arguments

n
indicates the number of rows the IMPORT procedure scans in the input file to determine the appropriate data type and length of variables. The range is 1 to 2147483647 (or MAX). The scan data process scans from row 1 to the number that is specified by the GUESSINGROWS option.

Note: You can change the default row value in the SAS Registry. From the SAS command line, enter `regedit`. When the **Registry Editor** opens, select **Products** ⇨ **BASE** ⇨ **EFI** ⇨ **GuessingRows**.

MAX
can be specified instead of 2147483647. Specifying the maximum value could adversely affect performance.

META Statement

Saves JMP metadata information to the specified SAS data set. (Deprecated)

Interaction: The META statement is valid only when DBMS=JMP.

Syntax

META=*libref.member-data-set*;

Required Argument

libref.member-data-set
specifies the SAS data set that contains the metadata information is to be written.

The META statement is no longer supported for importing a JMP file and is ignored. Instead, extended attributes are automatically used. When importing a JMP file with extended attributes, the attributes are automatically attached to the new SAS data set.

The META statement can remain in programs, yet it generates a NOTE in the log saying that META has been replaced by extended attributes and is ignored.

Examples: IMPORT Procedure

Example 1: Importing a Delimited File

Features:

PROC IMPORT statement options
- DATAFILE=
- DBMS=
- GETNAMES=
- OUT=
- REPLACE

DELIMITER= statement

OPTIONS statement

PRINT procedure

Details

This example imports the following delimited external file and creates a temporary SAS data set named WORK.MYDATA:

```
Region&State&Month&Expenses&Revenue
Southern&GA&JAN2001&2000&8000
Southern&GA&FEB2001&1200&6000
Southern&FL&FEB2001&8500&11000
Northern&NY&FEB2001&3000&4000
Northern&NY&MAR2001&6000&5000
Southern&FL&MAR2001&9800&13500
```

```
Northern&MA&MAR2001&1500&1000
;
```

Program

```
options nodate ps=60 ls=80;

proc import datafile="C:\My Documents\myfiles\delimiter.txt"
            dbms=dlm
            out=mydata
            replace;

     delimiter='&';

     getnames=yes;

run;


proc print data=mydata;
run;
```

Program Description

Set your system options. The NODATE option suppresses the display of the date and time in the output. The LINESIZE= option specifies the output line length, and the PAGESIZE= option specifies the number of lines on an output page.

```
options nodate ps=60 ls=80;
```

Specify the input file. Specify that the input file is a delimited file. Replace the data set if it exists. Identify the output SAS data set.

```
proc import datafile="C:\My Documents\myfiles\delimiter.txt"
            dbms=dlm
            out=mydata
            replace;
```

Specify delimiter as an & (ampersand).

```
     delimiter='&';
```

Generate variable names from first row of data.

```
     getnames=yes;

run;
```

Print out the output data set.

```
proc print data=mydata;
run;
```

Log

The SAS log displays information about the successful import. For this example, the IMPORT procedure generates a SAS DATA step, as shown in the partial log that follows.

Example Code 36.1 *External File Imported to Create a SAS Data Set*

```
1    options nodate ps=60 ls=80; proc import datafile="C:\My
1  ! Documents\myfiles\delimiter.txt" dbms=dlm out=mydata replace; delimiter='&'
1  !  delimiter='&'; getnames=yes;run;

2     /*************************************************************************
3     *   PRODUCT:   SAS
4     *   VERSION:   9.3
5     *   CREATOR:   External File Interface
6     *   DATE:      31JAN11
7     *   DESC:      Generated SAS Datastep Code
8     *   TEMPLATE SOURCE:  (None Specified.)
9     *************************************************************************/
10       data WORK.MYDATA    ;
11       %let _EFIERR_ = 0; /* set the ERROR detection macro variable */
12       infile 'C:\My Documents\myfiles\delimiter.txt' delimiter = '&' MISSOVER
12 !  DSD lrecl=32767 firstobs=2 ;
13          informat Region $8. ;
14          informat State $2. ;
15          informat Month MONYY7. ;
16          informat Expenses best32. ;
17          informat Revenue best32. ;
18          format Region $8. ;
19          format State $2. ;
20          format Month MONYY7. ;
21          format Expenses best12. ;
22          format Revenue best12. ;
23       input
24                   Region $
25                   State $
26                   Month
27                   Expenses
28                   Revenue
29       ;
30       if _ERROR_ then call symputx('_EFIERR_',1);  /* set ERROR detection
30 ! macro variable */
31       run;

NOTE: The infile 'C:\My Documents\myfiles\delimiter.txt' is:
      Filename=C:\My Documents\myfiles\delimiter.txt,
      RECFM=V,LRECL=32767,File Size (bytes)=254,
      Last Modified=31Jan2011:11:44:29,
      Create Time=31Jan2011:11:44:29

NOTE: 7 records were read from the infile 'C:\My Documents\myfiles\delimiter.txt'.
      The minimum record length was 29.
      The maximum record length was 30.
NOTE: The data set WORK.MYDATA has 7 observations and 5 variables.
NOTE: DATA statement used (Total process time):
      real time           0.06 seconds
      cpu time            0.03 seconds

7 rows created in WORK.MYDATA from C:\My Documents\myfiles\delimiter.txt.

NOTE: WORK.MYDATA data set was successfully created.
```

Output

Output 36.1 *Data Set Work.MyData*

The SAS System

Obs	Region	State	Month	Expenses	Revenue
1	Southern	GA	JAN2001	2000	8000
2	Southern	GA	FEB2001	1200	6000
3	Southern	FL	FEB2001	8500	11000
4	Northern	NY	FEB2001	3000	4000
5	Northern	NY	MAR2001	6000	5000
6	Southern	FL	MAR2001	9800	13500
7	Northern	MA	MAR2001	1500	1000

Example 2: Importing a Specific Delimited File Using a Fileref

Features:

PROC IMPORT statement options
- DATAFILE=
- DBMS=
- GETNAMES=
- OUT=
- REPLACE

FILENAME statement

PRINT procedure

Details

This example imports the following space-delimited file and creates a temporary SAS data set named Work.States.

```
Region State Capital Bird
South Georgia Atlanta 'Brown Thrasher'
South 'North Carolina' Raleigh Cardinal
North Connecticut Hartford Robin
West Washington Olympia 'American Goldfinch'
Midwest Illinois Springfield Cardinal
```

Program

```
filename stdata 'c:\temp\state_data.txt' lrecl=100;

proc import datafile=stdata
        dbms=dlm
        out=states
        replace;
     delimiter=' ';
     getnames=yes;
run;

proc print data=states;
run;
```

Program Description

Specify a filename.

```
filename stdata 'c:\temp\state_data.txt' lrecl=100;
```

Specify the input file. Specify the input file is a delimited file. Replace the data set if it exists. Identify the output SAS data set.

```
proc import datafile=stdata
        dbms=dlm
        out=states
        replace;
```

Specify a blank value for the DELIMITER statement. Generate variable names from the first row of data with the GETNAMES statement.

```
     delimiter=' ';
     getnames=yes;
run;
```

Print out the data set.

```
proc print data=states;
run;
```

Log

The SAS log displays information about the successful import. For this example, the IMPORT procedure generates a SAS DATA step, as shown in the partial log that follows.

Example Code 36.2 *Importing a Specific Delimited File Using a Fileref*

```
324  filename stdata 'c:\myfiles\state_data.txt' lrecl=100;
325
326  proc import datafile=stdata
327              dbms=dlm
328              out=states
329              replace;
330       delimiter=' ';
331       getnames=yes;
332
333  run;

334   /*********************************************************************
335   *   PRODUCT:   SAS
336   *   VERSION:   9.4
337   *   CREATOR:   External File Interface
338   *   DATE:      18APR14
339   *   DESC:      Generated SAS Datastep Code
340   *   TEMPLATE SOURCE:  (None Specified.)
341   *********************************************************************/
342      data WORK.STATES    ;
343      %let _EFIERR_ = 0; /* set the ERROR detection macro variable */
344      infile STDATA delimiter = ' ' MISSOVER DSD lrecl=32767 firstobs=2 ;
345         informat Region $7. ;
346         informat State $16. ;
347         informat Capital $11. ;
348         informat Bird $20. ;
349         format Region $7. ;
350         format State $16. ;
351         format Capital $11. ;
352         format Bird $20. ;
353      input
354                  Region $
355                  State $
356                  Capital $
357                  Bird $
358      ;
359      if _ERROR_ then call symputx('_EFIERR_',1);  /* set ERROR detection
359! macro variable */
360      run;

NOTE: The infile STDATA is:
      Filename=c:\myfiles\state_data.txt,
      RECFM=V,LRECL=32767,File Size (bytes)=225,
      Last Modified=15Apr2014:11:27:14,
      Create Time=15Apr2014:11:25:38

NOTE: 5 records were read from the infile STDATA.
      The minimum record length was 32.
      The maximum record length was 44.
NOTE: The data set WORK.STATES has 5 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.03 seconds
      cpu time            0.03 seconds


5 rows created in WORK.STATES from STDATA.



NOTE: WORK.STATES data set was successfully created.
```

Output

Output 36.2 *Work.States Data Set*

The SAS System

Obs	Region	State	Capital	Bird
1	South	Georgia	Atlanta	Brown Thrasher
2	South	North Carolina	Raleigh	Cardinal
3	North	Connecticut	Hartford	Robin
4	West	Washington	Olympia	American Goldfinch
5	Midwest	Illinois	Springfield	Cardinal

Example 3: Importing a Tab-Delimited File

Features:

PROC IMPORT statement options
- DATAFILE=
- DATAROW=
- DBMS=
- OUT=
- REPLACE

DELIMITER= statement

PRINT procedure

Details

This example imports the following tab-delimited file and creates a temporary SAS data set named Work.Class.

Input Data 36.1 *Input*

```
Name     Gender   Age
Joyce    F        11
Thomas   M        11
Jane     F        12
Louise   F        12
James    M        12
John     M        12
Robert   M        12
Alice    F        13
```

```
Barbara  F        13
Jeffery  M        13
Carol    F        14
Judy     F        14
Alfred   M        14
Henry    M        14
Jenet    F        15
Mary     F        15
Ronald   M        15
William  M        15
Philip   M        16
```

Program

```
proc import datafile='C:\userid\pathname\Class.txt'
            out=class
            dbms=dlm
            replace;

       datarow=5;

     delimiter='09'x;
run;

proc print data=class;
run;
```

Program Description

Specify the input file. The GETNAMES= option defaults to 'yes'. Specify the input file as a delimited file. Replace the data set if it exists. Specify the output data set.

```
proc import datafile='C:\userid\pathname\Class.txt'
            out=class
            dbms=dlm
            replace;
```

The first row read will be row 5 due to the DATAROW= option specification.

```
       datarow=5;
```

Specify the delimiter. On an ASCII platform, the hexadecimal representation of a tab is `'09'x`. On an EBCDIC platform, the hexadecimal representation of a tab is a `'05'x`.

```
     delimiter='09'x;
run;
```

Print out the output data set.

```
proc print data=class;
run;
```

Log

The SAS log displays information about the successful import. For this example, the IMPORT procedure generates a SAS DATA step, as shown in the partial log that follows.

Example Code 36.3 *Importing a Tab-Delimited File*

```
1    proc import datafile='C:\userid\pathname\Class.txt'
2                out=class
3                dbms=dlm
4                replace;
5             datarow=5;
6           delimiter='09'x;
7    run;
8     /*************************************************************************
9     *   PRODUCT:   SAS
10    *   VERSION:   9.4
11    *   CREATOR:   External File Interface
12    *   DATE:      04DEC18
13    *   DESC:      Generated SAS Datastep Code
14    *   TEMPLATE SOURCE:  (None Specified.)
15    *************************************************************************/
16       data WORK.CLASS    ;
17       %let _EFIERR_ = 0; /* set the ERROR detection macro variable */
18       infile 'C:\userid\pathname\Class.txt' delimiter='09'x MISSOVER DSD
lrecl=32767
18 ! firstobs=5 ;
19          informat Name $7. ;
20          informat Gender $1. ;
21          informat Age $3. ;
22          format Name $7. ;
23          format Gender $1. ;
24          format Age $3. ;
25       input
26                   Name  $
27                   Gender  $
28                   Age  $
29       ;
30       if _ERROR_ then call symputx('_EFIERR_',1);  /* set ERROR detection macro
variable */
31       run;

NOTE: The infile 'C:\userid\pathname\Class.txt' is:
      Filename=C:\userid\pathname\Class.txt,
      RECFM=V,LRECL=32767,File Size (bytes)=253,
      Last Modified=26Nov2018:14:06:26,
      Create Time=26Nov2018:13:50:27

NOTE: 16 records were read from the infile 'C:\userid\pathname\Class.txt'.
      The minimum record length was 9.
      The maximum record length was 12.
NOTE: The data set WORK.CLASS has 16 observations and 3 variables.
NOTE: DATA statement used (Total process time):
      real time           0.04 seconds
      cpu time            0.01 seconds


16 rows created in WORK.CLASS from C:\userid\pathname\Class.txt.



NOTE: WORK.CLASS data set was successfully created.
NOTE: The data set WORK.CLASS has 16 observations and 3 variables.
NOTE: PROCEDURE IMPORT used (Total process time):
      real time           0.45 seconds
      cpu time            0.20 seconds
```

Output

Output 36.3 *Work.Class Data Set*

The SAS System

Obs	Name	Gender	Age
1	Louise	F	12
2	James	M	12
3	John	M	12
4	Robert	M	12
5	Alice	F	13
6	Barbara	F	13
7	Jeffery	M	13
8	Carol	F	14
9	Judy	F	14
10	Alfred	M	14
11	Henry	M	14
12	Jenet	F	15
13	Mary	F	15
14	Ronald	M	15
15	William	M	15
16	Philip	M	16

Example 4: Importing a Comma-Delimited File with a CSV Extension

Features:

PROC IMPORT statement options
- DATAFILE=
- DBMS=
- GETNAMES=
- OUT=
- REPLACE

PRINT procedure

Details

This example imports the following comma-delimited file and creates a temporary SAS data set named Work.Shoes.

Note: In SAS, the default delimiter for a CSV file is a comma.

```
"Africa","Boot","Addis Ababa","12","$29,761","$191,821","$769"
"Asia","Boot","Bangkok","1","$1,996","$9,576","$80"
"Canada","Boot","Calgary","8","$17,720","$63,280","$472"
"Central America/Caribbean","Boot","Kingston","33","$102,372","$393,376","$4,454"
"Eastern Europe","Boot","Budapest","22","$74,102","$317,515","$3,341"
"Middle East","Boot","Al-Khobar","10","$15,062","$44,658","$765"
"Pacific","Boot","Auckland","12","$20,141","$97,919","$962"
"South America","Boot","Bogota","19","$15,312","$35,805","$1,229"
"United States","Boot","Chicago","16","$82,483","$305,061","$3,735"
"Western Europe","Boot","Copenhagen","2","$1,663","$4,657","$129"
```

Program

```
proc import datafile="C:\temp\test.csv"
        out=shoes
        dbms=csv
        replace;


     getnames=no;
run;

proc print data=work.shoes;
run;
```

Program Description

Specify the input data file. Replace the data set if it exists. Specify the output data set.

```
proc import datafile="C:\temp\test.csv"
        out=shoes
        dbms=csv
        replace;
```

Setting the GETNAMES= option to 'no' causes the variable names in record 1 are not used.

```
     getnames=no;
run;
```

Print the data set.

```
proc print data=work.shoes;
run;
```

Log

The SAS log displays information about the successful import. For this example, the IMPORT procedure generates a SAS DATA step, as shown in the partial log that follows.

Example Code 36.4 *Importing a Comma-Delimited File*

```
457  proc import datafile="C:\myfiles\test.csv"
458       dbms=csv
459       out=shoes
460       replace;
461       getnames=no;
462  run;

463   /*********************************************************************
464   *   PRODUCT:   SAS
465   *   VERSION:   9.4
466   *   CREATOR:   External File Interface
467   *   DATE:      18APR14
468   *   DESC:      Generated SAS Datastep Code
469   *   TEMPLATE SOURCE:  (None Specified.)
470   *********************************************************************/
471      data WORK.SHOES    ;
472      %let _EFIERR_ = 0; /* set the ERROR detection macro variable */
473      infile 'C:\myfiles\test.csv' delimiter = ',' MISSOVER DSD lrecl=32767 ;
474         informat VAR1 $27. ;
475         informat VAR2 $6. ;
476         informat VAR3 $13. ;
477         informat VAR4 $4. ;
478         informat VAR5 $10. ;
479         informat VAR6 $10. ;
480         informat VAR7 $8. ;
481         format VAR1 $27. ;
482         format VAR2 $6. ;
483         format VAR3 $13. ;
484         format VAR4 $4. ;
485         format VAR5 $10. ;
486         format VAR6 $10. ;
487         format VAR7 $8. ;
488      input
489                  VAR1 $
490                  VAR2 $
491                  VAR3 $
492                  VAR4 $
493                  VAR5 $
494                  VAR6 $
495                  VAR7 $
496      ;
497      if _ERROR_ then call symputx('_EFIERR_',1);  /* set ERROR detection
497! macro variable */
498      run;

NOTE: The infile 'C:\myfiles\test.csv' is:
      Filename=C:\myfiles\test.csv,
      RECFM=V,LRECL=32767,File Size (bytes)=657,
      Last Modified=18Apr2014:10:34:47,
      Create Time=18Apr2014:10:33:23

NOTE: 10 records were read from the infile 'C:\myfiles\test.csv'.
      The minimum record length was 51.
      The maximum record length was 81.
NOTE: The data set WORK.SHOES has 10 observations and 7 variables.
```

Output

Output 36.4 *Work.Shoes Data Set*

The SAS System

Obs	VAR1	VAR2	VAR3	VAR4	VAR5	VAR6	VAR7
1	Africa	Boot	Addis Ababa	12	$29,761	$191,821	$769
2	Asia	Boot	Bangkok	1	$1,996	$9,576	$80
3	Canada	Boot	Calgary	8	$17,720	$63,280	$472
4	Central America/Caribbean	Boot	Kingston	33	$102,372	$393,376	$4,454
5	Eastern Europe	Boot	Budapest	22	$74,102	$317,515	$3,341
6	Middle East	Boot	Al-Khobar	10	$15,062	$44,658	$765
7	Pacific	Boot	Auckland	12	$20,141	$97,919	$962
8	South America	Boot	Bogota	19	$15,312	$35,805	$1,229
9	United States	Boot	Chicago	16	$82,483	$305,061	$3,735
10	Western Europe	Boot	Copenhagen	2	$1,663	$4,657	$129

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JAVAINFO Procedure

Overview: JAVAINFO Procedure

What Does the JAVAINFO Procedure Do?

The JAVAINFO procedure conveys diagnostic information to the user about the Java environment that SAS is using. The diagnostic information can be used to confirm that the SAS Java environment has been configured correctly, and can be helpful when reporting problems to SAS technical support. Also, PROC JAVAINFO is often used to verify that the SAS Java environment is working correctly because PROC JAVAINFO uses Java to report its diagnostics.

Syntax: JAVAINFO Procedure

PROC JAVAINFO <*options*>;

Statement	Task
PROC JAVAINFO	Display diagnostic information about the SAS Java environment

PROC JAVAINFO Statement

Displays diagnostic information about the SAS Java environment.

Interaction: When a SAS server is in a locked-down state, the JAVAINFO procedure does not execute. For more information, see "SAS Processing Restrictions for Servers in a Locked-Down State" in *SAS Language Reference: Concepts*.

Syntax

PROC JAVAINFO <*options*>;

Optional Arguments

ALL
lists current information about the SAS Java environment.

CLASSPATHS
lists information about the classpaths that Java is using.

HELP
provides usage assistance in using the JAVAINFO procedure.

JREOPTIONS
lists the Java properties that are set when the JREOPTIONS configuration option is specified.

- When used in PROC JAVAINFO, JREOPTIONS specifies the JREOPTIONS Java properties that are set when Java is started.
- When used in PROC OPTIONS, JREOPTIONS specifies the Java options that are in the configuration file when SAS is started.

Note: SAS.cfg is the configuration file specified during installation, but other configuration files can be specified.

OS
lists information about the operating system that SAS is running under.

version
lists the Java Runtime Environment (JRE) that SAS is using.

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JSON Procedure

Overview: JSON Procedure

What Does the JSON Procedure Do?

The JSON procedure reads data from a SAS data set and writes it to an external file in JSON[1] representation. You can control the exported data with several options that remove content and affect the format. In addition to exporting data from a SAS data set, PROC JSON provides statements that enable you to write additional data to the external file and control JSON containers.

SAS provides the JSON engine to read a JSON file. For more information, see "LIBNAME Statement: JSON Engine" in *SAS Global Statements: Reference*.

Concepts: JSON Procedure

JSON Output File Containers

Structure of the JSON Output File

The JSON output file consists of a minimum of one container, which is referred to as the top-level container. All of the data, metadata, and additional containers are within the top-level container. The type of top-level container is determined by the statement that immediately follows the PROC JSON statement and the options that are enabled in that statement.

1. Java Script Object Notation (JSON) is a text-based, open standard data format that is designed for human-readable data interchange. JSON is based on a subset of the JavaScript programming language and uses JavaScript syntax for describing data objects.

JSON Containers

JSON output consists of two types of data structure containers:

JSON object container ({ })
: begins with a left brace ({) and ends with a right brace (}). An object container collects key-value pairs that are written as pairs of names and values. A value can be any of the supported JSON data types, an object, or an array. Each name is followed a colon and then the value. The key-value pairs are separated by a comma.

JSON array container ([ ])
: begins with a left bracket ([) and ends with a right bracket (]). An array container collects a list of values that are written as a list of values without names. A value can be any of the supported JSON data types, an object, or an array. Values are separated by a comma.

Creating Object Containers

The following statements create object containers:

- The EXPORT statement with default options enabled implicitly opens an object container as the top-level container. This object container is implicitly opened and automatically closed.

```
proc json out="example.json";
   export sashelp.class (where=(age=11));
...
```

- The WRITE VALUES statement opens an object container as the top-level container when it is the first statement after the PROC JSON statement. This object container is implicitly opened and automatically closed.

```
proc json out="example.json";
   write values "container" "object";
   write values "created" "implicitly";
...
```

- The WRITE OPEN OBJECT statement explicitly opens an object container, which you must explicitly close with the WRITE CLOSE statement.

```
proc json out="example.json"
   write open object;
   write values "container" "object";
   write values "created" "explicitly";
   write close;
...
```

Creating Array Containers

The following statements create array containers:

- The EXPORT statement with the NOSASTAGS option enabled opens an array container as the top-level container when it is the first statement after the PROC JSON statement. This top-level array container is implicitly opened and automatically closed.

```
proc json out="example.json";
   export sashelp.class (where=(age=11)) / nosastags;
...
```

- The WRITE OPEN ARRAY statement explicitly opens an array container, which you must explicitly close with the WRITE CLOSE statement.

```
proc json out="example.json";
   write open array;
   write values "container" "array";
   write values "created" "explictly";
   write close;
...
```

Nesting Containers

The top-level container can include any number of containers. Containers, likewise, can nest containers to an arbitrary depth. When nesting containers, be careful to observe the data structure requirements of the current container.

- Objects require a list of key-value pairs, where the value can itself be an object or array.
- Arrays have no such structural requirement of key-value pairs and are merely a list of values, objects, or arrays.
- The WRITE VALUES statement or statements for an object container must result in an even number of values, and the name portion of the key-value pair must be a string.

In this example, an array is nested within an implicitly opened object:

```
proc json out="example.json";
   write values "level" 1;              /* implicit open of object         */
   write values "container" "object";   /* write data to object            */
   write values "created" "implicitly"; /* write data to object            */
   write values "nest";                 /* required string to start object */
   write open array;                    /* explicit open of array          */
   write values "level" 2;              /* write data to array             */
   write values "container" "array";    /* write data to array             */
   write values "created" "explicitly"; /* write data to array             */
   write close;                         /* close explicit open             */
```

```
run;
```

```
{"level":1,"container":"object","created":"implicitly","nest":["level",2,
"container","array","created","explicitly"]}
```

In this example, the exported data is nested within three array containers.

```
proc json out="example.json";
   write open array;                                /* explicit open of array */
   write values "level" 1;                          /* write data to array    */
   write values "container" "array";                /* write data to array    */
   write values "created" "explicitly";             /* write data to array    */
   write open array;                                /* explicit open of array */
   write values "level" 2;                          /* write data to array    */
   write values "container" "array";                /* write data to array    */
   write values "created" "explicitly";             /* write data to array    */
   export sashelp.class (where=(age=11))/nokeys;    /* export SAS data  */
   write close;                                     /* close explicit open    */
   write close;                                     /* close explicit open    */
run;
```

```
["level",1,"container","array","created","explicitly",["level",2,"container",
"array","created","explicitly","SASJSONExport","1.0 NOKEYS",
"SASTableData+CLASS",[["Joyce","F",11,51.3,50.5],["Thomas","M",11,57.5,85]]]]
```

Missing Values

A missing value in SAS is a type of value for a variable that contains no data for a particular observation or variable. By default, SAS represents a missing numeric value as a single period and a missing character value as a blank space.

JSON also has the concept of missing values referred to as a null value, which is a special value that indicates the absence of information.

PROC JSON writes a JSON null value to the JSON output file when the following is true:

- a SAS data set numeric variable contains a missing value
- the WRITE VALUES statement writes the NULL keyword as a value

By default, SAS writes an empty string ("") to the JSON output file when a SAS data set character variable contains a missing value. However, if you specify the NOTRIMBLANKS option, the entire string of blanks is written to the JSON output file.

Scanning Input Strings

A JSON string is a sequence of zero or more characters that are wrapped in double quotation marks. A JSON string can be any Unicode character except double quotation marks ("), backslash (\), or a control character. A JSON string can contain a backslash as an escape character, which invokes an alternative interpretation on subsequent characters in a character sequence. For example, to allow a JSON string to contain double quotation marks, the " can be escaped by preceding the character with a \.

By default, PROC JSON scans input strings to ensure that they contain only characters that are acceptable as JSON strings. Unacceptable characters in an input string are replaced with the proper escape sequence.

You can specify the NOSCAN option to indicate that the input string is known to contain acceptable characters or has already been scanned. NOSCAN is supported in the PROC JSON statement, the EXPORT statement, and the WRITE VALUES statement.

JSON Output File Encoding

By default, the resulting JSON output file uses the Unicode encoding UTF-8. To override the encoding of a JSON output file, you can use the ENCODING= option in the FILENAME statement. However, you can do so only in the following situations:

- If the current SAS session encoding is UTF-8, you can specify one of the following Unicode encoding forms. Only UTF-8 and the following encoding forms are JSON standards compliant. Other encoding forms might not be recognized by standards-compliant JSON parsers.

  Table 38.1 *Encodings That Are Valid in UTF-8 SAS Session*

Name	Description
utf-16be	Unicode (UTF-16BE)
utf-32be	Unicode (UTF-32BE)
utf-32le	Unicode (UTF-32LE)

- If the current SAS session encoding is not UTF-8, you can override the encoding of a JSON output file only if the current SAS session encoding is compatible with US-ASCII and all strings written to the JSON output file contain only low-range Latin1 characters (that is, code points 0-127).

For example, the following code exports a JSON output file that uses the Unicode UTF-16BE character set encoding. The current SAS session encoding is Wlatin1. The ENCODING= option in the FILENAME statement tells PROC JSON to transcode the data from Wlatin1 to the specified Unicode UTF-16BE form when writing to the external file.

```
filename jsonout "C:\JsonOutput.json" encoding="utf-16be";

proc json out=jsonout;
   export sashelp.class;
quit;
```

Syntax: JSON Procedure

PROC JSON OUT=*fileref* | *"external-file"* <*options*>;

EXPORT <*libref.*>*SAS-data-set* <(*SAS-data-set-options*)> </*options*>;

WRITE VALUES *value(s)* </*options*>;

WRITE OPEN *type*;

WRITE CLOSE;

Statement	Task	Example
PROC JSON	Exports a SAS data set to a JSON file.	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 8
EXPORT	Identify the SAS data set to export and control the resulting output	Ex. 1, Ex. 2, Ex. 3, Ex. 5, Ex. 6, Ex. 7, Ex. 8
WRITE VALUES	Write one or more values to the output file	Ex. 4, Ex. 5, Ex. 6, Ex. 8
WRITE OPEN	Open and nest a JSON container in the output file	Ex. 4, Ex. 5, Ex. 6, Ex. 8
WRITE CLOSE	Close a JSON container that is open in the output file	Ex. 4, Ex. 5, Ex. 6, Ex. 8

PROC JSON Statement

Specifies the JSON output file and controls the resulting output.

Examples:

Syntax

PROC JSON OUT=*fileref* | "*external-file*" <*options*>;

Summary of Optional Arguments

FMTCHARACTER | NOFMTCHARACTER
: determines whether to apply a character SAS format to the resulting output if a character SAS format is associated with a SAS data set variable.

FMTDATETIME | NOFMTDATETIME
: determines whether to apply a date, time, or datetime SAS format to the resulting output if a date, time, or datetime SAS format is associated with a SAS data set variable.

FMTNUMERIC | NOFMTNUMERIC
: determines whether to apply a numeric SAS format to the resulting output if a numeric SAS format is associated with a SAS data set variable.

KEYS | NOKEYS
: determines whether exported observations are written as JSON objects or as JSON arrays.

PRETTY | NOPRETTY
: determines how to format the JSON output.

SASTAGS | NOSASTAGS
: determines whether to include or suppress SAS metadata when using the EXPORT statement.

SCAN | NOSCAN
: determines whether PROC JSON scans and encodes input strings to ensure that only characters that are acceptable are exported to the JSON output file.

TRIMBLANKS | NOTRIMBLANKS
: determines whether to remove or retain trailing blanks from the end of character data in the JSON output.

Required Argument

OUT=*fileref* | "*external-file*"
identifies the JSON output file.

fileref
specifies the SAS fileref that is assigned to the JSON output file. To assign a fileref, use the FILENAME statement.

"external-file"
is the physical location of the JSON output file. Include the complete pathname and the filename. Enclose the physical name in single or double quotation marks. The maximum length is 200 characters.

Optional Arguments

FMTCHARACTER | NOFMTCHARACTER
determines whether to apply a character SAS format to the resulting output if a character SAS format is associated with a SAS data set variable.

Alias FMTCHAR | NOFMTCHAR

Default NOFMTCHARACTER

Interaction You can specify FMTCHARACTER | NOFMTCHARACTER in the PROC JSON statement, the EXPORT statement, or both. If the option is specified in both statements, the EXPORT statement specification takes precedence.

Note User-defined formats are also supported.

FMTDATETIME | NOFMTDATETIME
determines whether to apply a date, time, or datetime SAS format to the resulting output if a date, time, or datetime SAS format is associated with a SAS data set variable. Applying a SAS format makes the date and time values in the resulting JSON output more readable.

Alias FMTDT | NOFMTDT

Default FMTDATETIME

Interaction You can specify FMTDATETIME | NOFMTDATETIME in the PROC JSON statement, the EXPORT statement, or both. If the option is specified in both statements, the EXPORT statement specification takes precedence.

Tip User-defined formats are also supported.

FMTNUMERIC | NOFMTNUMERIC
determines whether to apply a numeric SAS format to the resulting output if a numeric SAS format is associated with a SAS data set variable.

Alias FMTNUM | NOFMTNUM

Default NOFMTNUMERIC

Restriction Only the SAS formats BEST*w*., E*w*., and *w.d* write a JSON number to the output file. All other numeric SAS formats result in a JSON string.

Requirement FMTNUMERIC applies numeric SAS formats. For date, time, and datetime SAS formats, use the FMTDATETIME option.

Interactions With NOFMTNUMERIC or when a numeric variable does not have an associated SAS format, numeric values are written to the output file with a maximum of 12 digits.

You can specify FMTNUMERIC | NOFMTNUMERIC in the PROC JSON statement, the EXPORT statement, or both. If the option is specified in both statements, the EXPORT statement specification takes precedence.

Tip User-defined formats are also supported.

KEYS | NOKEYS
determines whether exported observations are written as JSON objects or as JSON arrays.

A JSON object stores SAS variable values from observations as key-value pairs. The SAS variable name is the key. A JSON array stores variable values only.

Default KEYS

Interaction You can specify NOKEYS in the PROC JSON statement, the EXPORT statement, or both. If the option is specified in both statements, the EXPORT statement specification takes precedence.

Tip Use NOKEYS to suppress SAS variable names in observation data when using the EXPORT statement.

See "Example 3: Suppressing SAS Variable Names in Observation Data When Using the EXPORT Statement" on page 1382and "Example 5: Writing Values and Exporting Data in the Same Program" on page 1387.

PRETTY | NOPRETTY
determines how to format the JSON output. PRETTY creates a more human-readable format that uses indention to illustrate the JSON container structure. NOPRETTY writes the output in a single line.

Default NOPRETTY

Restriction You can specify PRETTY | NOPRETTY in the PROC JSON statement only.

SASTAGS | NOSASTAGS
determines whether to include or suppress SAS metadata when using the EXPORT statement. The metadata consists of the SAS export version, exported SAS data set name, and any non-default option specification, such as PRETTY.

When EXPORT is the first statement in the procedure request, the top-level container for the exported data is a JSON object container. The SAS metadata precedes the exported data. When NOSASTAGS is specified, the top-level container is a JSON array container and the SAS metadata is suppressed.

See the following topics for information about what happens when the EXPORT statement is preceded by a WRITE OPEN statement in the PROC JSON request:

- WRITE OPEN ARRAY — "Example 5: Writing Values and Exporting Data in the Same Program" on page 1387.
- WRITE OPEN OBJECT — "Example 8: Exporting Multiple SAS Data Sets to a JSON File" on page 1398.

Default SASTAGS

Interactions NOSASTAGS affects the outermost container for exported data. The top-level JSON container is affected only when the EXPORT statement is the first statement in the procedure request.

You can specify NOSASTAGS in the PROC JSON statement, the EXPORT statement, or both. If the option is specified in both statements, the EXPORT statement specification takes precedence.

Note To modify the format of the exported observations, use the "KEYS | NOKEYS" option.

See "Example 2: Exporting Data to a Top-Level JSON Array Container" on page 1381 and "Example 6: Writing Values and Controlling Containers in Exported Data" on page 1391.

SCAN | NOSCAN

determines whether PROC JSON scans and encodes input strings to ensure that only characters that are acceptable are exported to the JSON output file.

Default SCAN

Interactions NOSCAN indicates that the input string is known to contain acceptable JSON text or has already been scanned. When NOSCAN is in effect, the input string or character value is taken as is, and the output JSON string is enclosed in quotation marks.

You can specify SCAN | NOSCAN in the PROC JSON statement, the EXPORT statement, the WRITE VALUES statement, or all three. If the option is specified in multiple statements, the EXPORT statement specification takes precedence.

See "Scanning Input Strings" on page 1362

TRIMBLANKS | NOTRIMBLANKS

determines whether to remove or retain trailing blanks from the end of character data in the JSON output. Only space characters are removed.

Default TRIMBLANKS

Interaction You can specify TRIMBLANKS | NOTRIMBLANKS in the PROC JSON statement, the EXPORT statement, the WRITE VALUES statement, or all three. If the option is specified in multiple statements, the EXPORT statement specification takes precedence.

EXPORT Statement

Identifies the SAS data set to be exported and controls the resulting output.

Alias: EX

Interaction: If the EXPORT statement is the first statement after the PROC JSON statement, the top-level container is a JSON object. However, if the NOSASTAGS option is specified in either the PROC JSON or the EXPORT statement, the top-level container is a JSON array. PROC JSON automatically closes the implicitly opened top-level container.

Notes: You can export multiple SAS data sets to the JSON output file by submitting multiple EXPORT statements.

The resulting JSON output uses the Unicode encoding form UTF-8. You cannot override the encoding in the output file with the ENCODING= data set option in the EXPORT statement. For information about overriding the encoding, see "JSON Output File Encoding" on page 1362.

Examples:

"Example 1: Exporting a JSON File Using Default Options" on page 1380

"Example 2: Exporting Data to a Top-Level JSON Array Container" on page 1381

"Example 3: Suppressing SAS Variable Names in Observation Data When Using the EXPORT Statement" on page 1382

"Example 5: Writing Values and Exporting Data in the Same Program" on page 1387

"Example 6: Writing Values and Controlling Containers in Exported Data" on page 1391

"Example 7: Applying SAS Formats to the Resulting Output" on page 1395

"Example 8: Exporting Multiple SAS Data Sets to a JSON File" on page 1398

Syntax

EXPORT <*libref.*>*SAS-data-set* <(*SAS-data-set-options*)> </*options*>;

Summary of Optional Arguments

(*SAS-data-set-options*)
specifies SAS data set options that apply to the input SAS data set.

FMTCHARACTER | NOFMTCHARACTER

determines whether to apply a character SAS format to the resulting output if a character SAS format is associated with a SAS data set variable.

FMTDATETIME | NOFMTDATETIME
: determines whether to apply a date, time, or datetime SAS format to the resulting output if a date, time, or datetime SAS format is associated with a SAS data set variable.

FMTNUMERIC | NOFMTNUMERIC
: determines whether to apply a numeric SAS format to the resulting output if a numeric SAS format is associated with a SAS data set variable.

KEYS | NOKEYS
: determines whether exported observations are written as JSON objects or as JSON arrays.

SASTAGS | NOSASTAGS
: determines whether to include or suppress SAS metadata when using the EXPORT statement.

SCAN | NOSCAN
: determines whether PROC JSON scans and encodes input strings to ensure that only characters that are acceptable are exported to the JSON output.

TABLENAME="*name*"
: specifies a name for the exported SAS data set.

TRIMBLANKS | NOTRIMBLANKS
: determines whether to remove or retain trailing blanks from the end of character data in the JSON output.

Required Argument

<libref.>SAS-data-set
: identifies the SAS data set to be exported with either a one- or two-level SAS name (library and member name). If you specify a one-level name, by default, the JSON procedure uses either the User library (if assigned) or the Work library.

Optional Arguments

(*SAS-data-set-options*)
: specifies SAS data set options that apply to the input SAS data set. For example, if the data set that you are exporting has an assigned password, you can use the ALTER=, PW=, READ=, or WRITE= data set options. To export a subset of data that meets a specified condition, you can use the WHERE= option. For information about SAS data set options, see *SAS Data Set Options: Reference*.

FMTCHARACTER | NOFMTCHARACTER
: determines whether to apply a character SAS format to the resulting output if a character SAS format is associated with a SAS data set variable.

Alias FMTCHAR | NOFMTCHAR

Default NOFMTCHARACTER

Interaction You can specify FMTCHARACTER | NOFMTCHARACTER in the PROC JSON statement, the EXPORT statement, or both. If the option is specified in both statements, the EXPORT statement specification takes precedence.

FMTDATETIME | NOFMTDATETIME
determines whether to apply a date, time, or datetime SAS format to the resulting output if a date, time, or datetime SAS format is associated with a SAS data set variable. Applying a SAS format makes the date and time values in the resulting JSON output more readable.

Alias FMTDT | NOFMTDT

Default FMTDATETIME

Interaction You can specify FMTDATETIME | NOFMTDATETIME in the PROC JSON statement, the EXPORT statement, or both. If the option is specified in both statements, the EXPORT statement specification takes precedence.

FMTNUMERIC | NOFMTNUMERIC
determines whether to apply a numeric SAS format to the resulting output if a numeric SAS format is associated with a SAS data set variable.

Alias FMTNUM | NOFMTNUM

Default NOFMTNUMERIC

Restriction Only the SAS formats BEST*w*., E*w*., and *w.d* write a JSON number to the output file. All other numeric SAS formats result in a JSON string.

Requirement FMTNUMERIC applies numeric SAS formats. For date, time, and datetime SAS formats, use the FMTDATETIME option.

Interactions With NOFMTNUMERIC or when a numeric variable does not have an associated SAS format, numeric values are written to the output file with a maximum of 12 digits.

You can specify FMTNUMERIC | NOFMTNUMERIC in the PROC JSON statement, the EXPORT statement, or both. If the option is specified in both statements, the EXPORT statement specification takes precedence.

KEYS | NOKEYS
determines whether exported observations are written as JSON objects or as JSON arrays.

A JSON object stores SAS variable values from observations as key-value pairs. The variable names are the keys. A JSON array stores variable values only.

Default KEYS

Interaction You can specify NOKEYS in the PROC JSON statement, the EXPORT statement, or both. If the option is specified in both statements, the EXPORT statement specification takes precedence.

Tip Use NOKEYS to suppress SAS variable names in observation data when using the EXPORT statement.

See "Example 3: Suppressing SAS Variable Names in Observation Data When Using the EXPORT Statement" on page 1382and "Example 5: Writing Values and Exporting Data in the Same Program" on page 1387.

SASTAGS | NOSASTAGS

determines whether to include or suppress SAS metadata when using the EXPORT statement. The metadata consists of the SAS export version, exported SAS data set name, and any non-default option specification, such as PRETTY.

When EXPORT is the first statement in the procedure request, the top-level container for the exported data is a JSON object container. The SAS metadata precedes the exported data. When NOSASTAGS is specified, the top-level container is a JSON array container and the SAS metadata is suppressed.

See the following topics for information about what happens when the EXPORT statement is preceded by a WRITE OPEN statement in the PROC JSON request:

- WRITE OPEN ARRAY — "Example 5: Writing Values and Exporting Data in the Same Program" on page 1387.
- WRITE OPEN OBJECT — "Example 8: Exporting Multiple SAS Data Sets to a JSON File" on page 1398.

Default SASTAGS

Interactions NOSASTAGS affects the outermost container for exported data. The top-level JSON container is affected only when the EXPORT statement is the first statement in the procedure request.

You can specify SASTAGS | NOSASTAGS in the PROC JSON statement, the EXPORT statement, or both. If the option is specified in both statements, the EXPORT statement specification takes precedence.

Note To modify the format of the exported observations, use the "KEYS | NOKEYS" option.

See "Example 2: Exporting Data to a Top-Level JSON Array Container" on page 1381 and "Example 6: Writing Values and Controlling Containers in Exported Data" on page 1391.

SCAN | NOSCAN

determines whether PROC JSON scans and encodes input strings to ensure that only characters that are acceptable are exported to the JSON output.

Default SCAN

Interactions NOSCAN indicates that the input string is known to contain acceptable JSON text or has already been scanned. When NOSCAN is in effect, the input string or character value is taken as is, and the output JSON string is enclosed in quotation marks.

You can specify SCAN | NOSCAN in the PROC JSON statement, the EXPORT statement, the WRITE VALUES statement, or all three statements. If the option is specified in multiple statements, the EXPORT statement specification takes precedence.

See "Scanning Input Strings" on page 1362

TABLENAME="*name*"
specifies a name for the exported SAS data set. The name is exported as SAS metadata in the JSON output file. Enclose the name in single or double quotation marks.

Default The default is the SAS data set member name.

Requirement The TABLENAME= option requires the SASTAGS option to include the SAS metadata in the JSON output.

TRIMBLANKS | NOTRIMBLANKS
determines whether to remove or retain trailing blanks from the end of character data in the JSON output. Only space characters are removed.

Default TRIMBLANKS

Interaction You can specify TRIMBLANKS | NOTRIMBLANKS in the PROC JSON statement, the EXPORT statement, the WRITE VALUES statement, or all three statements. If the option is specified in multiple statements, the EXPORT statement specification takes precedence.

WRITE VALUES Statement

Writes one or more values to the JSON output file.

Alias: W V

Interaction: If the WRITE VALUES statement is the first statement after the PROC JSON statement, PROC JSON opens a JSON object as the top-level container. PROC JSON automatically closes the implicitly opened top-level container.

Note: Specifying multiple values in one WRITE VALUES statement is equivalent to submitting multiple WRITE VALUES statements with only one value each. Only the order of the values is significant.

Examples: "Example 4: Writing JSON Output without Exporting a SAS Data Set" on page 1384
"Example 5: Writing Values and Exporting Data in the Same Program" on page 1387
"Example 6: Writing Values and Controlling Containers in Exported Data" on page 1391

"Example 8: Exporting Multiple SAS Data Sets to a JSON File" on page 1398

Syntax

WRITE VALUES *value(s)* </*options*>;

Summary of Optional Arguments

SCAN | NOSCAN
: determines whether PROC JSON scans and encodes input strings to ensure that only characters that are acceptable are exported to the JSON output.

TRIMBLANKS | NOTRIMBLANKS
: determines whether to remove or retain trailing blanks from the end of character data in the JSON output.

Required Argument

value(s)
specifies one or more values to write to the JSON output file. Separate values with a blank space. A value can be one of the following:

- a *string*, which can be enclosed in single or double quotation marks. If the string is enclosed in quotation marks, there are no restrictions regarding content or length. However, if the string is not enclosed in quotation marks, the following rules apply:
  - The length of the string cannot exceed 256 bytes.
  - The first character must begin with a letter of the Latin alphabet (A–Z, a–z) or the underscore. Subsequent characters can be letters of the Latin alphabet, numerals, or underscores.
  - The string cannot contain blanks or special characters except for the underscore. A string can contain mixed-case letters.
- a *number* represented in integer, floating point, or exponential format.
- the Boolean value TRUE | T or FALSE | F.
- NULL | N.

For example, the statement `write values "success" true;` causes the following results to be written to the JSON output file:

- **`"success": true`** if the current container is a JSON object
- **`"success", true`** if the current container is a JSON array

Requirement When writing values to a JSON object container, the name portion of the key-value pair must be a string. For example, the statement

`write values "abcd" "1";` is appropriate. However, the statement `write values 1 "abcd";` produces an error.

Optional Arguments

SCAN | NOSCAN

determines whether PROC JSON scans and encodes input strings to ensure that only characters that are acceptable are exported to the JSON output.

Default SCAN

Interactions NOSCAN indicates that the input string is known to contain acceptable JSON text or has already been scanned. When NOSCAN is in effect, the input string or character value is taken as is, and the output JSON string is enclosed in quotation marks.

You can specify SCAN | NOSCAN in the PROC JSON statement, the EXPORT statement, the WRITE VALUES statement, or all three statements. If the option is specified in multiple statements, the EXPORT statement specification takes precedence.

See "Scanning Input Strings" on page 1362

TRIMBLANKS | NOTRIMBLANKS

determines whether to remove or retain trailing blanks from the end of character data in the JSON output. Only space characters are removed.

Default TRIMBLANKS

Interaction You can specify TRIMBLANKS | NOTRIMBLANKS in the PROC JSON statement, the EXPORT statement, the WRITE VALUES statement, or all three statements. If the option is specified in multiple statements, the EXPORT statement specification takes precedence.

WRITE OPEN Statement

Opens and nests a JSON container in the output file.

Alias: W O

Interactions: If the WRITE OPEN statement is the first statement after the PROC JSON statement, the WRITE OPEN statement establishes the top-level container.

Submit the WRITE CLOSE statement for containers that you explicitly open with the WRITE OPEN statement.

Examples: "Example 6: Writing Values and Controlling Containers in Exported Data" on page 1391

"Example 8: Exporting Multiple SAS Data Sets to a JSON File" on page 1398

Syntax

WRITE OPEN *type*;

Required Argument

type
specifies the type of JSON container:

ARRAY
specifies that the JSON container is an array, which collects a list of values. An example statement is `write open array;`.

Alias A

OBJECT
specifies that the JSON container is an object, which collects key-value pairs. An example statement is `write open object;`.

Alias O

WRITE CLOSE Statement

Closes a JSON container that is open in the JSON output file.

Alias: W C

Restriction: The WRITE CLOSE statement cannot be the first statement after the PROC JSON statement.

Interaction: The WRITE CLOSE statement closes the most recently opened container of either type that was explicitly opened with the WRITE OPEN statement. You should submit the WRITE CLOSE statement for containers only if you explicitly opened the container with the WRITE OPEN statement.

Examples: "Example 6: Writing Values and Controlling Containers in Exported Data" on page 1391

"Example 8: Exporting Multiple SAS Data Sets to a JSON File" on page 1398

Syntax

WRITE CLOSE;

Usage: JSON Procedure

Exporting Data

The JSON procedure enables you to export one or more SAS data sets to a JSON output file. In the procedure statements, you specify the name of the JSON output file and the name of the SAS data set to be exported. For example, the following PROC JSON code writes the data in a SAS data set named Sashelp.Class to a JSON output file named Output.json.

```
proc json out="C:\Users\sasabc\JSON\Output.json";
   export sashelp.class;
run;
```

The exported data is written to a JSON object container ({ }) by default. Each observation of the data set is also put into a JSON object container. Options are available to enable you to create both the outer container and the observation containers as arrays. The SASTAGS (or NOSASTAGS) argument controls the outer container. The KEYS (or NOKEYS) argument controls the observation containers. For more information, see “Example 1: Exporting a JSON File Using Default Options” on page 1380, “Example 2: Exporting Data to a Top-Level JSON Array Container” on page 1381, and “Example 3: Suppressing SAS Variable Names in Observation Data When Using the EXPORT Statement” on page 1382.

Writing Values to a JSON Output File

PROC JSON provides the WRITE VALUES statement to explicitly write data to a JSON output file. The WRITE VALUES statement can be used to write one or more values to a JSON object container or a JSON array container. A value can be a string, a number, the Boolean value TRUE or FALSE, or the NULL keyword.

When the WRITE VALUES statement is the first statement specified under the PROC JSON statement, the statement implicitly creates a JSON object container to collect the specified values. In this way, you can use the WRITE VALUES statement in PROC JSON to create your own JSON output file without exporting a SAS data set. SAS variable values are collected in this object container as key and value pairs. For example:

```
proc json out="example.json";
   write values "container" "object";
   write values "created" "implicitly";
run;
```

```
{"container":"object","created":"implicitly"}
```

The WRITE VALUES statement cannot directly add values to a JSON container that contains data from an exported SAS data set. The EXPORT statement implicitly opens and automatically closes a JSON object. You cannot write values to a closed JSON container with the WRITE VALUES statement. To add values to a JSON object that includes exported data, you must precede the WRITE VALUES statement with a WRITE OPEN statement.

The WRITE OPEN statement explicitly opens a JSON container. It also enables you to specify the JSON container type: object or array.

When the WRITE VALUES statement follows a WRITE OPEN OBJECT statement, then the first value in the pair is considered to be a key name. The second value is the key's value. For example:

```
proc json out="example.json"
   write open object;
   write values "container" "object";
   write values "created" "explicitly";
   write close;
run;
```

```
{"container":"object","created":"explicitly"}
```

When the WRITE VALUES statement follows a WRITE OPEN ARRAY statement, then the WRITE VALUES statement creates a comma-separated list of values in the JSON array container.

```
proc json out="example.out";
   write open array;
   write values "container" "array";
   write values "created" "explictly";
   write close;
run;
```

```
["container","array","created","explictly"]
```

Use the WRITE OPEN statement when you want to add information to the JSON file that contains exported SAS data and when you want to nest JSON containers. For more information, see "Example 4: Writing JSON Output without Exporting a SAS Data Set" on page 1384, "Example 5: Writing Values and Exporting Data in the Same Program" on page 1387, "Example 6: Writing Values and Controlling Containers in Exported Data" on page 1391, and "Example 8: Exporting Multiple SAS Data Sets to a JSON File" on page 1398.

Controlling JSON Output with Options

PROC JSON supports several options that control the resulting JSON output. You can specify the options in the PROC JSON, EXPORT, and WRITE VALUES statements.

The following table lists the options and whether they are supported in a statement.

Note: Default option keywords appear in bold.

Table 38.2 Statement Option Availability in the PROC JSON, EXPORT, and WRITE VALUES Statements

Option	Function	PROC JSON Statement	EXPORT Statement	WRITE VALUES Statement
FMTCHARACTER | **NOFMTCHARACTER**	Determines whether to apply an associated character SAS format.	Yes	Yes	No
FMTDATETIME | NOFMTDATETIME	Determines whether to apply an associated date, time, or datetime SAS format.	Yes	Yes	No
FMTNUMERIC | **NOFMTNUMERIC**	Determines whether to apply an associated numeric SAS format (excluding date, time, and datetime SAS formats).	Yes	Yes	No
KEYS | NOKEYS	Determines whether exported observations are written as JSON object or array containers.	Yes	Yes	No
PRETTY | **NOPRETTY**	Determines how to format the JSON output.	Yes	No	No
SASTAGS | NOSASTAGS	Determines whether to include or suppress SAS metadata when using the EXPORT statement. When EXPORT is the first statement in the procedure request, also	Yes	Yes	No

Option	Function	PROC JSON Statement	EXPORT Statement	WRITE VALUES Statement
	determines whether the top-level JSON container is an object container or an array container.			
SAS-data-set-options	Specify actions that apply to the SAS data set.	No	Yes	No
SCAN | NOSCAN	Determines whether PROC JSON scans and encodes input strings.	Yes	Yes	Yes
TABLENAME="*name*"	Specifies a name in the SAS metadata for the exported SAS data set.	No	Yes	No
TRIMBLANKS | NOTRIMBLANKS	Determines whether to remove or retain trailing blanks.	Yes	Yes	Yes

Note: Options specified in the PROC JSON statement apply for the duration of the procedure. Options specified in the EXPORT and WRITE VALUES statement apply only to that statement. If options are specified in more than one statement, the options specified in the EXPORT statement or WRITE VALUES statement take precedence.

For an example, see "Example 2: Exporting Data to a Top-Level JSON Array Container" on page 1381.

PROC JSON Video

For a video that demos how to use PROC JSON, see How to Write JSON Output from SAS. The video shows you how to export a SAS data set to a JSON output file, how to export a subset of data and control the JSON output, and how to write free-form JSON output, control and nest JSON containers, and export multiple SAS data sets.

Examples: JSON Procedure

Example 1: Exporting a JSON File Using Default Options

Features:
PROC JSON statement
PROC JSON PRETTYstatement option
EXPORT statement
WHERE data set option

Details

This PROC JSON example exports a subset of the Sashelp.Class data set to a JSON output file. The PROC JSON PRETTY procedure option is specified to return the output in a format that uses indention to illustrate the default JSON container structure. Otherwise, the default export options are enabled.

Program

Specify the JSON output file and the EXPORT statement. The PROC JSON statement specifies the physical location of the JSON output file with the complete pathname and JSON filename. When the .json extension is omitted, the output is written to a text file.

```
proc json out="C:\Users\sasabc\JSON\DefaultOutput.json" pretty;
   export sashelp.class (where=(age=11));
run;
```

Output: Exporting a JSON File Using Default Options

The top-level container in the output file is a JSON object container ({ }). Each observation in the SAS data set is exported to a JSON object container; variable

values in each object container are key-value pairs. The set of observations is in a JSON array container ([ ]). SAS metadata is included in the top of the top-level container.

Output 38.1 *Content of PROC JSON Output File DefaultOutput.json*

```
{
  "SASJSONExport": "1.0 PRETTY",
  "SASTableData+CLASS": [
    {
      "Name": "Joyce",
      "Sex": "F",
      "Age": 11,
      "Height": 51.3,
      "Weight": 50.5
    },
    {
      "Name": "Thomas",
      "Sex": "M",
      "Age": 11,
      "Height": 57.5,
      "Weight": 85
    }
  ]
}
```

Example 2: Exporting Data to a Top-Level JSON Array Container

Features:

PROC JSON statement options
- PRETTY

EXPORT statement options
- WHERE= data set option
- NOSASTAGS

Details

This example exports a subset of the Sashelp.Class data set to a JSON output file and specifies to write the exported data to a JSON array container.

Program

```
proc json out="C:\Users\sasabc\JSON\NosastagsOutput.json" pretty;
   export sashelp.class (where=(age=11)) / nosastags;
run;
```

Program Description

Specify the JSON output file. The PROC JSON statement specifies the physical location of the JSON output file with the complete pathname and a JSON filename. The PRETTY option creates a more readable format.

```
proc json out="C:\Users\sasabc\JSON\NosastagsOutput.json" pretty;
```

Identify the SAS data set to be exported and control the top-level JSON container. NOSASTAGS in the EXPORT statement suppresses SAS metadata and specifies that the top-level container is an array container. The NOSASTAGS option can be specified on the PROC JSON statement or on the EXPORT statement.

```
   export sashelp.class (where=(age=11)) / nosastags;
run;
```

Output: Exporting Data to a Top-Level JSON Array Container

The top-level container in the output file is an array container ([ ]). There is no SAS metadata. Each observation in the SAS data set is a JSON object ({ }) container. Variable values within the object containers are key-value pairs.

Output 38.2 *Content of PROC JSON Output File NosastagsOutput.json*


```
[
  {
    "Name": "Joyce",
    "Sex": "F",
    "Age": 11,
    "Height": 51.3,
    "Weight": 50.5
  },
  {
    "Name": "Thomas",
    "Sex": "M",
    "Age": 11,
    "Height": 57.5,
    "Weight": 85
  }
]
```


Example 3: Suppressing SAS Variable Names in Observation Data When Using the EXPORT Statement

Features: PROC JSON statement options
PRETTY

EXPORT statement options
WHERE= data set option
NOKEYS

Details

This example exports a subset of the Sashelp.Class data set to a JSON output file and specifies to write the exported data set observations as an array. Array containers store variable values only.

Program

```
proc json out="C:\Users\sasabc\JSON\NokeysOutput.json" pretty;

   export sashelp.class (where=(age=11)) / nokeys;
run;
```

Program Description

Specify the JSON output file. The PROC JSON statement specifies the physical location of the JSON output file with the complete pathname and a JSON filename. The PRETTY option creates a more readable format.

```
proc json out="C:\Users\sasabc\JSON\NokeysOutput.json" pretty;
```

Identify the SAS data set to be exported and control the observation container. NOKEYS in the EXPORT statement writes data set observations as values in an array container instead of to object containers. The NOKEYS option can be specified on the PROC JSON statement or on the EXPORT statement.

```
   export sashelp.class (where=(age=11)) / nokeys;
run;
```

Output: Suppressing SAS Variable Names in Observation Data When Using the EXPORT Statement

The top-level container in the output file is a JSON object container ({ }). SAS metadata is included in the top-level container. Each selected observation in the SAS data set is exported in an array container ([ ]) that is nested in the top-level container. The arrays contain a list of variable values and no variable names.

Output 38.3 *Content of PROC JSON Output File NokeysOutput.json*

```
{
  "SASJSONExport": "1.0 NOKEYS PRETTY",
  "SASTableData+CLASS": [
    [
      "Joyce",
      "F",
      11,
      51.3,
      50.5
    ],
    [
      "Thomas",
      "M",
      11,
      57.5,
      85
    ]
  ]
}
```

Example 4: Writing JSON Output without Exporting a SAS Data Set

Features:

PROC JSON statement options
PRETTY

WRITE OPEN statement

WRITE VALUES statement

WRITE CLOSE statement

Details

This PROC JSON example illustrates how to write JSON output from SAS without exporting data from a SAS data set. This gives you complete control over the content of the JSON output, which enables you to produce arbitrary JSON output.

Program

```
proc json out="C:\Users\sasabc\JSON\WriteOpenOutput.json" pretty;

   write open object;
      write values "Nested object sample";

      write open object;
         write values "Comment" "In a nested object";
```

```
      write close;

   write values "Nested array sample";
   write open array;
      write open array;
         write values "In a nested array";
         write values 1 true null;
         write close;
      write close;

   write values "Finished" "End of samples";

   write close;
run;
```

Program Description

Specify the JSON output file. The PRETTY option creates the output in a more readable format.

```
proc json out="C:\Users\sasabc\JSON\WriteOpenOutput.json" pretty;
```

Open a JSON object container and write a value. The WRITE OPEN OBJECT statement explicitly opens a JSON object container ({ }) as the top-level container. The WRITE VALUES statement writes a string to the object container.

```
   write open object;
      write values "Nested object sample";
```

Nest an object container with values, and then close the nested object container. The WRITE OPEN OBJECT statement explicitly opens a second object container in the top-level container. The WRITE VALUES statement writes two strings in the second-level object container. The WRITE CLOSE statement closes the most recently opened container.

```
      write open object;
         write values "Comment" "In a nested object";
         write close;
```

Write a value to the JSON output file, open an array container, nest an array container with values, and then close the two array containers. The WRITE VALUES statement writes a string in the top-level container. The WRITE OPEN ARRAY statements create an array container in the top-level container, and then nests a second array container in the previously opened array container. The WRITE VALUES statements write a string, a number, the Boolean value TRUE, and the NULL keyword to the second-level array container. Two WRITE CLOSE statements close the array containers.

```
   write values "Nested array sample";
   write open array;
      write open array;
         write values "In a nested array";
         write values 1 true null;
         write close;
      write close;
```

Write a final value. The WRITE VALUES statement writes two strings to the top-level container.

```
    write values "Finished" "End of samples";
```

Close the top-level container. The WRITE CLOSE statement closes the remaining open container, which is the top-level container.

```
    write close;
run;
```

Output: Writing JSON Output without Exporting a SAS Data Set

Because the top-level container was specified as an object container, SAS expects the first WRITE VALUES statement to specify key-value pairs. The first WRITE VALUES statement specifies only one value. Therefore, the string “Nested object sample” is output as the key in a key-value pair. The first nested object is the value of this key-value pair. Because the nested container is also an object container, the nested WRITE VALUES statement is output as a key-value pair. The key in the string is “Comment” and the value is the string “In a nested object”. Because the nested object container is explicitly closed, the specified data is again being written to the top-level container, an object container, which is expected to contain a key-value pair. The string “Nested array sample” is the key in this key-value pair; the first array container is the value. The second, nested array container is an actual array. The nested WRITE VALUES statements define a list of four values in the second-level array container. Because the two array containers are explicitly closed, the final WRITE VALUES statement again is being written to the top-level container, which is expected to contain a key-value pair. The string “Finished” is the key in this key-value pair; the string “End of samples” is the value.

Output 38.4 *Content of PROC JSON Output File WriteOpenOutput.json*

```
{
  "Nested object sample": {
    "Comment": "In a nested object"
  },
  "Nested array sample": [
    [
      "In a nested array",
      1,
      true,
      null
    ]
  ],
  "Finished": "End of samples"
}
```

Example 5: Writing Values and Exporting Data in the Same Program

Features:

PROC JSON statement options
PRETTY
WRITE OPEN ARRAY statement
WRITE VALUES statement
EXPORT statement
WRITE CLOSE statement

Details

This example writes values and performs three exports of the same data to show the behavior of the default export settings, the NOSASTAGS option, and the NOKEYS option. The exported data is inserted into a top-level array container, to show the effect of NOSASTAGS on the exported data.

Program

```
proc json out="C:\Users\sasabc\JSON\WriteAndExport.json" pretty;

   write open array;
      write values "level" 1;
      write values "container" "array";
      write values "created" "explicitly";


      write values "Default Export";
      export sashelp.class (where=(age=11));

    write values "Export with NOSASTAGS Options";
     export sashelp.class (where=(age=11)) / nosastags;

     write values "Export with NOSASTAGS and NOKEYS Option";
      export sashelp.class (where=(age=11)) / nosastags nokeys;

      write close;
   run;
```

Program Description

Specify the JSON output file in the PROC JSON statement. The PRETTY option creates the output in a more readable format.

```
proc json out="C:\Users\sasabc\JSON\WriteAndExport.json" pretty;
```

Open a top-level JSON array container and specify values. The WRITE OPEN ARRAY statement explicitly opens a JSON array container ([ ]) as the top-level container. WRITE VALUES statements specify a string, a numeric value, and additional strings as values for the array.

```
write open array;
   write values "level" 1;
   write values "container" "array";
   write values "created" "explicitly";
```

Specify an EXPORT statement. The EXPORT statement specifies to export a subset of the observations from the SAS data set Sashelp.Class. The WHERE data set option limits the observations that are included in the output file. There are no export options specified. The EXPORT statement implicitly opens and closes the container that holds the exported data. A WRITE VALUES statement that contains a string of descriptive text is specified before the EXPORT statement.

```
   write values "Default Export";
   export sashelp.class (where=(age=11));
```

Specify an EXPORT statement that specifies the NOSASTAGS option. The EXPORT statement specifies to export the same data as the preceding EXPORT statement. NOSASTAGS suppresses the SAS metadata. The EXPORT statement implicitly opens and closes the container that holds the exported data. A WRITE VALUES statement that contains a string of descriptive text is specified before the EXPORT statement.

```
write values "Export with NOSASTAGS Options";
 export sashelp.class (where=(age=11)) / nosastags;
```

Specify an EXPORT statement that specifies the NOSASTAGS and NOKEYS options. The EXPORT statement specifies to export the same data as the preceding EXPORT statements. NOSASTAGS suppresses the SAS metadata. The NOKEYS option specified to export each data set observation to an array container, instead of an object container. The EXPORT statement implicitly opens and closes the container that holds the exported data. A WRITE VALUES statement is specified before the EXPORT statement to print a string containing descriptive text.

```
 write values "Export with NOSASTAGS and NOKEYS Option";
  export sashelp.class (where=(age=11)) / nosastags nokeys;
```

Close the outer JSON array container.

```
   write close;
run;
```

Output: Writing Values and Exporting Data in the Same Program

The default export behavior writes SAS metadata as variable values in the open array container. The exported data is added as an array value in the open array container. The exported observations are comma-separated JSON object containers within the new array. NOSASTAGS suppresses the SAS metadata, as well as the outer array container from the exported observations. The observations are added as comma-separated object containers in the existing array. When the NOKEYS and NOSASTAGS options are specified together, the exported observations are added to the existing array as comma-separated array values.

Output 38.5 *Content of PROC JSON Output File WriteAndExport.json*


```
[
  "level",
  1,
  "container",
  "array",
  "created",
  "explicitly",
  "Default Export",
  "SASJSONExport",
  "1.0 PRETTY",
  "SASTableData+CLASS",
  [
    {
      "Name": "Joyce",
      "Sex": "F",
      "Age": 11,
      "Height": 51.3,
      "Weight": 50.5
    },
    {
      "Name": "Thomas",
      "Sex": "M",
      "Age": 11,
      "Height": 57.5,
      "Weight": 85
    }
  ],
  "Export with NOSASTAGS Option",
  {
    "Name": "Joyce",
    "Sex": "F",
    "Age": 11,
    "Height": 51.3,
    "Weight": 50.5
  },
  {
    "Name": "Thomas",
    "Sex": "M",
    "Age": 11,
    "Height": 57.5,
    "Weight": 85
  },
  "Export with NOSASTAGS and NOKEYS Option",
  [
    "Joyce",
    "F",
    11,
    51.3,
    50.5
  ],
  [
    "Thomas",
    "M",
    11,
    57.5,
    85
  ]
]
```

Example 6: Writing Values and Controlling Containers in Exported Data

Features:

PROC JSON statement options
- NOSASTAGS
- PRETTY

WRITE OPEN statement

WRITE VALUES statement

EXPORT statement

WRITE CLOSE statement

Details

This PROC JSON example illustrates how to write additional values to a JSON output file and control and nest JSON containers. The example exports a subset of the Sashelp.Cars data set to the JSON output file.

Program

```
%let vehicleType=Truck;
%let minCost=26000;

proc json out="C:\Users\sasabc\JSON\WriteOpenArrayOutput.json"
nosastags pretty;

   write open array;
   write values "Vehicles";
   write open array;
   write values "&vehicleType";
   write open array;
   write values "Greater than $&minCost";
   /*********** Asian **********************/
   %let originator=Asia;
   write open object;
   write values "&originator";
   write open array;
   export sashelp.cars(where=((origin = "&originator")  and
                              (type   = "&vehicleType") and
                              (MSRP   > &minCost)           )
                       keep=make model type origin MSRP);
   write close; /* data values */
   write close; /* Asia */
   /*********** European **********************/
```

```
   %let originator=Europe;
   write open object;
   write values "&originator";
   write open array;
   export sashelp.cars(where=((origin = "&originator")  and
                              (type   = "&vehicleType") and
                              (MSRP   > &minCost)           )
                       keep=make model type origin MSRP);
   write close; /* data values */
   write close; /* Europe */
   /*********** American **********************/
   %let originator=USA;
   write open object;
   write values "&originator";
   write open array;
   export sashelp.cars(where=((origin = "&originator")  and
                              (type   = "&vehicleType") and
                              (MSRP   > &minCost)           )
                       keep=make model type origin MSRP);
   write close; /* data values */
   write close; /* USA */
   write close; /* expensive */
   write close; /* vehicleType */
   write close; /* cars */
run;
```

Program Description

Assign macro variables. The %LET statements create macro variables and assign values to be used throughout the code.

```
%let vehicleType=Truck;
%let minCost=26000;
```

Specify the JSON output file and control the resulting output. The PROC JSON statement specifies the physical location of the JSON output file with the complete pathname and filename. The NOSASTAGS option suppresses the SAS metadata and the PRETTY option creates a more readable format.

```
proc json out="C:\Users\sasabc\JSON\WriteOpenArrayOutput.json"
nosastags pretty;
```

Include additional PROC JSON statements. These statements open a series of nested containers for each type of car and write values as labels for the containers. The EXPORT statements specifies the SAS data set to export, selects specific observations, and requests only certain SAS variables.

```
   write open array;
   write values "Vehicles";
   write open array;
   write values "&vehicleType";
   write open array;
   write values "Greater than $&minCost";
   /*********** Asian **********************/
   %let originator=Asia;
```

```
   write open object;
   write values "&originator";
   write open array;
   export sashelp.cars(where=((origin = "&originator")  and
                              (type   = "&vehicleType") and
                              (MSRP   > &minCost)           )
                       keep=make model type origin MSRP);
   write close; /* data values */
   write close; /* Asia */
   /*********** European **********************/
   %let originator=Europe;
   write open object;
   write values "&originator";
   write open array;
   export sashelp.cars(where=((origin = "&originator")  and
                              (type   = "&vehicleType") and
                              (MSRP   > &minCost)           )
                       keep=make model type origin MSRP);
   write close; /* data values */
   write close; /* Europe */
   /*********** American **********************/
   %let originator=USA;
   write open object;
   write values "&originator";
   write open array;
   export sashelp.cars(where=((origin = "&originator")  and
                              (type   = "&vehicleType") and
                              (MSRP   > &minCost)           )
                       keep=make model type origin MSRP);
   write close; /* data values */
   write close; /* USA */
   write close; /* expensive */
   write close; /* vehicleType */
   write close; /* cars */
run;
```

Output: Controlling JSON Containers and Writing Values

Output 38.6 *PROC JSON Output File WriteOutput.json*


```
[
  "Vehicles",
  [
    "Truck",
    [
      "Greater than $26000",
      {
        "Asia": [
          {
            "Make": "Nissan",
            "Model": " Titan King Cab XE",
            "Type": "Truck",
            "Origin": "Asia",
            "MSRP": 26650
          }
        ]
      },
      {
        "Europe": [
        ]
      },
      {
        "USA": [
          {
            "Make": "Cadillac",
            "Model": " Escalade EXT",
            "Type": "Truck",
            "Origin": "USA",
            "MSRP": 52975
          },
          {
            "Make": "Chevrolet",
            "Model": " Avalanche 1500",
            "Type": "Truck",
            "Origin": "USA",
            "MSRP": 36100
          },
          {
            "Make": "Chevrolet",
            "Model": " Silverado SS",
            "Type": "Truck",
            "Origin": "USA",
            "MSRP": 40340
          },
          {
            "Make": "Chevrolet",
            "Model": " SSR",
            "Type": "Truck",
            "Origin": "USA",
            "MSRP": 41995
          },
```

```
          {
            "Make": "Ford",
            "Model": " F-150 Supercab Lariat",
            "Type": "Truck",
            "Origin": "USA",
            "MSRP": 33540
          },
          {
            "Make": "GMC",
            "Model": " Sierra HD 2500",
            "Type": "Truck",
            "Origin": "USA",
            "MSRP": 29322
          }
        ]
      }
    ]
  ]
]
```

Example 7: Applying SAS Formats to the Resulting Output

Features:

PROC JSON statement options
- PRETTY

EXPORT statement options
- FMTDATETIME
- FMTNUMERIC

DATA step

Details

This PROC JSON example exports a SAS data set named Work.Formats that contains variables with associated SAS formats. The resulting JSON output file applies the SAS formats, which makes the output values more readable.

Program

```
data formats;
   input name $ idnumber $ salary hiredate mmddyy10.;
   format salary dollar7. hiredate date9.;
   datalines;
   Brad 0755 21163 9/24/2012
   Lindzey 0767 34321 9/04/2012
   ;
```

```
proc json out="C:\Users\sasabc\JSON\FormatsOutput.json" pretty;

   export work.formats / fmtnumeric;
run;
```

Program Description

Create a SAS data set with variables that have associated SAS formats. The DATA step creates a SAS data set named Work.Formats with four variables. The FORMAT statement associates the DOLLAR7. SAS numeric format with the variable Salary and the SAS date format DATE9. with the variable HireDate.

```
data formats;
   input name $ idnumber $ salary hiredate mmddyy10.;
   format salary dollar7. hiredate date9.;
   datalines;
   Brad 0755 21163 9/24/2012
   Lindzey 0767 34321 9/04/2012
   ;
```

Specify the JSON output file and control the resulting output file. The PROC JSON statement specifies the physical location of the JSON output file with the complete pathname and filename and includes the PRETTY option to create a more readable format.

```
proc json out="C:\Users\sasabc\JSON\FormatsOutput.json" pretty;
```

Identify the SAS data set to be exported. The EXPORT statement specifies the SAS data set name. The FMTDATETIME option is available by default to apply the date SAS format that is associated with the HireDate variable. The FMTNUMERIC option is specified to apply the numeric SAS format DOLLAR7. that is associated with the Salary variable.

```
   export work.formats / fmtnumeric;
run;
```

Output: Applying SAS Formats to the Resulting Output

Output 38.7 *PROC JSON Output File FormatsOutput.json with FMTDATETIME and FMTNUMERIC*


```
{
  "SASJSONExport": "1.0 PRETTY FMTNUMERIC",
  "SASTableData+FORMATS": [
    {
      "name": "Brad",
      "idnumber": "0755",
      "salary": "$21,163",
      "hiredate": "24SEP2012"
    },
    {
      "name": "Lindzey",
      "idnumber": "0767",
      "salary": "$34,321",
      "hiredate": "04SEP2012"
    }
  ]
}
```


If the EXPORT statement specified the option NOFMTDATETIME and did not specify the option FMTNUMERIC, the resulting JSON output file would include Salary and HireDate values that are less readable.

Output 38.8 *PROC JSON Output File FormatsOutput.json with NOFMTDATETIME and NOFMTNUMERIC*


```
{
  "SASJSONExport": "1.0 PRETTY NOFMTDATETIME",
  "SASTableData+FORMATS": [
    {
      "name": "Brad",
      "idnumber": "0755",
      "salary": 21163,
      "hiredate": 19260
    },
    {
      "name": "Lindzey",
      "idnumber": "0767",
      "salary": 34321,
      "hiredate": 19240
    }
  ]
}
```

Example 8: Exporting Multiple SAS Data Sets to a JSON File

Features:

PROC JSON statement options
- PRETTY
- NOKEYS
- NOSASTAGS

WRITE OPEN statement

WRITE VALUES statement

EXPORT statement options
- WHERE= data set option
- DROP= data set option
- KEYS option

WRITE CLOSE statement

Details

This PROC JSON example exports two SAS data sets to a JSON output file. The SasHelp.Class data set contains student information such as their names, ages, and gender. The MyFiles.Fitness data set contains the student's fitness achievements, such as the number of crunches and push-ups that they can do. The example also illustrates how to control and nest JSON containers and write additional values to the JSON output file.

The resulting JSON output file contains the following content:

- The output begins by opening an object container ({ }) as the top-level container, because the first statement after the PROC JSON statement is WRITE OPEN OBJECT.
- There is no SAS metadata at the beginning of the output file.
- The output is in a more human-readable format that uses indention to illustrate the JSON container structure.
- User-defined strings are written as labels for the containers.
- A series of JSON containers are opened and nested.
- A subset of two SAS data sets is exported. The values for the first SAS data set are exported as nested array containers and consist of a list of values. The values for the second SAS data set are exported as nested object containers and consist of key-value pairs.
- The explicitly opened JSON containers are closed.

Program

```
proc json out='C:\Users\sasabc\\JSON\MultipleDataSets.json' pretty
nokeys;

   write open object; /* top-level object */
     write value "Fitness";
     write open array; /* fitness array */
       write value "Class List";
       write open array; /* class list array */
         export sashelp.class (where=(age eq 11) drop=height weight);

       write close; /* class list array */
     write close;  /* fitness array */

     write value "Results";
     write open array; /* results array */

       export myfiles.fitness (where=(age eq 11) drop=name)/ keys;

     write close; /* results array */
   write close; /* top-level object */
run;
```

Program Description

Specify the JSON output file and control the resulting output. The PROC JSON statement specifies the physical location of the JSON output file with the complete pathname and filename. The PRETTY option creates a more readable format. The NOKEYS option specifies to write the exported observations in array containers.

```
proc json out='C:\Users\sasabc\\JSON\MultipleDataSets.json' pretty
nokeys;
```

Open and nest labeled containers. The statements open a series of nested containers and write values as labels for the containers.

```
   write open object; /* top-level object */
     write value "Fitness";
     write open array; /* fitness array */
       write value "Class List";
       write open array; /* class list array */
```

Identify the first SAS data set to be exported. The EXPORT statement specifies the two-level SAS name. The WHERE= data set option specifies conditions for selecting observations. The DROP= data set option excludes the specified variables from being written to the output file. The selected observations are exported as nested array containers and consist of a list of values.

```
    export sashelp.class (where=(age eq 11) drop=height weight);
```

Close the two array containers. The two WRITE CLOSE statements close the two array containers. Note that when you explicitly open a container, you must explicitly close it.

```
    write close; /* class list array */
  write close;  /* fitness array */
```

Label and open a nested array container. The WRITE VALUE statement nests the user-defined string Results in the top-level container. The WRITE OPEN ARRAY statement opens a nested array container.

```
  write value "Results";
  write open array; /* results array */
```

Identify the second SAS data set to be exported. The EXPORT statement specifies the two-level SAS name. The WHERE= data set option specifies conditions for selecting observations. The DROP= data set option excludes the specified variable from being written to the output file. The KEYS option causes the selected observations to be exported as nested object containers and consist of key-value pairs. Note that for the EXPORT statement, the KEYS option overrides the NOKEYS option that is specified in the PROC JSON statement.

```
    export myfiles.fitness (where=(age eq 11) drop=name)/ keys;
```

Close the two open containers. Two WRITE CLOSE statements explicitly close the array container and the object container for the top-level container.

```
  write close; /* results array */
 write close; /* top-level object */
run;
```

Output: Exporting Multiple SAS Data Sets to a JSON File

Output 38.9 *PROC JSON Output File MultipleDataSets.json*


```
{
  "Fitness": [
    "Class List",
    [
      [
        "Joyce",
        "F",
        11
      ],
      [
        "Thomas",
        "M",
        11
      ]
    ]
  ],
  "Results": [
    {
      "Age": 11,
      "Push-ups": 15,
      "Crunches": 20
    },
    {
      "Age": 11,
      "Push-ups": 22,
      "Crunches": 33
    }
  ]
}
```

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LUA Procedure

Overview: LUA Procedure

What Does the LUA Procedure Do?

The Lua programming language is an embeddable scripting language that runs on any platform that has a standard C compiler. This includes all versions of UNIX, Windows, and mobile operating systems, including Android, iOS, and others. Lua uses simple syntax, runs fast computations, and automatically manages memory allocation.

The LUA procedure enables you to run statements from the Lua programming language within SAS code. You can submit Lua statements from an external Lua script, or enter Lua statements directly in SAS code.

Note: Support for the LUA procedure was added in SAS 9.4M3.

PROC LUA enables you to perform these tasks:

- run Lua code within a SAS session
- call most SAS functions within Lua statements
- call PROC FCMP functions within Lua statements
- submit SAS code from Lua
- call CAS actions

  Note: Support for calling CAS actions was added in SAS 9.4M5.

- read VARCHAR data

  Note: Support for VARCHAR data was added in SAS Viya 3.3.

Concepts: LUA Procedure

Specifying the Input Location for Lua Scripts

Using the LUAPATH Fileref

Typically, you store long blocks of Lua code in separate script files. This practice enables you to more easily manage your Lua code. The examples in this chapter use the SUBMIT and ENDSUBMIT statements to identify Lua code. However, any Lua code can be stored in a separate Lua script.

You run the code from the scripts by specifying the following information:

- the location of the Lua script
- the name of the Lua script to execute

You specify the location of your Lua scripts by using the FILENAME statement to define the LUAPATH fileref. To define a single location, enter a SAS statement that is similar to this one:

```
filename LUAPATH "/usr/local/scripts/lua";
```

You can specify more than one location for your Lua scripts. The system searches for the input Lua script from the locations that are listed, in the order in which you specify them. One of these locations must contain the Lua system scripts. To specify more than one location, enclose the list in parentheses and separate values with a comma:

```
filename LUAPATH ("/usr/local/scripts/lua","/user/my_name/my_lua_scripts");
```

Using a single or double quotation mark in your path might cause unexpected results. If there are quotation marks or apostrophes, such as `Mark's dir`, use the LUA_PATH environment variable. For more information, see "Using the LUA_PATH Environment Variable with Special Characters".

Note: If you change the value of LUAPATH during a SAS session, call the LUA procedure and specify the RESTART option. The RESTART option resets the status of Lua in SAS and picks up the last value for LUAPATH.

You specify the name of the Lua script to execute by using the INFILE= option in the PROC LUA statement. For more information, see "Example 2: Specifying Input from an External Lua Script" on page 1427.

Using the LUA_PATH Environment Variable with Special Characters

To specify a special character, such as a single or double quotation mark, in the path to your Lua scripts, use the LUA_PATH environment variable. To set LUA_PATH for multiple paths, use Lua syntax, where each path is separated by a semicolon (;). The Lua syntax also uses a '?' for wildcard matching with LUA or LUC files. For example, you might specify a path that includes a single quotation mark like this:

```
options set=LUA_PATH="/usr/local/lua/?.lua;/usr/local/lua/
lua'files/?.luc";
proc lua infile="script";
run;
```

Running External Lua Files

You can run external scripts that are written in the Lua programming language from the SAS command line. You can run both uncompiled Lua scripts (*.lua files) or precompiled Lua scripts (*.luc files). Support for running external Lua files directly in SAS invocation was added in SAS 9.4M3.

Note: To create a precompiled *.luc file, you must have Lua 5.2 or higher. See your Lua documentation about how to use the Lua compiler.

To run Lua files at invocation, use the -SYSIN option. For example, to run the file abc.lua, submit this command:

```
sas -sysin abc.lua
```

You can also run external Lua scripts (*.lua or *.luc files) by using the %INCLUDE statement in a SAS session. For example, to run the Lua script abc.luc, enter the following line in your SAS program:

```
%include "./tmp/abc.luc";
```

Calling CAS Actions with PROC LUA

Requirements to Connect to the CAS Server

If your system runs a CAS server (most often, as part of SAS Viya), you can call CAS actions from PROC LUA. You need to know the following information to connect to the CAS server:

- the name of the server (host) that is running the CAS server
- the CAS server port
- your user ID, which must have permission to access the CAS server

The following resources must also be in place. These files are typically installed automatically as part of your SAS Viya installation:

- middleclass.lua
- swat.lua
- tkluaswat.so

For more information, see "Requirements" in *Getting Started with SAS Viya for Lua*.

To connect to the CAS server and run Lua code, you must load the appropriate settings and utilities in your SAS program. You must also load the SAS Scripting Wrapper for Analytics Transfer (SWAT) library. For more information, see "Example 13: Connecting to the CAS Server" on page 1453.

Functions That Interact with the CAS Server

Here are the functions that interact with the CAS server. For an example that shows how to connect to the CAS server, see "Example 13: Connecting to the CAS Server" on page 1453.

Note: It is a SAS convention to document function names in all capitals. However, when you call these functions within the LUA procedure, you must use all lower-case letters.

Lua-var:HELP{}
: requests the list of available CAS actions for the CAS session that is associated with the Lua variable. For example, you might specify `s:help{}` if you have assigned your CAS session to the Lua variable s.

CAS.OPEN("*host-name*", *port*, "*user-ID*")
opens a session on the CAS server. You provide the host name and port for the CAS server, and you supply your user ID. Your user ID must have permission to access the CAS server.

Assign the result of CAS.OPEN to a Lua variable that represents the CAS session:

```
s = cas.open("host.mycompany.com", 5570, "myuserid")
```

After you establish the connection, you can refer to the attributes of s, such as s.port or s.hostname.

Lua-var:SHUTDOWN{}
ends the CAS session that is associated with the Lua variable and closes the connection to the CAS server. For example, to close the CAS session represented by the Lua variable s, use this command:

```
s:shutdown{}
```

Support for VARCHAR Data with PROC LUA

Support for reading VARCHAR data was added in SAS Viya 3.3. VARCHAR data is supported on the CAS server only. This means that DATA steps that run entirely on the CAS server and any actions that support VARCHAR data can use VARCHAR values. For other tasks, VARCHAR data is first converted to fixed-length character data.

For more information, see "Determining Where the DATA Step Is Running" in *SAS Cloud Analytic Services: DATA Step Programming* and the documentation for an action, procedure, or function to ensure that VARCHAR data is supported.

Calling Standard SAS Functions within Lua Statements

You can run most standard SAS functions within Lua statements by preceding the function call with a "SAS." prefix. For example, to call the SAS function MAX, precede it with "SAS." as shown here:

```
local max = sas.max(a,b,c)
```

Note: Functions that run only in the DATA step, such as ADDRLONG, do not run in Lua code.

If you do not supply a value for a required argument in a SAS function, then the SAS function converts that argument to a missing value.

Submitting SAS Code within Lua Statements

Functions That Submit SAS Code

Because Lua is a scripting language within SAS, you can submit SAS code and substitute SAS values within Lua statements. You submit SAS code by using the following functions:

Note: It is a SAS convention to document function names in all capitals. However, when you call these functions within the LUA procedure, you must use all lower-case letters.

SAS.SUBMIT(*[[SAS code]]*, {*substitution(s)*})
submits and executes the specified SAS code when the function is issued within Lua statements. Enclose SAS code within [[and]] brackets.

When substitutions are provided, they are assigned first. Any remaining substitutions are supplied by local variables.

If no substitution values are submitted, then local variables from the calling function environment are used. Enclose variables for substitution within @ symbols. For example, to assign the value of a variable called userID to a variable user, issue the following assignment:

```
user = @userID@
```

Here is an example that shows the use of a substitution with the call to SAS.SUBMIT.

```
sas.submit([[
   data @name@;
   x = @x@;
run;
]],{name="foo"})
```

When you submit SAS code, do not include these keywords within SAS comments:

run; %macro
quit; %mend

The presence of these keywords within comments in a SAS code block might trigger warnings or errors in the SAS log and might cause unexpected results. To avoid this situation, modify the keywords by placing blank spaces or escape characters within them. For example, `run ;` or `\%\macro` within a comment would not trigger unexpected behavior.

The return value from SAS.SUBMIT is assigned to the value of the SYSERR automatic macro variable.

SAS.SUBMIT_(*SAS code*, *substitution(s)*)
: submits SAS code and substitution values but does not execute the code. You must issue the SAS.SUBMIT function (no underscore) to run all submitted SAS commands and end preceding calls to SAS.SUBMIT_.

  If no substitution values are submitted, then local variables from the calling function environment are used. Enclose variables for substitution within @ symbols.

For more information, see "Opening a SAS Data Set within Lua Code" on page 1425.

About Lua Variable Substitution within SAS Statements

Variable substitutions are made via a hash table that contains key-value pairs. The key-value pairs are defined by the Lua variable assignments that are made within the submitted Lua statements. To substitute a value, enclose a key within @ symbols, such as @key@. The value of @key@ is replaced with its corresponding value. All substitutions are case sensitive, so @key@ and @Key@ are different key values.

Scope for PROC LUA

Any filerefs, librefs, and local variables that are defined within a call to PROC LUA are defined only for the duration of that procedure call. Similarly, macro variables and macro definitions that are created within a PROC LUA call can be used only within that procedure call. You cannot refer to these objects outside of the LUA procedure.

How PROC LUA Interprets Math.Huge

In Lua, the constant math.huge is a computer representation of infinity. SAS represents this value with the constant value 1.7976931348623E308.

How Lua Interprets Boolean Values

Lua has two data types that are used in the Boolean context. There is a Nil type, which can take the single value of **`nil`**. There is a Boolean type, which can take values **`true`** or **`false`**. In Lua, the values **`nil`** or **`false`** are considered to be false. All other values, including 0, are considered to be true.

In SAS, there are many numeric functions that return a value of 1 if a condition is true and 0 if that condition is false. Examples of these functions include SYMEXIST, SYMLOCAL, SYMGLOBAL, and MISSING. Other SAS functions, such as the ANY* character functions, search a string for given characters and return the position of the first occurrence in the string. These functions return 0 if the characters are not found.

If you call any of these SAS functions in your Lua code, make sure that your Lua code interprets the results as intended.

For example, suppose that the macro variable FOOBAR is not defined. Therefore, it does not exist in a local symbol table. The following code incorrectly states that the variable does exist and is local.

```
/* INCORRECT use of SAS Boolean functions */
proc lua;
   submit;
      if sas.symexist("foobar") then
         if sas.symlocal("foobar") then
            print("In Proc LUA, foobar exists and is LOCAL.")
         else
            print("In Proc LUA, foobar exists but is not LOCAL.")
         end
      else
         print(In Proc LUA, foobar does not exist.")
      end
   endsubmit;
run;
```

The preceding code incorrectly states that FOOBAR exists and is local, because the 0 value that is returned by the SAS functions SYMEXIST and SYMLOCAL are interpreted as true in Lua.

Instead, when you call SAS Boolean functions, explicitly test for the desired return value in your Lua code. The following code correctly tests to see whether the macro variable FOOBAR exists and is local.

```
/* CORRECT use of SAS Boolean functions */
proc lua;
   submit;
      if sas.symexist("foobar") == 1 then
         if sas.symlocal("foobar") == 1 then
            print("In Proc LUA, foobar exists and is LOCAL.")
         else
            print("In Proc LUA, foobar exists but is not LOCAL.")
         end
      else
         print("In Proc LUA, foobar does not exist.")
      end
   endsubmit;
run;
```

The preceding code correctly states that the macro variable FOOBAR does not exist and is not local, because it was never defined. The return value of 0 from the SAS function SYMEXIST is now explicitly compared to the value 1.

Data Set Functions for the LUA Procedure

The following functions have been defined to run in the LUA procedure. These functions interact with SAS or with data sets.

For small data sets, you can read an entire SAS data set into a Lua table. You can then modify or query the Lua table, and you can write changes to a new SAS data set. However, for large data sets, it is more efficient to process the data one observation at a time, as you would with a DATA step. For this reason, you should submit a DATA step within your Lua code for large data sets.

Here are the data set functions that run within the LUA procedure:

Note: It is a SAS convention to document function names in all capitals. However, when you call these functions within the LUA procedure, you must use all lower-case letters.

SAS.ADD_VARS(*data-set-ID*, *variable-definitions*)
adds the specified Lua variables to a new data set. That is, use SAS.ADD_VARS only when you open a data set using SAS.OPEN with mode 'o'.

The format for defining variables is as follows:

```
{ {name="varname", type="N|C",
format="format.", length="value",
label="varlabel", informat="informat."},
{additional variable definition}, ...
}
```

Only the variable name is required. The default variable type is numeric (N) if the Lua variable with the same name is also numeric. The default length of character variables is 200.

You can specify full SAS formats, such as `format="best12.3"`. If you supply a format that includes a period (.), then the system expects that the format is complete and additional format attributes are ignored. If you do not supply a full SAS format, you can use a combination of these variable attributes to provide the format of a variable:

- FORMAT specifies no length nor decimal specification (for example, `format="best"`)
- FORMAT_WIDTH specifies the number of characters or digits (for example, `format_width=12`)
- FORMAT_DEC specifies the number of decimal places (for example, `format_dec=3`)

For more information, see "Example 12: Defining and Adding Variables to a Data Set" on page 1452.

SAS.ATTR(*data-set-ID*, *attribute-name*)
returns the value of *attribute-name* for a data set. For example, `sas.attr(data-set-ID, 'label')` returns the label for the specified data set.

SAS.CLOSE(*data-set-ID*)
closes an open data set. This function exits if the data set ID is not valid.

SAS.EXISTS(*SAS-data-set-name*)
returns the Boolean value **`true`** if the data set exists or **`false`** if the data set does not exist.

Note: This function is different from the standard SAS function EXIST (with no 's' as the end), which returns a 0 or 1 value. In Lua code, 0 and 1 are interpreted as true. As an alternative, test whether the condition `(sas.exist("work.test") > 0)` is true. The SAS.EXISTS function is available only within Lua code blocks.

SAS.NOBS(*data-set-ID*)
returns the number of observations in a data set.

SAS.NVARS(*data-set-ID*)
returns the number of variables in a data set.

SAS.OPEN(*SAS-data-set-name<, mode>*)
opens a SAS data set and returns a data set ID if the data set opens successfully. If the data set does not open, then the function returns **`nil`**. Therefore, use the SAS.EXISTS function before calling the SAS.OPEN function.

In SAS 9.4M5, support was added for specifying data set options, such as KEEP=, DROP=, or WHERE=. For example, you can open the data set Sashelp.Class and keep only the variable Age with the following code:

```
local dsid = sas.open('sashelp.class(keep=age)')
```

Valid data set modes are *I* (for reading), *O* (for creating), and *U* (for updating). If you do not supply a value for data set mode, then the default value of I is used.

SAS.READ_DS(*SAS-data-set-name*)
returns a Lua table that contains the data from the specified SAS data set. If the data set does not exist, the function returns **`nil`**. Therefore, use the SAS.EXISTS function before calling the SAS.READ_DS function.

As a best practice, use the SAS.READ_DS function for small data sets only. For large data sets, iterate over observations with the functions that process individual observations. For more information, see "Functions That Process Observations" on page 1414.

Alias: SAS.LOAD_DS(*SAS-data-set-name*)

SAS.SET_ATTR(*data-set-ID*, *attribute-name*, *value*)
assigns a value to an attribute of a data set.

SAS.WHERE(*data-set-ID*, *where-clause*)
applies a WHERE clause to a data set. If there is a previously existing WHERE clause for the data set, then the specified WHERE clause is added to the previous one. However, if the Boolean value for the optional *replace-where-clause* argument is true, then the specified WHERE clause replaces a previously existing WHERE clause.

The return code from this function is an integer value. Because Lua interprets all integer values as true, explicitly test the return value to see whether it is equal to 0 (false in SAS).

Operations such as `sas.where(dsid, "also <new condition>")`, `sas.where(dsid, "undo")`, and `sas.where(dsid, "clear")` are supported. For more information, see *SAS Component Language: Reference*.

You can submit Lua statements similar to the following to apply a WHERE clause to a data set:

```
sas.submit("data work.air; set sashelp.air; run;")
dsid = sas.open("work.air")
rc, msg = sas.where(dsid,"air=222 or air=999")
print(rc, msg)
rc=sas.close(dsid)
```

SAS.WRITE_DS(*Lua-table*, *SAS-data-set-name*)
creates a SAS data set from a Lua table. You can specify a two-level name for the SAS data set, such as Work.Random. The Lua table must conform to the same structure that is returned by the SAS.READ_DS function.

Processing Data Set Observations

Functions That Process Observations

You can use the following Lua functions to process individual observations within a data set. You must first open the data set in Update mode ('u').

Note: It is a SAS convention to document function names in all capitals. However, when you call these functions within the LUA procedure, you must use all lower-case letters.

SAS.APPEND(*data-set-ID*)
appends a newly created observation to a data set.

SAS.DELOBS(*data-set-ID*)
deletes the current observation in a data set.

SAS.GET_VALUE(*data-set-ID*, *variable-number | variable-name*)
returns the value of the specified variable in the current observation. Identify the variable by its position (number) in the data set or by its name.

SAS.NEXT(*data-set-ID*)
moves to the next observation in a data set for processing. If you have not yet begun processing a data set, the SAS.NEXT function moves to the first observation in that data set. The SAS.NEXT function enables you to work directly with a SAS data set without needing to first read the data into a Lua table. This function is useful for large data sets.

SAS.PUT_VALUE(*data-set-ID*, *variable-name*, *value*)
loads a value into the specified variable in a data set.

Note: The SAS.PUT_VALUE function and syntax replaced the SAS.PUT function and syntax in SAS 9.4M5. Use only the name to identify a variable, not the position in the data set, which was allowed with the SAS.PUT function.

SAS.ROWS(*data-set-ID*)
iterates over the observations in a data set, loads each row into a Lua table for processing, and adds a Lua nil at the end of processing. This function is useful for data sets with relatively few variables.

SAS.UPDATE(*data-set-ID*)
updates an observation with values that were added by calling the SAS.PUT_VALUE function.

SAS.VARS(*data-set-ID*)
iterates over the variables in a data set.

Sequence to Add an Observation

To add a new observation, call the observation-processing functions in the following order:

1. SAS.APPEND.
2. SAS.PUT_VALUE. Repeat this function call until values are set for all desired variables in an observation.
3. SAS.UPDATE.

Out of Scope Warning

If a data set ID (handle) goes out of scope, then the associated SAS data set is automatically closed if it has not been closed already. A warning similar to the following appears in the SAS log:

```
WARNING: Closing SASHELP.CLASS - handle has gone out of scope.
```

A data set ID goes out of scope when the program is no longer able to access it. For example, when a data set ID is defined as a local variable in a user-defined function, the data set ID becomes out of scope at the end of that function definition. As a best practice, close a data set before the data set ID goes out of scope.

System Functions for the LUA Procedure

The following functions control the behavior of SAS code that is submitted from within the LUA procedure. For more information, see "Submitting SAS Code within Lua Statements" on page 1409.

Note: It is a SAS convention to document function names in all capitals. However, when you call these functions within the LUA procedure, you must use all lowercase letters.

SAS.GET_MAX_SYSERR()
: returns the current maximum SYSERR value that can be returned from calls to SAS.SUBMIT without triggering an error in the SAS log.

SAS.IS_QUIET()
: returns **`true`** or **`false`**, depending on the value that was set using the SAS.SET_QUIET function. This Boolean value indicates whether SAS language statements that are submitted to the SAS.SUBMIT function are written to the SAS log.

SAS.SET_MAX_SYSERR(*value*)
: specifies the maximum allowable SYSERR value that can be returned by SAS.SUBMIT calls. If SAS returns a SYSERR value greater than the specified value, an error is printed in the SAS log. The default is zero, and possible values include positive integers.

SAS.SET_QUIET(*value*)
: specifies whether SAS language statements that are submitted to the SAS.SUBMIT function are written to the SAS log.

  Possible argument values are **`true`** or **`false`**. The default value is **`false`**.

About Lua Libraries

Lua Libraries and SAS Extensions to Lua

The Lua programming language contains several libraries that can be used to manipulate tables and strings and to perform common math functions. Most of these functions are available to the LUA procedure. In addition, there are functions that were created for PROC LUA as an extension of the Lua language. These functions enable you to work with tables and strings and to perform calculations on your data. These extension functions are available within PROC LUA, but they are

not part of the Lua programming language and cannot be used outside of PROC LUA.

Restrictions to the Lua IO Library

When SAS is running in lockdown mode (in a locked-down state), access to functions in the Lua IO library is restricted. It is possible for a SAS administrator to disable this restriction. For more information, see LOCKDOWN Statement.

Table Functions for PROC LUA

Here some of the table functions that are available with PROC LUA. You call these functions by preceding them with 'TABLE', such as `table.size(t)`.

Note: It is a SAS convention to document function names in all capitals. However, when you call these functions within the LUA procedure, you must use all lower-case letters.

Here are some of the commonly used table functions from the Lua table library that are available to PROC LUA.

TABLE.CONCAT(*Lua-table*<, "*delimiter*"><, *start-position*<, *end-position*>>)

TABLE.INSERT(*Lua-table*, <*position*, > *value*)

TABLE.REMOVE(*Lua-table*<, *position*>)

TABLE.SORT(*Lua-table*<, *comparison-function*>)

Here are table functions that have been created specifically for PROC LUA. These functions can be called only within PROC LUA.

TABLE.CONTAINS(*Lua-table-name*,*v*)
returns the Boolean value **`true`** if the specified table contains the value *v*. Enclose character values in single or double quotation marks.

For example, suppose you have created table T with a list of names. You can check to see whether a text string is contained in that table and print an appropriate message to the log.

```
local t = {"John", "Paul", "George", "Ringo"}

if (table.contains(t,"Ringo")) then
   print ("The table contains 'Ringo'.")
else
   print ("The table does not contain 'Ringo'.")
end
```

TABLE.SIZE(*Lua-table-name*)
returns the number of elements in the specified table.

TABLE.TOSTRING(*Lua-table-name*)
returns a formatted string representation of the specified table.

For more information, see "Example 3: Loading a SAS Data Set and Viewing the Resulting Lua Table" on page 1428 and "Example 5: Using Table Functions" on page 1434.

Functions That Manipulate Strings

Here are the string functions that are available with PROC LUA. You call these functions by preceding them with 'STRING', such as `string.trim(`*`text-variable`*`)`.

Note: It is a SAS convention to document function names in all capitals. However, when you call these functions within the LUA procedure, you must use all lowercase letters.

These string functions have been created specifically for PROC LUA. These functions can be called only within PROC LUA.

STRING.ENDS_WITH(*string1*, *string2*)
returns a Boolean that indicates whether the end of String1 matches the value of String2. The comparison is case sensitive. Enclose a literal text value in quotation marks.

Note: Support for STRING.ENDS_WITH was added in SAS Viya 3.4.

STRING.RESOLVE(*string*, {token1="*text-value1*"<, token2="*text-value2*"<, ...>>});
returns a string with tokens substituted into it. You provide a string variable with a value that contains substitution tokens in the format @*token-name*@. For each token, you provide a text value to substitute into the returned string value.

For example, suppose you have declared the variable Code:

```
local code="data @results@; set @in@; where @where@; run;"
```

You can provide substitute values for the tokens results, in, and where:

```
string.resolve(code, {results="work.foo", in="bar", where="x > 2"})
```

This call to STRING.RESOLVE returns this string:

```
data work.foo; set bar; where x > 2; run;
```

Note: Support for STRING.RESOLVE was added in SAS Viya 3.4.

STRING.SPLIT(*string*, *delimiter*, *remove-empty-strings*)
separates a string value into a table of substrings by using the specified delimiter value. Enclose the delimiter value in single or double quotation marks or inside double square brackets ([[ ]]). Use the last argument, a Boolean value, to specify whether to remove empty strings from the resulting table. By default, the last argument is TRUE.

Note: Support for STRING.SPLIT was added in SAS Viya 3.4.

STRING.STARTS_WITH(*string1*, *string2*)
returns a Boolean that indicates whether the beginning of String1 matches the value of String2. The comparison is case sensitive. Enclose a literal text value in single or double quotation marks or inside double square brackets ([[ ]]).

Note: Support for STRING.STARTS_WITH was added in SAS Viya 3.4.

STRING.TRIM(*string*)
returns a string with whitespace characters removed from the beginning and end of the original string value. Enclose literal text in single or double quotation marks or inside double square brackets ([[ ]]).

Note: Support for STRING.TRIM was added in SAS Viya 3.4.

For more information, see "Example 6: Using String Functions" on page 1436.

Object Syntax within Lua Statements

For some objects, such as data set IDs, Lua code supports object syntax, where you specify a function preceded by the object that the function is to act upon. For example, the following Lua statements are equivalent:

```
local luavar = sas.get_value(dsid, 'some_var')

local luavar = dsid:get_value('some_var')
```

Make sure that you use a colon (:) when placing the object name before the function that it acts upon.

Similarly, the following code block from "Example 11: Using Iterator Functions for a Large Table" on page 1449 could be written in two ways.

```
-- Iterate over the rows of the data set
local i=0
while sas.next(dsid) do
   i=i+1
   print("OBS=" .. i)
   for vname,var in pairs(vars) do
      print(vname, '=', sas.get_value(dsid, vname) )
   end
end
```

The SAS.NEXT and SAS.GET_VALUE functions can both be represented with object syntax.

```
-- Iterate over the rows of the data set
local i=0
while dsid:next() do
   i=i+1
```

```
      print("OBS=" .. i)
      for vname,var in pairs(vars) do
         print(vname, '=', dsid:get_value(vname) )
      end
   end
```

Calling PROC FCMP Functions within Lua Statements

You can submit functions that are created using the FCMP procedure within Lua code. When you call PROC FCMP functions, you must specify the package in which the function is stored in the SAS OPTIONS statement.

If a PROC FCMP function modifies one of its arguments, that argument is specified in the OUTARGS statement. To retrieve changes to an argument in the OUTARGS statement within Lua code, that argument must be defined as an array.

For more information, see the following information:

- Chapter 24, “FCMP Procedure,” on page 873
- “Example 14: Running PROC FCMP Functions” on page 1458

Using the FULLSTIMER Option with PROC LUA

When you use the FULLSTIMER option with PROC LUA, the run times that FULLSTIMER reports in the log reflect the aggregate of run times for SAS code that is called within the LUA procedure. The run times include the run time of the LUA procedure itself.

For example, consider PROC LUA code that calls the SORT procedure three times. You might see the following output in the SAS log.

Output 39.1 *PROC LUA Output Using FULLSTIMER*

```
proc sort data=one; by i; run;
NOTE: There were 10000 observations read from the data set WORK.ONE.
NOTE: The data set WORK.ONE has 10000 observations and 2 variables.
NOTE: PROCEDURE SORT used (Total process time):
real time           0.03 seconds
user cpu time       0.03 seconds
system cpu time     0.00 seconds
memory              2252.60k
OS Memory           14492.00k
Timestamp           10/20/2015 11:43:40 AM
Step Count                        10  Switch Count  0

proc sort data=two; by i; run;
NOTE: There were 10000000 observations read from the data set WORK.TWO.
NOTE: The data set WORK.TWO has 10000000 observations and 2 variables.
NOTE: PROCEDURE SORT used (Total process time):
real time           8.03 seconds
user cpu time       12.34 seconds
system cpu time     0.70 seconds
memory              71231.17k
OS Memory           83136.00k
Timestamp           10/20/2015 11:43:48 AM
Step Count                        10  Switch Count  0

proc sort data=three; by i; run;
NOTE: There were 100 observations read from the data set WORK.THREE.
NOTE: The data set WORK.THREE has 100 observations and 2 variables.
NOTE: PROCEDURE SORT used (Total process time):
real time           0.01 seconds
user cpu time       0.00 seconds
system cpu time     0.01 seconds
memory              71231.17k
OS Memory           83136.00k
Timestamp           10/20/2015 11:43:48 AM
Step Count                        10  Switch Count  0

NOTE: PROCEDURE LUA used (Total process time):
real time           8.15 seconds
user cpu time       12.37 seconds
system cpu time     0.78 seconds
memory              71231.17k
OS Memory           83136.00k
Timestamp           10/20/2015 11:43:48 AM
Step Count                        10  Switch Count  0
```

In the output, the system CPU time, 0.78 seconds, reflects the aggregate of the calls to PROC SORT and additional CPU time that is used by PROC LUA.

Syntax: LUA Procedure

PROC LUA <INFILE='*filename*'> <RESTART> <TERMINATE>;

<SUBMIT <"*assignment(s);*">;>

... Lua statements ...

<ENDSUBMIT;>

```
run;
```

Statement	Task
PROC LUA	Execute Lua statements within SAS code or specify a file that contains Lua statements to execute
SUBMIT	Identify the beginning of a block of Lua statements
ENDSUBMIT	Identify the end of a block of Lua statements

PROC LUA Statement

Runs Lua statements within a SAS session.

Syntax

PROC LUA <INFILE='*filename*'> <RESTART> <TERMINATE>;

Optional Arguments

INFILE= '*filename*'
identifies a source file that contains Lua statements to run within a SAS session. SAS expects this file to end with a `.lua` file extension, but do not include the extension in the filename that you specify.

Requirements: Enclose the filename in single or double quotation marks.

If you use the INFILE= option, then you must specify the path to the Lua script. Define the path to your Lua scripts by providing a value for the LUAPATH filename before the PROC LUA statement. For more information, see "Example 2: Specifying Input from an External Lua Script" on page 1427.

Example: Specify
`INFILE='open_data'`
to use the code in the open_data.lua Lua script file.

RESTART
resets the state of Lua code submissions for a SAS session. The LUA procedure is a reentrant procedure that maintains the state for Lua code across calls to the LUA procedure. This means that global Lua variable assignments or function definitions remain in memory until you issue the RESTART option, issue the TERMINATE option, or end the SAS session.

You can specify RESTART at the beginning of a new block of Lua code.

Example
```
proc lua restart;
submit;
  <lua statements...>
endsubmit;
run;
```

TERMINATE
stops maintaining the Lua code state in memory and terminates the Lua state when the LUA procedure completes. Subsequent calls to the LUA procedure begin a new instance of the Lua code state.

SUBMIT Statement

Identifies the beginning of a block of Lua code. Enter Lua statements between the SUBMIT and ENDSUBMIT statements.

Requirement: Each SUBMIT statement must have a corresponding ENDSUBMIT statement.

Syntax

SUBMIT <*'assignment(s);'*>;

Optional Argument

assignment(s)
identifies one or more macro variable assignments that are passed to the block of Lua statements. If only one assignment is listed, then the semicolon (;) within the quotation marks is not required. SAS does not expand macro variables within a block of Lua statements. Therefore, macro values must be passed within the list of assignments for the SUBMIT statement.

Example To assign the value of macro variable N to the Lua variable Name, enter the following SUBMIT statement:
```
SUBMIT "name=&n";
```

ENDSUBMIT Statement

Identifies the end of a block of Lua statements. Do not enter any other statement on the same line as the ENDSUBMIT statement.

Syntax

ENDSUBMIT;

Usage: LUA Procedure

Submitting Lua Statements within a SAS Program

You can submit Lua statements within the PROC LUA invocation, between SUBMIT and ENDSUBMIT statements. The following code executes a single Lua print statement.

```
proc lua;
submit;
   print("Hello from Lua")
endsubmit;
run;
```

Any filerefs, librefs, macro variables, and so on, that you define within a SUBMIT and ENDSUBMIT block are available only within that block of code.

For example, the macro variable Mymacrovar is defined within the SUBMIT and ENSUBMIT block in the following call to PROC LUA. However, the variable is not defined in the %PUT statement at the end of the example.

```
proc lua restart;
submit;
   sas.submit([[%let mymacrovar=Hi there;]])
   txt = sas.symget("mymacrovar")
   print(txt)
endsubmit;
run;

%put &mymacrovar;
```

Output 39.2 *Scope for Macro Variable in PROC LUA*

```
%let mymacrovar=Hi there;
Hi there
NOTE: PROCEDURE LUA used (Total process time):
      real time           0.14 seconds
      cpu time            0.07 seconds


WARNING: Apparent symbolic reference MYMACROVAR not resolved.
17
18   %put &mymacrovar;
&mymacrovar
```

Opening a SAS Data Set within Lua Code

Calling the SAS.SUBMIT function enables you to submit a block of SAS code. Enclose the SAS code within [[and]] brackets. The submitted code in this sample first verifies that the SAS data set exists. You can make any changes to the data, via the submitted DATA step, that you would in Base SAS code.

```
/* Test whether a data set exists */
proc lua;
submit;
   if sas.exists("sashelp.air") then
      print("The data set SASHELP.AIR exists.")
   else
      print("The data set SASHELP.AIR does not exist.")
   end
endsubmit;
run;
```

If the data set exists, then you can open the data set and read it into a new data set, WORK.AIR. You can make any changes to the data via the submitted DATA step that you would in a typical DATA step.

Note: Longer blocks of SAS code are typically assigned to a Lua variable.

```
proc lua;
submit;
   sas.submit( [[ data work.air; set sashelp.air; run; ]] )
endsubmit;
run;
```

You can also substitute Lua variable values within the SAS code. The following code shows simple substitutions. For more information, see "Example 9: Submitting SAS Code with Lua Variable Substitutions" on page 1444.

```
proc lua;
submit;
   local dest = 'work.class'
   local source = 'sashelp.class'
```

```
   sas.submit( [[ data @dest@; set @source@; run; ]] )
endsubmit;
run;
```

Examples: LUA Procedure

Example 1: Create a Sample Data Set

This example creates a sample SAS data set, Homes, that contains several variables and 20 observations. This data set is the input for some of the examples that follow.

Here is the code to create a sample data set that can be accessed using PROC LUA.

```
data homes;
  input bad loan mortdue value reason $ job $ yoj derog delinq
        clage ninq clno debtinc;
datalines;
1 1100  25860  39025  HomeImp Other  10.5 0 0 94.37  1 9  .
0 4700  71855  88566  HomeImp Other  2.0  2 0 283.96 0 5  36.475
0 5500  72147  69918  HomeImp Sales  4.0  2 0 158.53 0 23 43.404
1 6400  25144  45200  HomeImp Other  25.0 0 2 128.00 4 17 .
0 7000  58114  93391  HomeImp ProfEx 6.0  0 0 200.08 1 24 31.737
1 7900  67222  75189  HomeImp Other  4.0  0 0 95.68  0 23 36.980
0 8300  54039  89301  HomeImp Other  18.0 0 0 173.19 0 28 26.267
0 8800  .      32221  DebtCon Other  0.0  0 0 276.84 0 14 24.199
0 9400  71600  99682  DebtCon Other  16.0 . . 159.04 4 16 25.607
0 10000 68807  76581  HomeImp Office 14.0 0 0 237.65 0 32 42.336
0 10200 16322  86505  DebtCon Other  8.0  0 0 259.16 0 14 21.253
0 10700 115118 124198 DebtCon Self   6.0  1 0 174.34 0 19 31.758
0 11100 148235 182053 HomeImp Office 4.0  0 0 198.81 0 55 33.539
0 11700 56441  86987  HomeImp Other  17.0 0 0 198.03 0 16 33.931
0 12100 58556  76724  HomeImp Other  3.0  0 1 234.66 1 16 37.639
0 12500 81865  101048 DebtCon Other  1.0  0 0 147.40 0 23 38.855
0 12900 18106  37881  DebtCon Mgr    8.0  0 0 134.38 0 10 20.516
0 13400 98701  129679 HomeImp ProfEx 10.0 0 0 179.13 2 32 29.549
1 13900 .      .      HomeImp Other  4.0  0 2 209.48 0 15 35.775
0 14400 45516  63924  DebtCon Other  .    0 0 109.33 1 19 40.872
;
```

Example 2: Specifying Input from an External Lua Script

Features: FILENAME statement
PROC LUA statement, INFILE= option

Details

This example specifies an external Lua script and one or more possible paths to that script by using the FILENAME statement and the INFILE= option in the PROC LUA statement.

Program

```
filename LUAPATH ('/usr/local/scripts/lua','/home/user/myname/
my_scripts');

proc lua infile='my_script';
run;
```

Program Description

Specify the directories to search for the input Lua script. The FILENAME statement defines the directories in which Lua scripts are stored and assigns them to the LUAPATH fileref. Enclose a directory path within single or double quotation marks.

```
filename LUAPATH ('/usr/local/scripts/lua','/home/user/myname/
my_scripts');
```

Execute the PROC LUA statement and specify the Lua script name. The INFILE= option provides the name of the Lua script that contains Lua statements. In this example, SAS executes the Lua statements in the my_script.lua file. Do not specify the '.lua' or '.luc' file extension. Check the package.path variable for your system to see whether LUA or LUC files are opened first.

```
proc lua infile='my_script';
run;
```

Example 3: Loading a SAS Data Set and Viewing the Resulting Lua Table

Features: SAS.EXISTS function
SAS.READ_DS function
Observation processing: WHILE and FOR loops

Details

This example uses the Homes data set that you created in Example 1.

In this example, you read the SAS data set Homes and print the data to the SAS log. Treat individual observations as an entry in an array. Each array entry contains associated attributes that are derived from the variables in the original SAS data set. For example, the value of t[2].loan is **4700**.

Program

```
proc lua;
submit;
   if (sas.exists("work.homes")) then
      local t = sas.read_ds("work.homes")
      i=1

      while(t[i] ~= nil) do
         print("Obs #" .. i)
         for k,v in pairs(t[i]) do
             print(k,v)
         end
         print("\n")
         i = i+1
      end

   end
endsubmit;
run;
```

Program Description

Verify that the SAS data set Homes exists and read it into the Lua table T. Each observation in the data set can be accessed as if it were in an array, such as t[i].

```
proc lua;
submit;
   if (sas.exists("work.homes")) then
      local t = sas.read_ds("work.homes")
      i=1
```

Process each observation in the data set. Initialize an iterator, i, and process each observation by using a WHILE loop. Check to see whether the next observation exists and then print each variable-value pair. Use a FOR loop to process each variable name and value, printing both to the SAS log. At the end of each observation, print a newline character and increment i.

```
      while(t[i] ~= nil) do
         print("Obs #" .. i)
         for k,v in pairs(t[i]) do
             print(k,v)
         end
         print("\n")
         i = i+1
      end
```

Submit the PROC LUA call to SAS.

```
   end
endsubmit;
run;
```

Output: Lua Table

Output 39.3 *Sample Lua Data*

```
Obs #1
reason    HomeImp
derog    0
job    Other
yoj    10.5
clno    9
loan    1100
bad    1
debtinc    .
mortdue    25860
value    39025
clage    94.37
ninq    1
delinq    0

...
Obs #20
reason    DebtCon
derog    0
job    Other
yoj    .
clno    19
loan    14400
bad    0
debtinc    40.872
mortdue    45516
value    63924
clage    109.33
ninq    1
delinq    0


NOTE: PROCEDURE LUA used (Total process time):
      real time           0.17 seconds
      cpu time            0.18 seconds
```

Example 4: Writing a SAS Data Set from a Lua Table

Features: PROC LUA statement
SUBMIT and ENDSUBMIT statements
SAS.WRITE_DS function
TABLE.TOSTRING function

Details

This example creates a Lua table and then writes that table to a SAS data set. The values in the Lua table are generated by calling the SAS RANNOR and RANUNI random number generator functions. This code also uses Lua conventions for processing arrays.

Program

```
proc lua;
submit;
   local tbl = {}

   for i=1,10 do
       vars = {}
       vars.seed = 1234 * i;
       vars.randnor = sas.rannor( vars.seed )
       vars.randuni = sas.ranuni( vars.seed )
       vars.color = "purple"
       tbl[#tbl+1] = vars
   end

   print("Lua table:", table.tostring(tbl))

   sas.write_ds(tbl, "work.random")
endsubmit;
run;

proc print data=random;run;
```

Program Description

Execute the PROC LUA statement and begin a block of Lua code. Declare a local Lua array called `TBL`.

```
proc lua;
submit;
   local tbl = {}
```

Generate the contents of the Lua table. This example generates the content for the array `TBL`. The variables Seed, Randnor, Randuni, and Color are created and assigned a value over ten iterations of a FOR loop.

```
   for i=1,10 do
       vars = {}
```

```
        vars.seed = 1234 * i;
        vars.randnor = sas.rannor( vars.seed )
        vars.randuni = sas.ranuni( vars.seed )
        vars.color = "purple"
        tbl[#tbl+1] = vars
    end
```

Print the generated Lua table. The resulting Lua table is printed to the SAS log.

```
    print("Lua table:", table.tostring(tbl))
```

Write the Lua table to a SAS data set. This example writes the Lua table to a SAS data set called Random in the Work library. By saving the data set to the Work library, it is accessible only within the same SAS session. You can save the data set permanently by saving it to a library, such as Sasuser.

```
    sas.write_ds(tbl, "work.random")
endsubmit;
run;
```

Print the SAS data set. After you have written the SAS data set, you can access it outside of the LUA procedure. If you save the data set to a library, such as Sasuser, then the data set is accessible in later SAS sessions.

```
proc print data=random;run;
```

Output: SAS Table from a Lua Table

Output 39.4 *Partial Lua Table from the SAS Log*

```
Lua table:    table: 000000002892EAE0=
{
  [1]=table: 00000000289359A0=
  {
    ["color"]="purple"
    ["randuni"]=0.3831937143
    ["randnor"]=1.4215132075
    ["seed"]=1234
  }
  [2]=table: 0000000028937640=
  {
    ["color"]="purple"
    ["randuni"]=0.088249594
    ["randnor"]=-0.102644377
    ["seed"]=2468
  }
  [3]=table: 000000000C195400=
  {
    ["color"]="purple"
    ["randuni"]=0.4458283407
    ["randnor"]=2.0089305781
    ["seed"]=3702
  }
  [4]=table: 0000000028928FE0=
  {
    ["color"]="purple"
    ["randuni"]=0.4562234927
    ["randnor"]=1.9125666228
...
```

Output 39.5 *Generated SAS Table*

The SAS System

Obs	seed	randuni	randnor	color
1	1234	0.38319	1.42151	purple
2	2468	0.08825	-0.10264	purple
3	3702	0.44583	2.00893	purple
4	4936	0.45622	1.91257	purple
5	6170	0.96744	1.82697	purple
6	7404	0.37316	-0.63993	purple
7	8638	0.28390	-1.49036	purple
8	9872	0.43640	-0.05252	purple
9	11106	0.00276	-0.45912	purple
10	12340	0.23450	0.96227	purple

Example 5: Using Table Functions

Features:
PROC LUA statement
SUBMIT and ENDSUBMIT statements
TABLE.CONCAT function
TABLE.INSERT function
TABLE.REMOVE function
TABLE.SIZE function
TABLE.SORT function
TABLE.TOSTRING function

Details

This example creates a simple table, prints the number of elements, and prints the table to the SAS log.

Program

```
proc lua;
submit;

  local t={"a", "b", "c", "foo", "bar"}

  print(table.size(t))
  print("Output with function TABLE.TOSTRING")
  print(table.tostring(t))
  print("Output with function TABLE.CONCAT")
  print(table.concat(t, ", "))

  print("Inserting and Removing Values")
  table.insert(t,5,"new")
  print("Table with new value: ", table.concat(t,", "))
  table.remove(t,4)
  print("Table after removing value at position 4: ",
table.concat(t,", "))

  print("Sorting a Table")
  table.sort(t)
  print("Table with sorted values: ",table.concat(t,", "))
  table.sort(t, function(a,b) return a>b end)
```

```
  print("Table sorted in descending order: ",table.concat(t,", "))
endsubmit;
run;
```

Program Description

Execute the PROC LUA statement. The PROC LUA statement enables you to call Lua code within your SAS session.

```
proc lua;
```

Identify the beginning of a block of Lua statements. The SUBMIT statement identifies the beginning of a block of Lua statements.

```
submit;
```

Create a simple table. Assign elements in a table T.

```
  local t={"a", "b", "c", "foo", "bar"}
```

Print information about the table. Print the number of elements in the table and then print the table using the TABLE.TOSTRING function and the TABLE.CONCAT function.

```
  print(table.size(t))
  print("Output with function TABLE.TOSTRING")
  print(table.tostring(t))
  print("Output with function TABLE.CONCAT")
  print(table.concat(t, ", "))
```

Insert and remove items in the table. Print a label, and then insert the value "new" into the table in the fifth position using the TABLE.INSERT function. Print the table to see the added value. Remove the value in the fourth position in the table, "foo", using the TABLE.REMOVE function. Print the resulting table.

```
  print("Inserting and Removing Values")
  table.insert(t,5,"new")
  print("Table with new value: ", table.concat(t,", "))
  table.remove(t,4)
  print("Table after removing value at position 4: ",
table.concat(t,", "))
```

Sort values in the table. Print a label, and then sort the table in ascending order using the TABLE.SORT function. Print the resulting table to see the sorted values. Next, sort the table again and specify a function that sorts the table in descending order. Print the resulting table.

```
  print("Sorting a Table")
  table.sort(t)
  print("Table with sorted values: ",table.concat(t,", "))
  table.sort(t, function(a,b) return a>b end)
  print("Table sorted in descending order: ",table.concat(t,", "))
```

Identify the end of a block of Lua statements with the ENDSUBMIT statement.

```
endsubmit;
run;
```

Output: SAS Log That Shows Table Details

Output 39.6 *Results of TABLE Functions*

```
Output with function TABLE.TOSTRING
table: 00000000289200E0=
{
  [1]="a"
  [2]="b"
  [3]="c"
  [4]="foo"
  [5]="bar"
}
Output with function TABLE.CONCAT
a, b, c, foo, bar
Inserting and Removing Values
Table with new value:     a, b, c, foo, new, bar
Table after removing value at position 4:     a, b, c, new, bar
Sorting a Table
Table with sorted values:     a, b, bar, c, new
Table sorted in descending order:     new, c, bar, b, a
NOTE: PROCEDURE LUA used (Total process time):
      real time           0.03 seconds
      cpu time            0.01 seconds
```

Example 6: Using String Functions

Features:

PROC LUA statement
SUBMIT and ENDSUBMIT statements
STRING.ENDS_WITH function
STRING.RESOLVE function
STRING.SPLIT function
STRING.STARTS_WITH function
STRING.TRIM function

Details

This example uses the STRING functions to manipulate text values.

Program

```
proc lua;
   submit;

   mystring = "@noun@ @verb@ the @object@"

   newstring1 = string.resolve(mystring,
{noun="Pigs",verb="eat",object="pie"})
   newstring2 = string.resolve(mystring, {noun="Cars",verb="guzzle",
                               object="gasoline"})

   print ("Original string: " .. mystring)
   print ("New string 1: " .. newstring1)
   print ("New string 2: " .. newstring2)


   if string.starts_with(newstring2, "Cars") then
      print("Could be about cars: " .. newstring2)
   else
      print("Not about cars: " .. newstring2)
   end

   if string.ends_with(newstring2, "pie") then
      print ("I love pie!" .. newstring2)
   else
      print("Too bad. No pie: " .. newstring2)
   end


   mystring = "     The fox ate the chicken.  "
   trimmedstring = string.trim(mystring)

   print ("Original string between ***s: ***" .. mystring .. "***")
   print ("Trimmed string between ***s:  ***" .. trimmedstring ..
"***")


   t = string.split(mystring," ")

   for element in pairs(t) do
      print("Table index " .. element .. ", Value is: " ..
t[element] .. "\n")
   end


   endsubmit;
run;
```

Program Description

Execute the PROC LUA statement and begin processing Lua statements. The PROC LUA statement enables you to call Lua code within your SAS session. The SUBMIT statement identifies the beginning of a block of Lua statements.

```
proc lua;
```

```
submit;
```

Create a string variable and substitute different values in it. Create a string, Mystring, that contains substitution tokens Noun, Verb, and Object. Use the STRING.RESOLVE function to generate new strings, Newstring1 and Newstring2. Print the original string and the new strings to the SAS log.

```
mystring = "@noun@ @verb@ the @object@"

newstring1 = string.resolve(mystring,
{noun="Pigs",verb="eat",object="pie"})
newstring2 = string.resolve(mystring, {noun="Cars",verb="guzzle",
                            object="gasoline"})

print ("Original string: " .. mystring)
print ("New string 1: " .. newstring1)
print ("New string 2: " .. newstring2)
```

Look for matching at the beginning and end of string variables. Use the STRING.STARTS_WITH function to check whether Newstring2 begins with “Cars” and then print the appropriate message. Next, use the STRING.ENDS_WITH function to check whether Newstring2 ends with “pie” and then print the appropriate message.

```
if string.starts_with(newstring2, "Cars") then
   print("Could be about cars: " .. newstring2)
else
   print("Not about cars: " .. newstring2)
end

if string.ends_with(newstring2, "pie") then
   print ("I love pie!" .. newstring2)
else
   print("Too bad. No pie: " .. newstring2)
end
```

Trim leading and trailing whitespace characters from a string value. Assign a new value to Mystring. Use the STRING.TRIM function to remove leading and trailing whitespace characters. Print the original and trimmed strings for comparison.

```
mystring = "     The fox ate the chicken.  "
trimmedstring = string.trim(mystring)

print ("Original string between ***s: ***" .. mystring .. "***")
print ("Trimmed string between ***s:  ***" .. trimmedstring ..
"***")
```

Create a list of words in a sentence string. Use the STRING.SPLIT function to generate a list of individual words from the string Mystring. By default, blank values are not included in the resulting list. Print the list of words in Mystring.

```
t = string.split(mystring," ")

for element in pairs(t) do
   print("Table index " .. element .. ", Value is: " ..
t[element] .. "\n")
```

```
end
```

End the block of Lua statements and run the LUA procedure. End the block of Lua statements with the ENDSUBMIT statement.

```
    endsubmit;
run;
```

Output: SAS Log That Shows String Function Results

Output 39.7 *Results of STRING Functions*

```
NOTE: Lua initialized.
Original string: @noun@ @verb@ the @object@
New string 1: Pigs eat the pie
New string 2: Cars guzzle the gasoline
Could be about cars: Cars guzzle the gasoline
Too bad. No pie: Cars guzzle the gasoline
Original string between ***s: ***    The fox ate the chicken.    ***
Trimmed string between ***s: ***The fox ate the chicken.***
Table index 1, Value is: The

Table index 2, Value is: fox

Table index 3, Value is: ate

Table index 4, Value is: the

Table index 5, Value is: chicken.

NOTE: PROCEDURE LUA used (Total process time):
      real time           0.20 seconds
      cpu time            0.06 seconds
```

Example 7: Adding an Observation to a Lua Table

Features:

SAS.APPEND function
SAS.CLOSE function
SAS.GET_VALUE function
SAS.PUT_VALUE function
SAS.UPDATE function
Concatenation operator (..)

Details

This example demonstrates how to add an observation using the SAS functions in PROC LUA. First, create a simple data set, and add a record to it using the SAS.APPEND, SAS.PUT_VALUE, and SAS.UPDATE functions. Next, retrieve and print the values from the updated data set.

Program

```
data foo;
  input x y;
  id+1;
  datalines;
1 10
2 20
3 30
;

proc lua;
submit;
   dsid = sas.open("work.foo",'u')

   while(sas.next(dsid) ~= nil) do
      myid = sas.get_value(dsid,"id")
      myx = sas.get_value(dsid,"x")
      myy = sas.get_value(dsid,"y")
      print("ID: " .. myid .. " x: " .. myx .. " y: " .. myy)
   end

   while(sas.next(dsid) ~= nil) do
      myid = sas.get_value(dsid,"id")
      myx = sas.get_value(dsid,"x")
      myy = sas.get_value(dsid,"y")
      print("ID: " .. myid .. " x: " .. myx .. " y: " .. myy)
   end


   sas.append(dsid)
   sas.put_value(dsid,"id",4)
   sas.put_value(dsid,"x",4)
   sas.put_value(dsid,"y",40)
   sas.update(dsid)
   rc=sas.close(dsid)
endsubmit;
run;


proc lua restart;
submit;
   dsid=sas.open("work.foo")
```

```
   while(sas.next(dsid) ~= nil) do
      myid = sas.get_value(dsid,"id")
      myx = sas.get_value(dsid,"x")
      myy = sas.get_value(dsid,"y")
      print("ID: " .. myid .. " x: " .. myx .. " y: " .. myy)
   end


   rc=sas.close(dsid)
endsubmit;
run;
```

Program Description

Create a data set. Use the DATA step to create a small data set called Foo.

```
data foo;
  input x y;
  id+1;
  datalines;
1 10
2 20
3 30
;
```

Invoke PROC LUA and open the Foo data set for updating. Use the SAS.OPEN function to assign the contents of the Foo data set to the Dsid Lua variable. By specifying that you want to open the data set in Update mode (by using the `'u'` argument), you are able to write to the data set. If you do not specify Update mode, the data set opens in Read-Only mode by default.

```
proc lua;
submit;
   dsid = sas.open("work.foo",'u')

   while(sas.next(dsid) ~= nil) do
      myid = sas.get_value(dsid,"id")
      myx = sas.get_value(dsid,"x")
      myy = sas.get_value(dsid,"y")
      print("ID: " .. myid .. " x: " .. myx .. " y: " .. myy)
   end
```

Read the values in Foo and print them to the SAS log. Use the WHILE loop with the SAS.NEXT function to iterate through observations in the data set. For each observation, retrieve the values for Myid, Myx, and Myy from the ID, X, and Y variables, respectively. Print these values to the SAS log.

```
   while(sas.next(dsid) ~= nil) do
      myid = sas.get_value(dsid,"id")
      myx = sas.get_value(dsid,"x")
      myy = sas.get_value(dsid,"y")
      print("ID: " .. myid .. " x: " .. myx .. " y: " .. myy)
   end
```

Append a new observation and assign a value to each variable. Call the SAS.APPEND function to prepare the data set for a new observation. Assign values using the SAS.PUT_VALUE function and finally update the data set with the SAS.UPDATE function. Close the data set.

```
      sas.append(dsid)
      sas.put_value(dsid,"id",4)
      sas.put_value(dsid,"x",4)
      sas.put_value(dsid,"y",40)
      sas.update(dsid)
      rc=sas.close(dsid)
endsubmit;
run;
```

Restart PROC LUA and open the Work.Foo data set. Assign the contents of Work.Foo to the Dsid Lua variable.

```
proc lua restart;
submit;
   dsid=sas.open("work.foo")
```

Retrieve the data from the Work.Foo data set. Use a WHILE loop to process observations in the Work.Foo data set. Retrieve the values using the SAS.GET_VALUE function, and print the values to the SAS log.

```
      while(sas.next(dsid) ~= nil) do
         myid = sas.get_value(dsid,"id")
         myx = sas.get_value(dsid,"x")
         myy = sas.get_value(dsid,"y")
         print("ID: " .. myid .. " x: " .. myx .. " y: " .. myy)
      end
```

Close the Work.Foo data set.

```
      rc=sas.close(dsid)
endsubmit;
run;
```

Output 39.8 *Listing of Original Work.Foo Data Set*

```
ID: 1 x: 1 y: 10
ID: 2 x: 2 y: 20
ID: 3 x: 3 y: 30
NOTE: PROCEDURE LUA used (Total process time):
      real time           0.02 seconds
      cpu time            0.01 seconds
```

Output 39.9 *Listing of Work.Foo Data Set Appended with New Observation*

```
ID: 1 x: 1 y: 10
ID: 2 x: 2 y: 20
ID: 3 x: 3 y: 30
ID: 4 x: 4 y: 40
NOTE: PROCEDURE LUA used (Total process time):
      real time           0.16 seconds
      cpu time            0.06 seconds
```

Example 8: Using SAS Macro Variable Values within Lua Statements

Features:

PROC LUA statement
SUBMIT and ENDSUBMIT statements
Macro variable assignments
Concatenation operator (..)

Details

No macro substitution occurs between the semicolon (;) at the end of the SUBMIT statement and the beginning of the ENDSUBMIT statement, except for those within a SAS.SUBMIT code block. You must specify macro value assignments for Lua commands within the SUBMIT statement. This example shows how to assign macro variable values for use within Lua code.

Separate multiple assignments with a semicolon (;) and place all assignments within a single pair of quotation marks. This example prints the following text to the SAS log: `Hello, George. Have a nice day.`

Program

```
%let g='George';
%let h='Have a nice day.';

proc lua;

submit "name=&g; msg=&h";

   print('Hello, ' .. name .. '. ' .. msg)

endsubmit;
run;
```

Program Description

Define macro variable values. The macro variables G and H are assigned to character values. The use of single quotation marks in the macro variable assignment is required for Lua. Single quotation marks are not normally required for macro variable assignments in SAS.

```
%let g='George';
%let h='Have a nice day.';
```

Execute the PROC LUA statement. The PROC LUA statement enables you to call Lua code within your SAS session.

```
proc lua;
```

Identify the beginning of a block of Lua statements and assign any macro variables. The SUBMIT statement identifies the beginning of a block of Lua statements. This example assigns the values of the macro variables `g` and `h` to the local Lua variables `name` and `msg`, respectively. No macro expansion occurs between the end of the SUBMIT statement and the beginning of the ENDSUBMIT statement. The Lua code refers to the local Lua variables.

```
submit "name=&g; msg=&h";
```

Execute Lua statements. Enter Lua statements between the SUBMIT and ENDSUBMIT statements. Lua statements are not required to end with a semicolon (;). This example prints text values to the SAS log. Concatenate strings using the '..' operator. Each print statement that you use begins on a new line in the log.

```
   print('Hello, ' .. name .. '. ' .. msg)
```

Identify the end of a block of Lua statements with the ENDSUBMIT statement.

```
endsubmit;
run;
```

Example 9: Submitting SAS Code with Lua Variable Substitutions

Features:

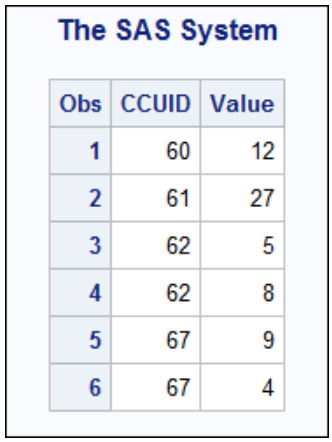
PROC LUA statement
SUBMIT and ENDSUBMIT statements
SAS.SUBMIT function
Variable substitution

Details

This example submits a block of Lua statements. Within the Lua statements, assign a block of SAS code to a local variable. The example then invokes the SAS code with the SAS.SUBMIT function and substitutes variable values.

The example uses the Work.Answer data set as input to the local Lua variable Code.

Figure 39.1 *Work.Answer Data Set*



The SAS System

Obs	CCUID	Value
1	60	12
2	61	27
3	62	5
4	62	8
5	67	9
6	67	4

Program

```
proc lua;
submit;

   local rc
   local code = [[
         data sample; set answer;
         where CCUID = @ccuid@;
         y = @subValue@;
         run;
   ]]
   rc = sas.submit(code, {ccuid="67", subValue=72})
endsubmit;
run;

proc print data=sample;
run;
```

Program Description

Execute the LUA procedure.

```
proc lua;
```

Identify the beginning of the block of Lua statements to execute. Use the SUBMIT statement to identify the Lua statements. Declare a local variable Rc. Semicolons (;) are not required at the end of Lua statements.

```
submit;

   local rc
```

Assign a block of SAS code to a local Lua variable. A block of SAS code, indicated by the [[and]] brackets, is assigned to the local Lua variable Code. The SAS code opens the WORK.ANSWER data set and keeps only records where the value of CCUID matches the value that is specified by @ccuid@. When the SAS code is executed, a value is assigned to the key `@ccuid@`. A new variable Y is assigned to the value that is specified by `@subValue@`. The resulting data set is saved to the WORK.SAMPLE data set.

```
local code = [[
      data sample; set answer;
      where CCUID = @ccuid@;
      y = @subValue@;
      run;
]]
```

Execute the SAS code and assign the result to the Lua variable Rc. The SAS.SUBMIT function tells the system to run SAS code. The code block that was assigned to the Code variable is now executed. The call to the SAS.SUBMIT function includes two variable substitutions. When the SAS code executes, the character value *"67"* is substituted for `@ccuid@`, and the value *72* is substituted for `@subValue@`.

```
rc = sas.submit(code, {ccuid="67", subValue=72})
```

The ENDSUBMIT statement identifies the end of the block of Lua statements. The RUN statement completes the call to PROC LUA.

```
endsubmit;
run;
```

Print the resulting data set, Work.Sample.

```
proc print data=sample;
run;
```

Output: SAS Table Resulting from Substituted Lua Values

Output 39.10 *Generated Work.Sample Table*

The SAS System

Obs	CCUID	Value	y
1	67	9	72
2	67	4	72

Example 10: Using an Iterator Function for a Small Table

Features: SAS.OPEN function
SAS.ROWS function
SAS.CLOSE function

Details

This example traverses a data set and prints the variable names and corresponding values for each observation. Use the SAS.ROWS function when there are relatively few variables.

Program

```
proc lua;
submit;

   local dsid = sas.open("sashelp.class")

   for row in sas.rows(dsid) do
      for n,v in pairs(row) do
         if type(n)=="string" then
            print(n,'=', v)
         end
      end
```

```
   end

   sas.close(dsid)
endsubmit;
run;
```

Program Description

Execute the PROC LUA and SUBMIT statements to begin a block of Lua code.

```
proc lua;
submit;
```

Open the Sashelp.Class SAS data set and load the contents into the Lua variable Dsid. By default, the data set is opened for reading.

```
local dsid = sas.open("sashelp.class")
```

Process the rows of the data set. The outer FOR loop processes each row in the data set. The PAIRS function pulls the variable name and value pairs from each row in the Sashelp.Class data set. The pairs of variable names and values are then printed to the SAS log. Note that in Lua, a double equal sign (==) is used to assess whether two values are equal in the IF condition.

```
for row in sas.rows(dsid) do
   for n,v in pairs(row) do
      if type(n)=="string" then
         print(n,'=', v)
      end
   end
end
```

Close the data set, end the block of Lua code, and complete the call to the LUA procedure.

```
   sas.close(dsid)
endsubmit;
run;
```

Output: ROWS Iterator for a Small Data Set

Output 39.11 *Iterating over a Small Data Set with the ROWS Function (Partial Output)*

```
sex    =    M
height    =    69
name    =    Alfred
weight    =    112.5
age    =    14
sex    =    F
height    =    56.5
name    =    Alice
weight    =    84
age    =    13
sex    =    F
height    =    65.3
name    =    Barbara
weight    =    98
age    =    13
sex    =    F
height    =    62.8
name    =    Carol
weight    =    102.5
age    =    14
...
sex    =    M
height    =    66.5
name    =    William
weight    =    112
age    =    15
NOTE: PROCEDURE LUA used (Total process time):
      real time           0.08 seconds
      cpu time            0.06 seconds
```

Example 11: Using Iterator Functions for a Large Table

Features:

SAS.OPEN function
SAS.VARS function
SAS.NEXT function
SAS.GET_VALUE function
SAS.CLOSE function

Details

This example uses the SAS.VARS and SAS.NEXT functions to traverse a SAS data set and print its contents.

Program

```
proc lua;
submit;
   local dsid = sas.open("sashelp.company") -- open for input
   local vars = {}
   -- Iterate over the variables in the data set
   for var in sas.vars(dsid) do
      vars[var.name:lower()] = var
   end
   -- Iterate over the rows of the data set
   local i=0
   while (sas.next(dsid) ~= nil) do
      i=i+1
      print("OBS=" .. i)
      for vname,var in pairs(vars) do
         print(vname, '=', sas.get_value(dsid, vname) )
      end
   end
   sas.close(dsid)
endsubmit;
run;
```

Program Description

Execute the PROC LUA and SUBMIT statements to begin a block of Lua code.

```
proc lua;
submit;
```

Open the Sashelp.Company data set.

```
local dsid = sas.open("sashelp.company") -- open for input
```

Declare a local Lua array, VARS, and populate it with the values of the variables in the data set. The brackets ({ }) identify an array in Lua. Use the SAS.VARS function to iterate over all the variables in the data set. The example assigns the value of each variable to the Vars array, where the array key is the variable name in lowercase.

```
local vars = {}
-- Iterate over the variables in the data set
for var in sas.vars(dsid) do
   vars[var.name:lower()] = var
end
```

Iterate over each data set observation and print the values for each variable. The example initializes an iterator variable, I, to 0. The SAS.NEXT iterator function then cycles through the observations in the data set. For each observation, the example prints the variable name and corresponding value for each variable.

```
-- Iterate over the rows of the data set
local i=0
```

```
   while (sas.next(dsid) ~= nil) do
      i=i+1
      print("OBS=" .. i)
      for vname,var in pairs(vars) do
         print(vname, '=', sas.get_value(dsid, vname) )
      end
   end
```

Close the data set and end the call to the LUA procedure.

```
   sas.close(dsid)
endsubmit;
run;
```

Output: Iterators with a Large Data Set

Output 39.12 *Using Iterator Functions with a Large Data Set*

```
OBS=1
level4    =    CONTRACTS
job1    =    MANAGER
level3    =    ADMIN
level2    =    TOKYO
n    =    1
depthead    =    1
level1    =    International Ai
level5    =    So Suumi
OBS=2
level4    =    CONTRACTS
job1    =    ASSISTANT
level3    =    ADMIN
level2    =    TOKYO
n    =    1
depthead    =    2
level1    =    International Ai
level5    =    Steffen Graff
...
OBS=48
level4    =    MIS
job1    =    TECH. CONS.
level3    =    TECHN. SERVICES
level2    =    NEW YORK
n    =    1
depthead    =    2
level1    =    International Ai
level5    =    Roy Hobbs
NOTE: PROCEDURE LUA used (Total process time):
      real time           0.23 seconds
      cpu time            0.21 seconds
```

Example 12: Defining and Adding Variables to a Data Set

Features:
PROC LUA statement
SAS.OPEN function with 'o' option
SAS.ADD_VARS function
SAS.CLOSE function

Details

This example defines new variables within Lua code and adds them to a data set. The example uses the SAS.ADD_VARS function to define the variables and add them to the output data set.

Program

```
proc lua;
submit;

   local dsid = sas.open("work.sample","o")

   sas.add_vars(dsid, {  {name="var1", type="N", format="BEST12.2"},
                         {name="var2", type="C", length=500,
format="$char80."},
                         {name="var3", type="C", label="Character
Data"}
                      })

   sas.close(dsid)
endsubmit;
run;
```

Program Description

Execute the PROC LUA statement and begin the block of Lua statements. The PROC LUA statement enables you to call Lua code within your SAS session. The SUBMIT statement identifies the beginning of the block of Lua statements.

```
proc lua;
submit;
```

Open the data set and assign its contents to a local Lua variable. Invoke the SAS.OPEN function to open the WORK.SAMPLE data set. Use the 'o' mode to create the data set if it does not already exist.

```
local dsid = sas.open("work.sample","o")
```

Define variables to add to the data set. This example invokes the SAS.ADD_VARS function to add three variables—Var1, Var2, and Var3—to the data set. The type, numeric (N) or character (C), is specified for each variable. Various additional attributes are assigned to the variables. Only the name attribute is required. For more information, see "Data Set Functions for the LUA Procedure" on page 1412.

```
   sas.add_vars(dsid, {  {name="var1", type="N", format="BEST12.2"},
                         {name="var2", type="C", length=500,
format="$char80."},
                         {name="var3", type="C", label="Character
Data"}
                      })
```

Close the data set and end the call to the LUA procedure. This example executes the SAS.CLOSE function to close the data set that is associated with the Lua variable Dsid.

```
   sas.close(dsid)
endsubmit;
run;
```

Output: Adding Variables to a Data Set

Output 39.13 *Partial Output from PROC CONTENTS for Work.Sample*

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Label
1	var1	Num	8	BEST12.2	
2	var2	Char	500	$CHAR80.	
3	var3	Char	200		Character Data

Example 13: Connecting to the CAS Server

Features: CAS.OPEN function
CLOSE function
SUBMIT and ENDSUBMIT statements

Details

This example shows how to connect to a CAS server. The host name is **server.mycompany.com**, the port is **5570**.

Note: This example assumes that you have SAS Viya 3.5 installed.

Program

```
proc lua;
submit;

-- Show the content of the swat_enabled variable
print("NOTE: swat_enabled=", swat_enabled)

-- Show path and cpath info at start
print("NOTE: before")
print("NOTE: package.path=\n" .. package.path)
print("NOTE: package.cpath=\n" .. package.cpath)

-- Add required directories to path and cpath
if swat_enabled == false or swat_enabled == nil then
  print("NOTE: changing path and cpath")
package.path = package.path ..
    ';/opt/sas/viya/home/SASFoundation/misc/casluaclnt/lua/?.lua'
package.path = package.path ..
    ';/opt/sas/viya/home/SASFoundation/misc/casluaclnt/lua/deps/?.lua'
package.cpath = package.cpath ..
    ';/opt/sas/viya/home/SASFoundation/misc/casluaclnt/lua/lib/?.so'

swat_enabled = true

-- Show updated path and cpath values
print("NOTE: after")
print("NOTE: package.path=\n" .. package.path)
print("NOTE: package.cpath=\n" .. package.cpath)
end

-- Preload library
cas = require "swat"


-- Connect to the CAS server on your host
s=cas.open("server.mycompany.com",5570)

-- Print the session ID
print("NOTE: s=", s)

-- Run the builtins.serverStatus action
```

```
-- and display session information
result = s:builtins_serverStatus
print("NOTE: server=\n",result['server'])
print("NOTE: nodestatus=\n",result['nodestatus'])


-- Run the addFmtLib action to add a format library
s:addFmtLib{fmtlibname="myformats"}

-- Create a format called demo in the myformats library
s:addFormat{fmtLibName="myformats",
            fmtname="demo",
            ranges={"0-17='demo1'","18-34='demo2'",
                    "35-49='demo3'","50-64='demo4'"
                   }}

-- Format some values with the newly created format
result = s:listFmtValues{fmtname = "demo",
              nvals = {15,23,39,61}}

-- Display the results
print(result)


-- Shutdown the CAS session
s:close{}

endsubmit;
run;
```

Program Description

Start PROC LUA and load utility resources. Use the concatenation operator to append the middleclass.lua location to the package.path value. Similarly, add the location of the tkluaswat.so file to the package.cpath value. A variable called Swat_enabled is created to prevent updating the package.path and package.cpath values if you run this program more than once. For more information about SWAT, see "Requirements" in *Getting Started with SAS Viya for Lua*.

```
proc lua;
submit;

-- Show the content of the swat_enabled variable
print("NOTE: swat_enabled=", swat_enabled)

-- Show path and cpath info at start
print("NOTE: before")
print("NOTE: package.path=\n" .. package.path)
print("NOTE: package.cpath=\n" .. package.cpath)

-- Add required directories to path and cpath
if swat_enabled == false or swat_enabled == nil then
  print("NOTE: changing path and cpath")
package.path = package.path ..
    ';/opt/sas/viya/home/SASFoundation/misc/casluaclnt/lua/?.lua'
```

```
package.path = package.path ..
    ';/opt/sas/viya/home/SASFoundation/misc/casluaclnt/lua/deps/?.lua'
package.cpath = package.cpath ..
    ';/opt/sas/viya/home/SASFoundation/misc/casluaclnt/lua/lib/?.so'

swat_enabled = true

-- Show updated path and cpath values
print("NOTE: after")
print("NOTE: package.path=\n" .. package.path)
print("NOTE: package.cpath=\n" .. package.cpath)
end
```

Load the SWAT library.

```
-- Preload library
cas = require "swat"
```

Connect to the CAS server. Use the CAS.OPEN function to start a CAS session on the CAS server. Assign the CAS session to the Lua variable S. Verify that the connection was successful and print session information. This version of the CAS.OPEN function assumes that you have created an authinfo file. For more information, see "Connect and Start a Session" in *Getting Started with SAS Viya for Lua*.

```
-- Connect to the CAS server on your host
s=cas.open("server.mycompany.com",5570)

-- Print the session ID
print("NOTE: s=", s)

-- Run the builtins.serverStatus action
-- and display session information
result = s:builtins_serverStatus
print("NOTE: server=\n",result['server'])
print("NOTE: nodestatus=\n",result['nodestatus'])
```

Run a CAS action. Run the addFmtLib action to add a new format library. Add a new format definition with the addFormat action. Then apply the format to some values and check the output to see the formatted values.

```
-- Run the addFmtLib action to add a format library
s:addFmtLib{fmtlibname="myformats"}

-- Create a format called demo in the myformats library
s:addFormat{fmtLibName="myformats",
            fmtname="demo",
            ranges={"0-17='demo1'","18-34='demo2'",
                    "35-49='demo3'","50-64='demo4'"
                   }}

-- Format some values with the newly created format
result = s:listFmtValues{fmtname = "demo",
              nvals = {15,23,39,61}}

-- Display the results
```

```
print(result)
```

Shut down the CAS session and disconnect from the CAS server with the CLOSE function. End the Lua code block and submit the call to PROC LUA.

```
-- Shutdown the CAS session
s:close{}

endsubmit;
run;
```

Output 39.14 *Connecting to the CAS Server Output*

```
NOTE: Lua initialized.

NOTE: swat_enabled=    nil

NOTE: before

NOTE: package.path=
/usr/local/.../init.lua;./?.lua

NOTE: package.cpath=
/usr/local/.../loadall.so;./?.so

NOTE: changing path and cpath

NOTE: after

NOTE: package.path=
/usr/local/.../init.lua;./?.lua;SASHOME/SASFoundation/misc/casluaclnt/lua/?.lua;
SASHOME/SASFoundation/misc/casluaclnt/lua/deps/?.lua

NOTE: package.cpath=
/usr/local/.../loadall.so;./?.so;SASHOME/SASFoundation/misc/casluaclnt/lua/
lib/?.so

NOTE: s=    CAS{'server.mycompany.com', 5570, 'myuserID',
session='7239a98g3-1l5c-6932-7jjc-9ez39s0d1'}

NOTE: server=
          Server Status
Node Count  Total Actions
         1              1

NOTE: nodestatus=
                              Node Status
Node Name             Role        Uptime (Sec)  Running  Stalled
server.mycompany.com  controller         0.647        0        0
[listFmtValues]

                  ListFmtValues
Format Name  Number Value  Dest   Character value
demo                  15  demo1
                      23  demo2
                      39  demo3
                      61  demo4
```

Example 14: Running PROC FCMP Functions

Features: PROC FCMP statement
PROC LUA statement
FILENAME statement
SUBMIT and ENDSUBMIT statements

Restriction: When you call a function that was created with the FCMP procedure, you can modify only OUTARG arguments that are arrays.

Details

This example calls functions that have been defined using the FCMP procedure, similar to calling standard SAS functions. The function definitions do not need to be included in the same SAS program. PROC FCMP functions can be stored in a function library for use by any program if the CMPLIB system option has been defined within that program. This example defines the SUMX and ADD_SCALAR functions and saves them to the Sasuser.myFuncs data set in the ArrayFuncs package. A *package* is a collection of related routines that are specified by a user. The package name groups related functions in the data set that contains the PROC FCMP functions.

Program

```
proc fcmp outlib=sasuser.myFuncs.ArrayFuncs;
function sumx(x[*]);
  sum = 0;
  do i = 1 to dim(x);
     sum = sum + x[i];
  end;
  return(sum );
endsub;

function add_scalar( scalar, x[*] );
   outargs x;
   do i = 1 to dim(x);
      x[i] = x[i] + scalar;
   end;
   return( dim(x) );
endsub;
run;


options cmplib=sasuser.myFuncs;
```

```
proc lua;
submit;
   array = { 1, 2, 3, 4, 5 }
   sum = sas.sumx(array)
   print(sum)
endsubmit;
run;


proc lua;
submit;
   array = { 1, 2, 3, 4, 5 }
   dim = sas.add_scalar(5, array)
   a1 = array[1]
   a2 = array[2]
   print(a1)
   print(a2)
endsubmit;
run;
```

Program Description

Define functions using the FCMP procedure. The SUMX function sums the values of an array and returns that value. The ADD_SCALAR function adds a scalar value to each member of an array. Because the OUTARGS argument for ADD_SCALAR specifies an array, the call to this function using PROC LUA can change the value of the submitted array. The ADD_SCALAR function returns the number of elements in the array.

```
proc fcmp outlib=sasuser.myFuncs.ArrayFuncs;
function sumx(x[*]);
  sum = 0;
  do i = 1 to dim(x);
     sum = sum + x[i];
  end;
  return(sum );
endsub;

function add_scalar( scalar, x[*] );
   outargs x;
   do i = 1 to dim(x);
      x[i] = x[i] + scalar;
   end;
   return( dim(x) );
endsub;
run;
```

Specify the location of the compiled functions. This example finds the previously defined functions in the Sasuser.myFuncs data set. The call to the FCMP procedure does not need to be included in the same program with the LUA procedure if the functions are stored. Use the OPTIONS statement to specify the function location before calling the function within the LUA procedure.

```
options cmplib=sasuser.myFuncs;
```

Call the SUMX function within the LUA procedure. You call the SUMX function by preceding the call with "SAS.", similar to calling any standard SAS function.

```
proc lua;
submit;
   array = { 1, 2, 3, 4, 5 }
   sum = sas.sumx(array)
   print(sum)
endsubmit;
run;
```

Call the ADD_SCALAR function within the LUA procedure. You call the ADD_SCALAR function by preceding the call with "SAS.", similar to calling any standard SAS function. The calls to SUMX and ADD_SCALAR can come within the same LUA procedure.

```
proc lua;
submit;
   array = { 1, 2, 3, 4, 5 }
   dim = sas.add_scalar(5, array)
   a1 = array[1]
   a2 = array[2]
   print(a1)
   print(a2)
endsubmit;
run;
```

Output: Working with User-Defined Array Functions

Output 39.15 *Calling Functions That Were Created By Using PROC FCMP*

```
388  proc fcmp outlib=sasuser.myFuncs.ArrayFuncs;
389  function sumx(x[*]);
390    sum = 0;
391    do i = 1 to dim(x);
392      sum = sum + x[i];
393    end;
394    return(sum );
395  endsub;
396
397  function add_scalar( scalar, x[*] );
398    outargs x;
399    do i = 1 to dim(x);
400      x[i] = x[i] + scalar;
401    end;
402    return( dim(x) );
403  endsub;
404  run;

NOTE: Function add_scalar saved to sasuser.myFuncs.ArrayFuncs.
NOTE: Function sumx saved to sasuser.myFuncs.ArrayFuncs.
NOTE: PROCEDURE FCMP used (Total process time):
      real time           1.06 seconds
      cpu time            0.15 seconds


405
406  options cmplib=sasuser.myFuncs;
407
408  proc lua;
409  submit;
410    array = { 1, 2, 3, 4, 5 }
411    sum = sas.sumx(array)
412    print(sum)
413  endsubmit;
414  run;

NOTE: Resuming Lua state from previous PROC LUA invocation.
15
NOTE: PROCEDURE LUA used (Total process time):
      real time           0.30 seconds
      cpu time            0.07 seconds


415
416  proc lua;
417  submit;
418    array = { 1, 2, 3, 4, 5 }
419    dim = sas.add_scalar(5, array)
420    a1 = array[1]
421    a2 = array[2]
422    print(a1)
423    print(a2)
424  endsubmit;
425  run;

NOTE: Resuming Lua state from previous PROC LUA invocation.
6
7
NOTE: PROCEDURE LUA used (Total process time):
      real time           0.05 seconds
      cpu time            0.04 seconds
```

40

MEANS Procedure

Overview: MEANS Procedure

What Does the MEANS Procedure Do?

The MEANS procedure provides data summarization tools to compute descriptive statistics for variables across all observations and within groups of observations. For example, PROC MEANS does the following:

- calculates descriptive statistics based on moments
- estimates quantiles, which includes the median
- calculates confidence limits for the mean
- identifies extreme values
- performs a *t* test

By default, PROC MEANS displays output. You can also use the OUTPUT statement to store the statistics in a SAS data set.

PROC MEANS and PROC SUMMARY are very similar; see Chapter 69, "SUMMARY Procedure," on page 2455 for an explanation of the differences.

What Types of Output Does PROC MEANS Produce?

PROC MEANS Default Output

Output 1.1 shows the default output that PROC MEANS displays. The data set that PROC MEANS analyzes contains the integers 1 through 10. The output reports the number of observations, the mean, the standard deviation, the minimum value, and the maximum value. The statements that produce the output follow:

```
proc means data=OnetoTen;
run;
```

Output 40.1 *The Default Descriptive Statistics*

```
                              The SAS System                                1

                          The MEANS Procedure

                       Analysis Variable : Integer

        N            Mean         Std Dev         Minimum         Maximum
-------------------------------------------------------------------------------
       10       5.5000000       3.0276504       1.0000000      10.0000000
-------------------------------------------------------------------------------
```

PROC MEANS Customized Output

The following output shows the results of a more extensive analysis of two variables, MoneyRaised and HoursVolunteered. The analysis data set contains information about the amount of money raised and the number of hours volunteered by high-school students for a local charity. PROC MEANS uses six combinations of two categorical variables to compute the number of observations, the mean, and the range. The first variable, School, has two values and the other variable, Year, has three values. For an explanation of the program that produces the output, see “Example 11: Identifying an Extreme Value with the Output Statistics” on page 1544.

Output 40.2 Specified Statistics for Class Levels and Identification of Maximum Values

```
                Summary of Volunteer Work by School and Year                1

                             The MEANS Procedure

                             N
School                Year  Obs  Variable               N           Mean          Range
--------------------------------------------------------------------------------
Kennedy               1992   15  MoneyRaised           15     29.0800000     39.7500000
                                 HoursVolunteered      15     22.1333333     30.0000000

                      1993   20  MoneyRaised           20     28.5660000     23.5600000
                                 HoursVolunteered      20     19.2000000     20.0000000

                      1994   18  MoneyRaised           18     31.5794444     65.4400000
                                 HoursVolunteered      18     24.2777778     15.0000000

Monroe                1992   16  MoneyRaised           16     28.5450000     48.2700000
                                 HoursVolunteered      16     18.8125000     38.0000000

                      1993   12  MoneyRaised           12     28.0500000     52.4600000
                                 HoursVolunteered      12     15.8333333     21.0000000

                      1994   28  MoneyRaised           28     29.4100000     73.5300000
                                 HoursVolunteered      28     19.1428571     26.0000000

--------------------------------------------------------------------------------
```

```
            Best Results: Most Money Raised and Most Hours Worked            2

                                          Most      Most       Money      Hours
 Obs   School     Year   _TYPE_   _FREQ_   Cash      Time      Raised   Volunteered

   1                .       0       109    Willard   Tonya      78.65        40
   2             1992       1        31    Tonya     Tonya      55.16        40
   3             1993       1        32    Cameron   Amy        65.44        31
   4             1994       1        46    Willard   L.T.       78.65        33
   5   Kennedy      .       2        53    Luther    Jay        72.22        35
   6   Monroe       .       2        56    Willard   Tonya      78.65        40
   7   Kennedy   1992       3        15    Thelma    Jay        52.63        35
   8   Kennedy   1993       3        20    Bill      Amy        42.23        31
   9   Kennedy   1994       3        18    Luther    Che-Min    72.22        33
  10   Monroe    1992       3        16    Tonya     Tonya      55.16        40
  11   Monroe    1993       3        12    Cameron   Myrtle     65.44        26
  12   Monroe    1994       3        28    Willard   L.T.       78.65        33
```

In addition to the report, the program also creates an output data set (located on page 2 of the output) that identifies the students who raised the most money and who volunteered the most time over all the observations and within the combinations of School and Year:

- The first observation in the data set shows the students with the maximum values overall for MoneyRaised and HoursVolunteered.
- Observations 2 through 4 show the students with the maximum values for each year, regardless of school.
- Observations 5 and 6 show the students with the maximum values for each school, regardless of year.

- Observations 7 through 12 show the students with the maximum values for each school-year combination.

PROC MEANS and the ODS OUTPUT Statement

The template for procedures MEANS and SUMMARY causes ODS to apply default formats and format attributes to its output, overriding any formats associated and applied to variables of the input data set, because the option USE_FORMAT_DEFAULTS is specified in the template. This option affects the width and alignment of ODS–formatted output, which can vary from the width and alignment of formats found in the input data set or those specified on a FORMAT or ATTRIB statement. These format defaults affect ODS output and not internal–numeric representation or calculations.

For example, numeric format outputs can be wider and have more characters than expected when the default–format width is greater than the specified width specified in the data set or the statement.

You can prevent default formats being applied to the output data set by creating your output data set using the OUTPUT statement instead of the ODS OUTPUT statement.

If you prefer that format defaults not be applied to ODS output, you can modify the Base.Summary ODS table template with the following code:

```
proc template;
   edit base.summary;
   use_format_defaults=off;
end;
run;
```

Concepts: MEANS Procedure

Using Class Variables

Using TYPES and WAYS Statements

The TYPES statement controls which of the available class variables PROC MEANS uses to subgroup the data. The unique combinations of these active class

variable values that occur together in any single observation of the input data set determine the data subgroups. Each subgroup that PROC MEANS generates for a given type is called a level of that type. Note that for all types, the inactive class variables can still affect the total observation count of the rejection of observations with missing values.

When you use a WAYS statement, PROC MEANS generates types that correspond to every possible unique combination of *n* class variables chosen from the complete set of class variables. For example

```
proc means;
 class a b c d e;
 ways 2 3;
 run;
```

is equivalent to

```
proc means;
 class a b c d e;
 types a*b a*c a*d a*e b*c b*d b*e c*d c*e d*e
       a*b*c a*b*d a*b*e a*c*d a*c*e a*d*e
       b*c*d b*c*e c*d*e;
 run;
```

If you omit the TYPES statement and the WAYS statement, then PROC MEANS uses all class variables to subgroup the data (the NWAY type) for displayed output and computes all types (2^k) for the output data set.

Ordering the Class Values

PROC MEANS determines the order of each class variable in any type by examining the order of that class variable in the corresponding one-way type. You see the effect of this behavior in the options ORDER=DATA or ORDER=FREQ. If you specify the ORDER=DATA option for input data in a DBMS table, PROC MEANS computation might produce different results for separate runs of the same analysis. In addition to determining the order of variable levels in crosstabulation table displays, the ORDER= option can also affect the values of many of the test statistics and measures that PROC MEANS computes. When PROC MEANS subdivides the input data set into subsets, the classification process does not apply the options ORDER=DATA or ORDER=FREQ independently for each subgroup. Instead, one frequency and data order is established for all output based on a non-subdivided view of the entire data set. For example, consider the following statements:

```
data pets;
 input Pet $ Gender $;
 datalines;
dog  m
dog  f
dog  f
dog  f
cat  m
cat  m
cat  f
```

```
;

proc means data=pets order=freq;
   class pet gender;
run;
```

The statements produce this output.

Output 40.3 *Ordering Class Values*

```
                    The SAS System                              1

                 The MEANS Procedure

                                     N
          Pet         Gender       Obs
          ---------------------------
          dog         f              3

                      m              1

          cat         f              1

                      m              2
          ---------------------------
```

In the example, PROC MEANS does not list male cats before female cats. Instead, it determines the order of gender for all types over the entire data set. PROC MEANS found more observations for female pets (f=4, m=3). The default for ORDER is ORDER=INTERNAL.

Computational Resources

PROC MEANS uses the same memory allocation scheme across all operating environments. When class variables are involved, PROC MEANS must keep a copy of each unique value of each class variable in memory. You can estimate the memory requirements to group the class variable by calculating

$$Nc_1(Lc_1 + K) + Nc_2(Lc_2 + K) + ... + Nc_n(Lc_n + K)$$

where

Nc_i
: is the number of unique values for the class variable.

Lc_i
: is the combined unformatted and formatted length of c_i .

K
: is some constant on the order of 32 bytes (64 for 64-bit architectures).

When you use the GROUPINTERNAL option in the CLASS statement, Lc_i is simply the unformatted length of c_i .

Each unique combination of class variables, $c_{1_i}\ c_{2_j}$ for a given type forms a level in that type. See "TYPES Statement" on page 1506. You can estimate the maximum potential space requirements for all levels of a given type, when all combinations actually exist in the data (a complete type), by calculating

$$W * Nc_1 * Nc_2 * \ ... \ * Nc_n$$

where

W
is a constant based on the number of variables analyzed and the number of statistics calculated (unless you request QMETHOD=OS to compute the quantiles).

$Nc_1 ... Nc_n$
are the number of unique levels for the active class variables of the given type.

Clearly, the memory requirements of the levels overwhelm the levels of the class variables. For this reason, PROC MEANS can open one or more utility files and write the levels of one or more types to disk. These types are either the primary types that PROC MEANS built during the input data scan or the derived types.

If PROC MEANS must write partially complete primary types to disk while it processes input data, then one or more merge passes can be required to combine type levels in memory with the levels on disk. In addition, if you use an order other than DATA for any class variable, then PROC MEANS groups the completed types on disk. For this reason, the peak disk space requirements can be more than twice the memory requirements for a given type.

When PROC MEANS uses a temporary work file, you receive the following note in the SAS log:

```
Processing on disk occurred during summarization.
Peak disk usage was approximately nnn
Mbytes.
Adjusting MEMSIZE or REALMEMSIZE may improve performance.
```

In most cases processing ends normally.

When you specify class variables in a CLASS statement, the amount of data-dependent memory that PROC MEANS uses before it writes to a utility file is controlled by the SAS system option REALMEMSIZE=. The value of REALMEMSIZE= indicates the amount of real as opposed to virtual memory that SAS can expect to allocate. PROC MEANS determines how much data-dependent memory to use before writing to utility files by calculating the lesser of these two values:

- the value of REALMEMSIZE=
- 0.8*(M-U), where M is the value of MEMSIZE= and U is the amount of memory that is already in use

REALMEMSIZE also affects the behavior of other memory intensive PROCs such as PROC SORT.

As an alternative, you can use the PROC option SUMSIZE=. Like the PROC option SORTSIZE=, SUMSIZE= sets the memory threshold where disk-based operations begin. For best results, set SUMSIZE= to less than the amount of real memory that

is likely to be available for the task. For efficiency reasons, PROC MEANS can internally round up the value of SUMSIZE=. SUMSIZE= has no effect unless you specify class variables.

Operating Environment Information: The REALMEMSIZE= SAS system option is not available in all operating environments. For details, see the SAS Companion for your operating environment.

If PROC MEANS reports that there is insufficient memory, then increase SUMSIZE= (or REALMEMSIZE=). A SUMSIZE= (or REALMEMSIZE=) value that is greater than MEMSIZE= has no effect. Therefore, you might also need to increase MEMSIZE=. If PROC MEANS reports insufficient disk space, then increase the WORK space allocation. See the SAS documentation for your operating environment for more information about how to adjust your computation resource parameters.

Another way to enhance performance is by carefully applying the TYPES or WAYS statement, limiting the computations to only those combinations of class variables that you are interested in. In particular, significant resource savings can be achieved by not requesting the combination of all class variables.

In-Database Processing for PROC MEANS

When large data sets are stored in an external database, the transfer of the data sets to computers that run SAS can be impacted by performance, security, and resource management issues. SAS in-database processing can greatly reduce data transfer by having the database perform the initial data aggregation.

In-database processing for PROC MEANS supports the following database management systems:

- Amazon Redshift
- Aster
- DB2
- Google BigQuery
- Greenplum
- Hadoop
- HAWQ
- Impala
- Microsoft SQL Server
- Netezza
- Oracle
- PostgreSQL
- SAP HANA
- Snowflake
- Teradata

- Vertica
- Yellowbrick

Under the correct conditions, PROC MEANS generates an SQL query based on the statements that are used and the output statistics that are specified in the PROC step. If class variables are specified, the procedure creates an SQL GROUP BY clause that represents the n-way type. The result set that is created when the aggregation query executes in the database is read by SAS into the internal PROC MEANS data structure, and all subsequent types are derived from the original n-way type to form the final analysis results. When SAS format definitions have been deployed in the database, formatting of class variables occurs in the database. If the SAS format definitions have not been deployed in the database, the in-database aggregation occurs on the raw values, and the relevant formats are applied by SAS as the results' set is merged into the PROC MEANS internal structures. Multi-label formatting is always done by SAS using the initially aggregated result set that is returned by the database. The CLASS, TYPES, WAYS, VAR, BY, FORMAT, and WHERE statements are supported when PROC MEANS is processed inside the database. FREQ, ID, IDMIN, IDMAX, and IDGROUPS are not supported. The following statistics are supported for in-database processing: N, NMISS, MIN, MAX, RANGE, SUM, SUMWGT, MEAN, CSS, USS, VAR, STD, STDERR, PRET, UCLM, LCLM, CLM, and CV.

Weighting for in-database processing is supported only for N, NMISS, MIN, MAX, RANGE, SUM, SUMWGT, and MEAN.

The following statistics are currently not supported for in-database processing: SKEW, KURT, P1, P5, P10, P20, P25/Q1, P30, P40, P50/MEDIAN, P60, P70, P75/Q3, P80, P90, P95, P99, and MODE.

The SQLGENERATION system option or LIBNAME statement option controls whether and how in-database procedures are run inside the database. By default, the in-database procedures are run inside the database when possible. There are many data set options that prevent in-database processing, such as, OBS=, FIRSTOBS=, RENAME=, and DBCONDITION=. For a complete listing, see Data Set-Related Options

In-database processing can greatly reduce the volume of data transferred to the procedure if there are no class variables (one row is returned) or if the selected class variables have a small number of unique values. However, because PROC MEANS loads the result set into its internal structures, the memory requirements for the SAS process are equivalent to what would have been required without in-database processing. The CPU requirements for the SAS process should be significantly reduced if the bulk of the data summarization occurs inside the database. The real time required for summarization should be significantly reduced because many database-process queries are in parallel.

For more information about in-database processing, see *SAS/ACCESS for Relational Databases: Reference*.

Threaded Processing of Input DATA Sets

The THREADS option enables or disables parallel processing of the input data set. Threaded processing achieves a degree of parallelism in the processing operations. This parallelism is intended to reduce the real time to completion for a given operation and therefore limit the cost of additional CPU resources. For more information, see “Support for Parallel Processing in *SAS Language Reference: Concepts*.

The value of the SAS system option CPUCOUNT= affects the performance of the threaded sort. CPUCOUNT= suggests how many system CPUs are available for use by the threaded procedures.

For more information see the “THREADS System Option” and “CPUCOUNT= System Option” in the *SAS System Options: Reference*.

Calculated statistics can vary slightly, depending on the order in which observations are processed. Such variations are due to numerical errors that are introduced by floating–point arithmetic, the results of which should be considered approximate and not exact. The order of observation processing can be affected by nondeterministic effects of multithreaded or parallel processing. The order of processing can also be affected by inconsistent or nondeterministic ordering of observations that are produced by a data source, such as a DBMS that delivers query results through an ACCESS engine. For more information, see “Numerical Accuracy in SAS Software” in *SAS Language Reference: Concepts* and “Threading in Base SAS” in *SAS Language Reference: Concepts*.

CAS Processing for PROC MEANS

When analyzing a data table that resides on a CAS server, a portion of the work that is performed by PROC MEANS is done within CAS. The work that is done in CAS is similar to work performed within a DBMS by in-database processing. If your input data set originates from CAS, some of the PROC MEANS processing can be performed by the CAS server. Running PROC MEANS with CAS actions has several advantages over processing within SAS. These advantages include reduced network traffic, and the potential for faster processing. Faster processing is possible because in-memory tables are manipulated locally on the server instead of being transferred across a relatively slow network connection. CAS is used because it might have more processing resources.

Under the correct conditions, PROC MEANS generates and executes a CAS action based on the statements that are used and the output statistics that are specified in the PROC step. If class variables are specified, the procedure creates a GROUPBY input table parameter that represents the *n*-way type. The result set that is created when the action executes on the CAS server is read by SAS into the internal PROC MEANS data structure. All subsequent types are derived from the original *n*-way type to form the final analysis results.

For intrinsic formats, formatting of class variables occurs in CAS. For user-defined formats, formatting of class variables occurs in CAS if the formats have been defined in or copied to the server. If formats are not available on the CAS server, initial aggregation occurs on the server using raw values, and the relevant formats are applied by SAS as the result set is merged into PROC MEANS internal structure. Multilabel formatting is always done by SAS using the initially aggregated result set that is returned by CAS.

The CLASS, TYPES, WAYS, VAR, BY, FORMAT, and WHERE statements are supported when PROC MEANS is processed inside the CAS server. FREQ, ID, IDMIN, IDMAX, and IDGROUPS are not supported.

The following statistics are supported for processing: N, NMISS, MIN, MAX, RANGE, SUM, SUMWGT, MEAN, CSS, USS, VAR, STD, STDERR, PRET, UCLM, LCLM, CLM, and CV.

Weighting for CAS processing is supported only for N, NMISS, MIN, MAX, RANGE, SUM, SUMWGT, and MEAN.

The following statistics are currently not supported in CAS: SKEW, KURT, P1, P5, P10, P20, P25/Q1, P30, P40, P50/MEDIAN, P60, P70, P75/Q3, P80, P90, P95, P99, and MODE.

By default, when the DATA= input data set references an in-memory table or view in CAS, the MEANS procedure runs on the CAS server when possible. There are many data set options that prevent processing in CAS, such as OBS=, FIRSTOBS=, and RENAME=.

Processing in CAS can reduce the volume of data that is transferred to the procedure if there are no class variables (one row is returned) or if the selected class variables have a small number of unique values. However, because PROC MEANS loads the result set into its internal structure, the memory requirements for the SAS process are equivalent to what would have been required when not processing in CAS. The CPU requirements for the SAS process should be significantly reduced if the bulk of the data summarization occurs inside the CAS server. The real-time processing required for summarization should be significantly reduced because CAS can process the data in parallel. If the results of PROC MEANS are directed back to the CAS server using an OUTPUT statement, processing of intermediate aggregates must still be performed by the MEANS procedure in SAS. If you want all processing to be performed in CAS, you can invoke an appropriate action directly, using PROC CAS or one of the many other CAS clients and languages.

Note: Intermediate results are always processed by the client regardless of the final destination–CAS or the client.

Here is an example of how to run PROC MEANS with CAS. The CAS LIBNAME engine is used to connect a SAS 9.4 session to an existing CAS session through the CAS session name or the CAS session UUID. The resulting libref is then used by SAS to communicate with the specific CAS session.

```
/* Connect to a CAS server */
cas casauto host="cloud.example.com" port=5570;
/* Specify the CAS engine LIBNAME statement and use the CAS engine
libref*/
```

```
libname mycas cas sessref=casauto;
/* Enable INFO messages so that the SAS log reports the use of CAS
actions. */
options msglevel=i;
/*For demonstration purposes, move Grade to CAS and rename it to
GradeBySection.*/
proc casutil;
load data=Grade casout=GradeBySection;
quit;
/*Execute the PROC MEANS procedure*/
/* A SORT step is not needed for BY-processing when running in CAS */
proc means data=cas.GradeBySection min max mean;
   by Section;
   var Score;
   class Status Year;
   title1 'Final Exam Scores for Student Status and Year of
Graduation';
   title2 'Within Each Section';
run;
cas casauto terminate;
```

Syntax: MEANS Procedure

Tip: You can use the ATTRIB, FORMAT, LABEL, and WHERE statements. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73. You can also use any global statement. For a list, see "Global Statements" in *SAS DATA Step Statements: Reference*.

PROC MEANS <*options*> <*statistic-keyword(s)*>;

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...> <NOTSORTED>;

CLASS *variable(s)* </ *options*>;

FREQ *variable*;

ID *variable(s)*;

OUTPUT <OUT=*SAS-data-set*> <*output-statistic-specification(s)*> <*id-group-specification(s)*> <*maximum-id-specification(s)*> <*minimum-id-specification(s)*> </ *options*> ;

TYPES *request(s)*;

VAR *variable(s)* </ WEIGHT=*weight-variable*>;

WAYS *list*;

WEIGHT *variable*;

Statement	Task	Example
PROC MEANS	Compute descriptive statistics for variables	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 8,

Statement	Task	Example
		Ex. 9, Ex. 10, Ex. 12, Ex. 13
BY	Calculate separate statistics for each BY group	Ex. 3
CLASS	Identify variables whose values define subgroups for the analysis	Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 8, Ex. 9, Ex. 10, Ex. 11, Ex. 12
FREQ	Identify a variable whose values represent the frequency of each observation	
ID	Include additional identification variables in the output data set	
OUTPUT	Create an output data set that contains specified statistics and identification variables	Ex. 8, Ex. 9, Ex. 10, Ex. 11, Ex. 12
TYPES	Identify specific combinations of class variables to use to subdivide the data	Ex. 2, Ex. 5, Ex. 12
VAR	Identify the analysis variables and their order in the results	Ex. 1
WAYS	Specify the number of ways to make unique combinations of class variables	Ex. 6
WEIGHT	Identify a variable whose values weight each observation in the statistical calculations	Ex. 6

PROC MEANS Statement

Computes descriptive statistics for variables.

See: Chapter 69, "SUMMARY Procedure," on page 2455

Examples: "Example 1: Computing Specific Descriptive Statistics" on page 1516
"Example 2: Computing Descriptive Statistics with Class Variables" on page 1518
"Example 3: Using the BY Statement with Class Variables" on page 1521
"Example 4: Using a CLASSDATA= Data Set with Class Variables" on page 1523
"Example 5: Using Multilabel Value Formats with Class Variables" on page 1526
"Example 6: Using Preloaded Formats with Class Variables" on page 1531
"Example 7: Computing a Confidence Limit for the Mean" on page 1535
"Example 8: Computing Output Statistics" on page 1537

Syntax

PROC MEANS <*options*> <*statistic-keyword(s)*>;

Summary of Optional Arguments

DATA=*SAS-data-set*
: specifies the input data set.

INCAS=(YES | NO)
: specifies whether to allow in-CAS processing.

NOTHREADS
: overrides the SAS system option THREADS | NOTHREADS.

NOTRAP
: disables floating point exception recovery.

SUMSIZE=*value*
: specifies the amount of memory to use for data summarization with class variables.

THREADS | NOTHREADS
: overrides the SAS system option THREADS | NOTHREADS.

Control the classification levels

CLASSDATA=*SAS-data-set*
: specifies a secondary data set that contains the combinations of class variables to analyze.

COMPLETETYPES
: creates all possible combinations of class variable values.

EXCLUSIVE
: excludes from the analysis all combinations of class variable values that are not in the CLASSDATA= data set.

MISSING
: uses missing values as valid values to create combinations of class variables.

Control the output

FW=*field-width*
: specifies the field width for the statistics.

MAXDEC=*number*
: specifies the number of decimal places for the statistics.

NONOBS
: suppresses reporting the total number of observations for each unique combination of the class variables.

NOPRINT
: suppresses all displayed output.

ORDER=DATA | FORMATTED | FREQ | UNFORMATTED
: orders the values of the class variables according to the specified order.

PRINTALLTYPES
: displays the analysis for all requested combinations of class variables.

PRINTIDVARS
: displays the values of the ID variables.

PRINT | NOPRINT
: displays the output.

STACKODSOUTPUT
: produces an ODS output object

Control the output data set

CHARTYPE
: specifies that the _TYPE_ variable contain character values.

DESCENDTYPES
: orders the output data set by descending _TYPE_ value.

IDMIN
: selects ID variables based on minimum values.

NWAY
: limits the output statistics to the observations with the highest _TYPE_ value.

Control the statistical analysis

ALPHA=*value*
: specifies the confidence level for the confidence limits.

EXCLNPWGT
: excludes observations with nonpositive weights from the analysis.

QMARKERS=*number*
: specifies the sample size to use for the P2 quantile estimation method.

QMETHOD=OS | P2
: specifies the quantile estimation method.

QNTLDEF=1 | 2 | 3 | 4 | 5
: specifies the mathematical definition used to compute quantiles.

statistic-keyword(s)
: selects the statistics.

VARDEF=*divisor*
: specifies the variance divisor.

Optional Arguments

ALPHA=*value*
specifies the confidence level to compute the confidence limits for the mean. The percentage for the confidence limits is (1−*value*)×100. An example is (ALPHA=.05 results in a 95% confidence limit).

Default .05

Range between 0 and 1

Interaction To compute confidence limits specify the *statistic-keyword* CLM, LCLM, or UCLM.

See "Confidence Limits" on page 1511

"Example 7: Computing a Confidence Limit for the Mean" on page 1535

CHARTYPE
specifies that the _TYPE_ variable in the output data set is a character representation of the binary value of _TYPE_. The length of the variable equals the number of class variables.

Interaction When you specify more than 32 class variables, _TYPE_ automatically becomes a character variable.

See "Output Data Set" on page 1514

"Example 10: Computing Output Statistics with Missing Class Variable Values" on page 1542

CLASSDATA=*SAS-data-set*
specifies a data set that contains the combinations of values of the class variables that must be present in the output. Any combinations of values of the class variables that occur in the CLASSDATA= data set but not in the input data set appear in the output and have a frequency of zero.

Restriction The CLASSDATA= data set must contain all class variables. Their data type and format must match the corresponding class variables in the input data set.

Interaction If you use the EXCLUSIVE option, then PROC MEANS excludes any observation in the input data set whose combination of class variables is not in the CLASSDATA= data set.

Tip Use the CLASSDATA= data set to filter or to supplement the input data set.

See "Example 4: Using a CLASSDATA= Data Set with Class Variables" on page 1523

COMPLETETYPES
creates all possible combinations of class variables even if the combination does not occur in the input data set.

Interaction The PRELOADFMT option in the CLASS statement ensures that PROC MEANS writes all user-defined format ranges or values for the combinations of class variables to the output, even when a frequency is zero.

Tip Using COMPLETETYPES does not increase the memory requirements.

See "Example 6: Using Preloaded Formats with Class Variables" on page 1531

DATA=*SAS-data-set*
identifies the input SAS data set.

See "Input Data Sets" on page 26

DESCENDTYPES
orders observations in the output data set by descending _TYPE_ value.

Aliases DESCENDING

DESCEND

Interaction Descending has no effect if you specify NWAY.

Tip Use DESCENDTYPES to make the overall total (_TYPE_=0) the last observation in each BY group.

See "Output Data Set" on page 1514

"Example 9: Computing Different Output Statistics for Several Variables" on page 1539

EXCLNPWGT
excludes observations with nonpositive weight values (zero or negative) from the analysis. By default, PROC MEANS treats observations with negative weights like observations with zero weights and counts them in the total number of observations.

Alias EXCLNPWGTS

See "WEIGHT Statement" on page 1509

WEIGHT= option on the VAR statement on page 1507

EXCLUSIVE
excludes from the analysis all combinations of the class variables that are not found in the CLASSDATA= data set.

Requirement If a CLASSDATA= data set is not specified, then this option is ignored.

See "Example 4: Using a CLASSDATA= Data Set with Class Variables" on page 1523

FW=*field-width*
specifies the field width to display the statistics in printed or displayed output. FW= has no effect on statistics that are saved in an output data set.

Default 12

Tip If PROC MEANS truncates column labels in the output, then increase the field width.

See "Example 1: Computing Specific Descriptive Statistics" on page 1516

"Example 4: Using a CLASSDATA= Data Set with Class Variables" on page 1523

"Example 5: Using Multilabel Value Formats with Class Variables" on page 1526

INCAS=(YES | NO)
specifies whether to allow in-CAS processing.

YES
Use in-CAS processing. YES is the default.

NO
Do not use in-CAS processing.

IDMIN
specifies that the output data set contain the minimum value of the ID variables.

Interaction Specify PRINTIDVARS to display the value of the ID variables in the output.

See "ID Statement" on page 1496

MAXDEC=*number*
specifies the maximum number of decimal places to display the statistics in the printed or displayed output. MAXDEC= has no effect on statistics that are saved in an output data set.

Default BEST. width for columnar format, typically about 7.

Range 0-8

See "Example 2: Computing Descriptive Statistics with Class Variables" on page 1518

"Example 4: Using a CLASSDATA= Data Set with Class Variables" on page 1523

MISSING
considers missing values as valid values to create the combinations of class variables. Special missing values that represent numeric values (the letters A through Z and the underscore (_) character) are each considered as a separate value.

Default If you omit MISSING, then PROC MEANS excludes the observations with a missing class variable value from the analysis.

See *SAS Language Reference: Concepts* for a discussion of missing values that have special meaning.

"Example 6: Using Preloaded Formats with Class Variables" on page 1531

NONOBS
suppresses the column that displays the total number of observations for each unique combination of the values of the class variables. This column corresponds to the _FREQ_ variable in the output data set.

See "The N Obs Statistic" on page 1514

"Example 5: Using Multilabel Value Formats with Class Variables" on page 1526

"Example 6: Using Preloaded Formats with Class Variables" on page 1531

NOPRINT
See the `"PRINT | NOPRINT" option.

NOTHREADS
See the "THREADS | NOTHREADS" option.

NOTRAP
disables floating point exception (FPE) recovery during data processing. By default, PROC MEANS traps these errors and sets the statistic to missing.

In operating environments where the overhead of FPE recovery is significant, NOTRAP can improve performance. Note that normal SAS FPE handling is still in effect so that PROC MEANS terminates in the case of math exceptions.

NWAY
specifies that the output data set contain only statistics for the observations with the highest _TYPE_ and _WAY_ values. When you specify class variables, NWAY corresponds to the combination of all class variables.

Interaction If you specify a TYPES statement or a WAYS statement, then PROC MEANS ignores this option.

See "Output Data Set" on page 1514

"Example 10: Computing Output Statistics with Missing Class Variable Values" on page 1542

ORDER=DATA | FORMATTED | FREQ | UNFORMATTED
specifies the sort order to create the unique combinations for the values of the class variables in the output, where

DATA
orders values according to their order in the input data set.

Interaction If you use PRELOADFMT in the CLASS statement, then the order for the values of each class variable matches the order that PROC FORMAT uses to store the values of the associated user-defined format. If you use the CLASSDATA= option, then PROC MEANS uses the order of the unique values of each class variable in the CLASSDATA= data set to order the output levels. If you use both options, then PROC MEANS first uses the user-defined formats to order the output. If you omit EXCLUSIVE, then PROC MEANS appends after the user-defined format and the CLASSDATA= values the unique values of the class variables in the input data set based on the order in which they are encountered.

Tip By default, PROC FORMAT stores a format definition in sorted order. Use the NOTSORTED option to store the values or ranges of a user-defined format in the order in which you define them.

FORMATTED
orders values by their ascending formatted values. This order depends on your operating environment.

Aliases FMT

EXTERNAL

FREQ
orders values by descending frequency count so that levels with the most observations are listed first.

Interactions For multiway combinations of the class variables, PROC MEANS determines the order of a class variable combination from the individual class variable frequencies.

Use the ASCENDING option in the CLASS statement to order values by ascending frequency count.

UNFORMATTED
orders values by their unformatted values. This order depends on your operating environment. This sort sequence is particularly useful for displaying dates chronologically.

Specifying ORDER=UNFORMATTED usually, but not always, produces the same results as PROC SORT. For more information about ordering data, see "Controlling the Order of Data Values" on page 27.

Aliases UNFMT

INTERNAL

See "Ordering the Class Values" on page 1468

Default UNFORMATTED

PRINT | NOPRINT
specifies whether PROC MEANS displays the statistical analysis. NOPRINT suppresses all the output.

Default PRINT

Tip Use NOPRINT when you want to create only an OUT= output data set.

See "Example 8: Computing Output Statistics" on page 1537

"Example 12: Identifying the Top Three Extreme Values with the Output Statistics" on page 1547

PRINTALLTYPES
displays all requested combinations of class variables (all _TYPE_ values) in the printed or displayed output. Normally, PROC MEANS shows only the NWAY type.

Alias PRINTALL

Interaction If you use the NWAY option, the TYPES statement, or the WAYS statement, then PROC MEANS ignores this option.

See "Example 4: Using a CLASSDATA= Data Set with Class Variables" on page 1523

PRINTIDVARS
displays the values of the ID variables in printed or displayed output.

Alias PRINTIDS

Interaction Specify IDMIN to display the minimum value of the ID variables.

See "ID Statement" on page 1496

QMARKERS=*number*
specifies the default number of markers to use for the P^2 quantile estimation method. The number of markers controls the size of fixed memory space.

Default The default value depends on which quantiles you request. For the median (P50), *number* is 7. For the quantiles (P25 and P50), *number* is 25. For the quantiles P1, P5, P10, P75 P90, P95, or P99, *number* is 105. If you request several quantiles, then PROC MEANS uses the largest value of *number*.

Range an odd integer greater than 3

Tip Increase the number of markers above the defaults settings to improve the accuracy of the estimate; reduce the number of markers to conserve memory and computing time.

See "Quantiles" on page 1512

QMETHOD=OS | P2
specifies the method that PROC MEANS uses to process the input data when it computes quantiles. If the number of observations is less than or equal to the

QMARKERS= value and QNTLDEF=5, then both methods produce the same results.

OS
uses order statistics. This method is the same method that PROC UNIVARIATE uses.

Note: This technique can be very memory-intensive.

P2
uses the P^2 method to approximate the quantile.

Default OS

Restriction When QMETHOD=P2, PROC MEANS does not compute MODE or weighted quantiles.

Tip When QMETHOD=P2, reliable estimations of some quantiles (P1,P5,P95,P99) might not be possible for some data sets.

See "Quantiles" on page 1512

QNTLDEF=1 | 2 | 3 | 4 | 5
specifies the mathematical definition that PROC MEANS uses to calculate quantiles when QMETHOD=OS. To use QMETHOD=P2, you must use QNTLDEF=5.

Alias PCTLDEF=

Default 5

See "Quantile and Related Statistics" on page 2706

statistic-keyword(s)
specifies which statistics to compute and the order to display them in the output. The available keywords in the PROC statement are

Descriptive statistic keywords	
CLM	NMISS
CSS	RANGE
CV	SKEWNESS | SKEW
KURTOSIS | KURT	STDDEV | STD
LCLM	STDERR
MAX	SUM
MEAN	SUMWGT

MIN	UCLM
MODE	USS
N	VAR
Quantile statistic keywords	
MEDIAN | P50	Q3 | P75
P1	P90
P5	P95
P10	P99
P20	P30
P40	P60
P70	P80
Q1 | P25	QRANGE
Hypothesis testing keywords	
PROBT | PRT	T

Default N, MEAN, STD, MIN, and MAX

Requirement To compute standard error, confidence limits for the mean, and the Student's *t*-test, you must use the default value of the VARDEF= option, which is DF. To compute skewness or kurtosis, you must use VARDEF=N or VARDEF=DF.

Tip Use CLM or both LCLM and UCLM to compute a two-sided confidence limit for the mean. Use only LCLM or UCLM, to compute a one-sided confidence limit.

See The definitions of the keywords and the formulas for the associated statistics are listed in "Keywords and Formulas" on page 2700.

"Example 1: Computing Specific Descriptive Statistics" on page 1516

"Example 3: Using the BY Statement with Class Variables" on page 1521

STACKODSOUTPUT
produces an ODS output object whose data set resembles the printed output.

The STACKODSOUTPUT option affects output data sets created by ODS OUTPUT statements, not the PROC MEANS OUTPUT statement.

Alias STACKODS

See "Example 13: Using the STACKODSOUTPUT Option to Control Data" on page 1552

SUMSIZE=*value*
specifies the amount of memory that is available for data summarization when you use class variables. *value* might be one of the following:

n
***n*K**
***n*M**
***n*G**
specifies the amount of memory available in bytes, kilobytes, megabytes, or gigabytes, respectively. If *n* is 0, then PROC MEANS use the value of the SAS system option SUMSIZE=.

MAXIMUM
MAX
specifies the maximum amount of memory that is available.

Default The value of the SUMSIZE= system option.

Note Specifying SUMSIZE=0 enables PROC MEANS to use the preferred global REALMEMSIZE option.

Tip For best results, do not make SUMSIZE= larger than the amount of physical memory that is available for the PROC step. If additional space is needed, then PROC MEANS uses utility files.

See The SAS system option SUMSIZE= in *SAS System Options: Reference*.

THREADS | NOTHREADS
enables or disables parallel processing of the input data set. This option overrides the SAS system option THREADS | NOTHREADS unless the system option is restricted. (See Restriction.) For more information, see "Support for Parallel Processing" in the *SAS Language Reference: Concepts*.

Default value of SAS system option THREADS | NOTHREADS.

Restriction Your site administrator can create a restricted options table. A restricted options table specifies SAS system option values that are established at start-up and cannot be overridden. If the THREADS | NOTHREADS system option is listed in the restricted options table, any attempt to set these system options is ignored and a warning message is written to the SAS log.

Interaction PROC MEANS honors the SAS system option THREADS except when a BY statement is specified or the value of the SAS system option CPUCOUNT is less than 2. You can use THREADS in the

PROC MEANS statement to force PROC MEANS to use parallel processing in these situations.

Note If THREADS is specified (either as a SAS system option or in the PROC MEANS statement) and another program has the input data set open for reading, writing, or updating, then PROC MEANS might fail to open the input data set. In this case, PROC MEANS stops processing and writes a message to the SAS log.

VARDEF=*divisor*

specifies the divisor to use in the calculation of the variance and standard deviation. The following table shows the possible values for *divisor* and associated divisors.

Table 40.1 *Possible Values for VARDEF=*

Value	Divisor	Formula for Divisor
DF	Degrees of freedom	$n - 1$
N	Number of observations	n
WDF	Sum of weights minus one	$(\Sigma_i w_i) - 1$
WEIGHT | WGT	Sum of weights	$\Sigma_i w_i$

The procedure computes the variance as $CSS/divisor$, where CSS is the corrected sums of squares and equals $\Sigma (x_i - \overline{x})^2$. When you weight the analysis variables, CSS equals $\Sigma w_i(x_i - \overline{x}_w)^2$, where $\overline{x}_w$ is the weighted mean.

Default DF

Requirement To compute the standard error of the mean, confidence limits for the mean, or the Student's *t*-test, use the default value of VARDEF=.

Tips When you use the WEIGHT statement and VARDEF=DF, the variance is an estimate of σ^2 , where the variance of the *i*th observation is $var(x_i) = \sigma^2/w_i$ and w_i is the weight for the *i*th observation. This method yields an estimate of the variance of an observation with unit weight.

When you use the WEIGHT statement and VARDEF=WGT, the computed variance is asymptotically (for large *n*) an estimate of $\sigma^2/\overline{w}$, where $\overline{w}$ is the average weight. This method yields an asymptotic estimate of the variance of an observation with average weight.

See "Keywords and Formulas" on page 2700

"Weighted Statistics Example" on page 84

BY Statement

Produces separate statistics for each BY group.

See: "BY" on page 74
"Comparison of the BY and CLASS Statements" on page 1495
Example: "Example 3: Using the BY Statement with Class Variables" on page 1521

Syntax

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...> <NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you omit the NOTSORTED option in the BY statement, then the observations in the data set either must be sorted by all the variables that you specify or must be indexed appropriately. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the observations are sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The observations are sorted in another way (for example, chronological order).

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. The procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

Details

Using the BY Statement with the SAS System Option NOBYLINE

If you use the BY statement with the SAS system option NOBYLINE, which suppresses the BY line that normally appears in output that is produced with BY-group processing, then PROC MEANS always starts a new page for each BY group. This behavior ensures that if you create customized BY lines by putting BY-group information in the title and suppressing the default BY lines with NOBYLINE, then the information in the titles matches the report on the pages. See "Creating Titles That Contain BY-Group Information " on page 57. Also see "Suppressing the Default BY Line" on page 57.

CLASS Statement

Specifies the variables whose values define the subgroup combinations for the analysis.

Note: CLASS statements without options use ORDER=INTERNAL, which is the default, or the value specified by the ORDER= option in the PROC MEANS statement. For example, in the following code, variables c and d would use ORDER=INTERNAL. If an ORDER= option had been specified in the PROC MEANS statement, then variables c and d would use the value specified by the ORDER= option in the PROC MEANS statement.

```
class a b / order=data;
 class c d;
```

Tips: You can use multiple CLASS statements.

Some CLASS statement options are also available in the PROC MEANS statement. They affect all CLASS variables. Options that you specify in a CLASS statement apply only to the variables in that CLASS statement.

See: For information about how the CLASS statement groups formatted values, see "Formatted Values" on page 63.

Examples:

"Example 2: Computing Descriptive Statistics with Class Variables" on page 1518

"Example 3: Using the BY Statement with Class Variables" on page 1521

"Example 4: Using a CLASSDATA= Data Set with Class Variables" on page 1523

"Example 5: Using Multilabel Value Formats with Class Variables" on page 1526

"Example 6: Using Preloaded Formats with Class Variables" on page 1531

"Example 7: Computing a Confidence Limit for the Mean" on page 1535

"Example 8: Computing Output Statistics" on page 1537

"Example 9: Computing Different Output Statistics for Several Variables" on page 1539

"Example 10: Computing Output Statistics with Missing Class Variable Values" on page 1542

"Example 11: Identifying an Extreme Value with the Output Statistics" on page 1544

"Example 12: Identifying the Top Three Extreme Values with the Output Statistics" on page 1547

Syntax

CLASS *variable(s)* </ *options*>;

Required Argument

variable(s)
specifies one or more variables that the procedure uses to group the data. Variables in a CLASS statement are referred to as *class variables*. Class variables are numeric or character. Class variables can have continuous values, but they typically have a few discrete values that define levels of the variable. You do not have to sort the data by class variables.

Interaction Use the TYPES statement or the WAYS statement to control which class variables PROC MEANS uses to group the data.

Tip To reduce the number of class variable levels, use a FORMAT statement to combine variable values. When a format combines several internal values into one formatted value, PROC MEANS outputs the lowest internal value.

See "Using Class Variables " on page 1467

Optional Arguments

ASCENDING
specifies to sort the class variable levels in ascending order.

Alias ASCEND

Interaction PROC MEANS issues a warning message if you specify both ASCENDING and DESCENDING and ignores both options.

See "Example 10: Computing Output Statistics with Missing Class Variable Values" on page 1542

DESCENDING
specifies to sort the class variable levels in descending order.

Alias DESCEND

Interaction PROC MEANS issues a warning message if you specify both ASCENDING and DESCENDING and ignores both options.

EXCLUSIVE
excludes from the analysis all combinations of the class variables that are not found in the preloaded range of user-defined formats.

Requirement You must specify PRELOADFMT to preload the class variable formats.

See "Example 6: Using Preloaded Formats with Class Variables" on page 1531

GROUPINTERNAL

specifies not to apply formats to the class variables when PROC MEANS groups the values to create combinations of class variables.

Interactions If you specify the PRELOADFMT option, then PROC MEANS ignores the GROUPINTERNAL option and uses the formatted values.

If you specify the ORDER=FORMATTED option, then PROC MEANS ignores the GROUPINTERNAL option and uses the formatted values.

Tip This option saves computer resources when the numeric class variables contain discrete values.

See "Computer Resources" on page 1496

MISSING

considers missing values as valid values for the class variable levels. Special missing values that represent numeric values (the letters A through Z and the underscore (_) character) are each considered as a separate value.

Default If you omit MISSING, then PROC MEANS excludes the observations with a missing class variable value from the analysis.

See *SAS Language Reference: Concepts* for a discussion of missing values with special meanings.

"Example 10: Computing Output Statistics with Missing Class Variable Values" on page 1542

MLF

enables PROC MEANS to use the primary and secondary format labels for a given range or overlapping ranges to create subgroup combinations when a multilabel format is assigned to a class variable.

Requirement You must use PROC FORMAT and the MULTILABEL option in the VALUE statement to create a multilabel format.

Interactions If you use the OUTPUT statement with MLF, then the class variable contains a character string that corresponds to the formatted value. Because the formatted value becomes the internal value, the length of this variable is the number of characters in the longest format label.

Using MLF with ORDER=FREQ might not produce the order that you expect for the formatted values. You might not get the expected results when you use MLF with CLASSDATA and EXCLUSIVE because MLF processing requires that each TYPE be

computed independently. Types other than NWAY might contain more levels than expected.

Note When the formatted values overlap, one internal class variable value maps to more than one class variable subgroup combination. Therefore, the sum of the N statistics for all subgroups is greater than the number of observations in the data set (the overall N statistic).

Tip If you omit MLF, then PROC MEANS uses the primary format labels. This action corresponds to using the first external format value to determine the subgroup combinations.

See The MULTILABEL option in the VALUE statement of the FORMAT procedure "Optional Arguments" on page 1100.

"Example 5: Using Multilabel Value Formats with Class Variables" on page 1526

ORDER=DATA | FORMATTED | FREQ | UNFORMATTED

specifies the order to group the levels of the class variables in the output, where

DATA

orders values according to their order in the input data set.

Interaction If you use PRELOADFMT, then the order of the values of each class variable matches the order that PROC FORMAT uses to store the values of the associated user-defined format. If you use the CLASSDATA= option in the PROC statement, then PROC MEANS uses the order of the unique values of each class variable in the CLASSDATA= data set to order the output levels. If you use both options, then PROC MEANS first uses the user-defined formats to order the output. If you omit EXCLUSIVE in the PROC statement, then PROC MEANS appends after the user-defined format and the CLASSDATA= values the unique values of the class variables in the input data set based on the order in which they are encountered.

Tip By default, PROC FORMAT stores a format definition in sorted order. Use the NOTSORTED option to store the values or ranges of a user-defined format in the order in which you define them.

See "Example 10: Computing Output Statistics with Missing Class Variable Values" on page 1542

FORMATTED

orders values by their ascending formatted values. This order depends on your operating environment. If no format has been assigned to a class variable, then the default format, BEST12., is used.

Aliases FMT

EXTERNAL

See "Example 5: Using Multilabel Value Formats with Class Variables" on page 1526

FREQ
orders values by descending frequency count so that levels with the most observations are listed first.

Interactions For multiway combinations of the class variables, PROC MEANS determines the order of a level from the individual class variable frequencies.

Use the ASCENDING option to order values by ascending frequency count.

See "Example 5: Using Multilabel Value Formats with Class Variables" on page 1526

UNFORMATTED
orders values by their unformatted values. This order depends on your operating environment. This sort sequence is particularly useful for displaying dates chronologically.

Specifying ORDER=UNFORMATTED usually, but not always, produces the same results as PROC SORT. For more information about ordering data, see "Controlling the Order of Data Values" on page 27.

Aliases UNFMT

INTERNAL

See "Ordering the Class Values" on page 1468

Default UNFORMATTED

PRELOADFMT
specifies that all formats are preloaded for the class variables.

Requirement PRELOADFMT has no effect unless you specify either COMPLETETYPES, EXCLUSIVE, or ORDER=DATA and you assign formats to the class variables.

Interactions The combination of PRELOADFMT and COMPLETETYPES generates values that might not appear within the input data set. In some cases, for a character class variable, extremely low or high sentinel values are generated. These values might not represent valid characters of the session encoding. These values should not be printed in their raw form but should be printed using the associated format. Use of the OTHER= value in the format definition can prevent the raw sentinel values from printing when using the format.

To limit PROC MEANS output to the combinations of formatted class variable values present in the input data set, use the EXCLUSIVE option in the CLASS statement.

To include all ranges and values of the user-defined formats in the output, even when the frequency is zero, use COMPLETETYPES in the PROC statement.

Note When preloading a character format, there must be at least one representative raw value that produces the label. If a range does not have any raw values, the range is considered unreachable and an error is generated. For example, you cannot preload a multi-label character format with both Other= and Low-High ranges. Other is a special keyword that refers to values or ranges that remain after all labels have been defined. For character formats, missing values are included in the low range so that there are no raw values left to occupy the Other range.

See "Example 6: Using Preloaded Formats with Class Variables" on page 1531

Details

Comparison of the BY and CLASS Statements

Using the BY statement is similar to using the CLASS statement and the NWAY option in that PROC MEANS summarizes each BY group as an independent subset of the input data. Therefore, no overall summarization of the input data is available. However, unlike the CLASS statement, the BY statement requires that the data is pre-sorted or indexed by the variables in the BY statement.

When you use the NWAY option, PROC MEANS might encounter insufficient memory for the summarization of all the class variables. You can move some class variables to the BY statement. For maximum benefit, move class variables to the BY statement that are already sorted or that have the greatest number of unique values.

You can use the CLASS and BY statements together to analyze the data by the levels of class variables within BY groups. See "Example 3: Using the BY Statement with Class Variables" on page 1521.

How PROC MEANS Handles Missing Values for Class Variables

By default, if an observation contains a missing value for any class variable, then PROC MEANS excludes that observation from the analysis. If you specify the MISSING option in the PROC statement, then the procedure considers missing values as valid levels for the combination of class variables.

Specifying the MISSING option in the CLASS statement enables you to control the acceptance of missing values for individual class variables.

Computer Resources

The total of unique class variable values that PROC MEANS allows depends on the amount of computer memory that is available. See "Computational Resources" on page 1469 for more information.

The GROUPINTERNAL option can improve computer performance because the grouping process is based on the internal values of the class variables. If a numeric class variable is not assigned a format and you do not specify GROUPINTERNAL, then PROC MEANS uses the default format, BEST12., to format numeric values as character strings. Then PROC MEANS groups these numeric variables by their character values, which takes additional time and computer memory.

FREQ Statement

Specifies a numeric variable that contains the frequency of each observation.

See: "FREQ" on page 79

Syntax

FREQ *variable*;

Required Argument

variable
specifies a numeric variable whose value represents the frequency of the observation. If you use the FREQ statement, then the procedure assumes that each observation represents *n* observations, where *n* is the value of *variable*. If *n* is not an integer, then SAS truncates it. If *n* is less than 1 or is missing, then the procedure does not use that observation to calculate statistics.

The sum of the frequency variable represents the total number of observations.

Note: The FREQ variable does not affect how PROC MEANS identifies multiple extremes when you use the IDGROUP syntax in the OUTPUT statement.

ID Statement

Includes additional variables in the output data set.

See: Discussion of id-group-specification in "OUTPUT Statement" on page 1497.

Syntax

ID *variable(s)*;

Required Argument

variable(s)
identifies one or more variables from the input data set whose maximum values for groups of observations PROC MEANS includes in the output data set.

Interaction Use IDMIN in the PROC statement to include the minimum value of the ID variables in the output data set.

Tip Use the PRINTIDVARS option in the PROC statement to include the value of the ID variable in the displayed output.

Details

Selecting the Values of the ID Variables

When you specify only one variable in the ID statement, the value of the ID variable for a given observation is the maximum (minimum) value found in the corresponding group of observations in the input data set. When you specify multiple variables in the ID statement, PROC MEANS selects the maximum value by processing the variables in the ID statement in the order in which you list them. PROC MEANS determines which observation to use from all the ID variables by comparing the values of the first ID variable. If more than one observation contains the same maximum (minimum) ID value, then PROC MEANS uses the second and subsequent ID variable values as "tiebreakers." In any case, all ID values are taken from the same observation for any given BY group or classification level within a type.

See "Sorting Orders for Character Variables " on page 2359 for information about how PROC MEANS compares character values to determine the maximum value.

OUTPUT Statement

Writes statistics to a new SAS data set.

Tip: You can use multiple OUTPUT statements to create several OUT= data sets.

Examples:
"Example 8: Computing Output Statistics" on page 1537
"Example 9: Computing Different Output Statistics for Several Variables" on page 1539
"Example 10: Computing Output Statistics with Missing Class Variable Values" on page 1542
"Example 11: Identifying an Extreme Value with the Output Statistics" on page 1544

"Example 12: Identifying the Top Three Extreme Values with the Output Statistics" on page 1547

Syntax

OUTPUT <OUT=*SAS-data-set*> <*output-statistic-specification(s)*> <*id-group-specification(s)*> <*maximum-id-specification(s)*> <*minimum-id-specification(s)*> </ *options*>;

Optional Arguments

OUT=*SAS-data-set*
names the new output data set. If *SAS-data-set* does not exist, then PROC MEANS creates it. If you omit OUT=, then the data set is named DATA*n*, where *n* is the smallest integer that makes the name unique.

Default DATA*n*

Tip You can use data set options with the OUT= option.

output-statistic-specification(s)
specifies the statistics to store in the OUT= data set and names one or more variables that contain the statistics. The form of the *output-statistic-specification* is

statistic-keyword<(*variable-list*)>=<*name(s)*>

where

statistic-keyword
specifies which statistic to store in the output data set. The available statistic keywords are

Descriptive statistics keyword	
CLM	NMISS
CSS	RANGE
CV	SKEWNESS | SKEW
KURTOSIS | KURT	STDDEV | STD
LCLM	STDERR
MAX	SUM
MEAN	SUMWGT
MIN	UCLM

MODE	USS
N	VAR
Quantile statistics keyword	
MEDIAN | P50	Q3 | P75
P1	P90
P5	P95
P10	P99
P20	P30
P40	P60
P70	P80
Q1 | P25	QRANGE
Hypothesis testing keyword	
PROBT | PRT	T

By default the statistics in the output data set automatically inherit the analysis variable's format, informat, and label. However, statistics computed for N, NMISS, SUMWGT, USS, CSS, VAR, CV, T, PROBT, PRT, SKEWNESS, and KURTOSIS do not inherit the analysis variable's format because this format might be invalid for these statistics (for example, dollar or datetime formats).

Restriction If you omit *variable* and *name(s)*, then PROC MEANS allows the *statistic-keyword* only once in a single OUTPUT statement, unless you also use the AUTONAME option.

See "Example 8: Computing Output Statistics" on page 1537

"Example 9: Computing Different Output Statistics for Several Variables" on page 1539

"Example 11: Identifying an Extreme Value with the Output Statistics" on page 1544

"Example 12: Identifying the Top Three Extreme Values with the Output Statistics" on page 1547

variable-list
specifies the names of one or more numeric analysis variables whose statistics you want to store in the output data set.

Default all numeric analysis variables

name(s)
specifies one or more names for the variables in the output data set that contain the analysis variable statistics. The first name contains the statistic for the first analysis variable; the second name contains the statistic for the second analysis variable; and so on.

Default the analysis variable name. If you specify AUTONAME, then the default is the combination of the analysis variable name and the *statistic-keyword*. If you use the CLASS statement and an OUTPUT statement without an *output-statistic-specification*, then the output data set contains five observations for each combination of class variables: the value of N, MIN, MAX, MEAN, and STD. If you use the WEIGHT statement or the WEIGHT option in the VAR statement, then the output data set also contains an observation with the sum of weights (SUMWGT) for each combination of class variables.

Interaction If you specify *variable-list*, then PROC MEANS uses the order in which you specify the analysis variables to store the statistics in the output data set variables.

Tip Use the AUTONAME option to have PROC MEANS generate unique names for multiple variables and statistics.

See "Example 8: Computing Output Statistics" on page 1537

id-group-specification
combines the features and extends the ID statement, the IDMIN option in the PROC statement, and the MAXID and MINID options in the OUTPUT statement to create an OUT= data set that identifies multiple extreme values. The form of the *id-group-specification* is

IDGROUP (<MIN | MAX (*variable-list-1*) <...MIN | MAX (*variable-list-n*)>>
<<MISSING>
<OBS> <LAST>> OUT <[*n*]>
(*id-variable-list*)=<*name(s)*>)

MIN
MAX(*variable-list*)
specifies the selection criteria to determine the extreme values of one or more input data set variables specified in *variable-list*. Use MIN to determine the minimum extreme value and MAX to determine the maximum extreme value.

When you specify multiple selection variables, the ordering of observations for the selection of *n* extremes is done the same way that PROC SORT sorts data with multiple BY variables. PROC MEANS concatenates the variable values into a single key. The MAX(*variable-list*) selection criterion is similar to using PROC SORT and the DESCENDING option in the BY statement.

Default If you do not specify MIN or MAX, then PROC MEANS uses the observation number as the selection criterion to output observations.

Restriction If you specify criteria that are contradictory, then PROC MEANS uses only the first selection criterion.

Interaction When multiple observations contain the same extreme values in all the MIN or MAX variables, PROC MEANS uses the observation number to resolve which observation to write to the output. By default, PROC MEANS uses the first observation to resolve any ties. However, if you specify the LAST option, then PROC MEANS uses the last observation to resolve any ties.

LAST

specifies that the OUT= data set contains values from the last observation (or the last *n* observations, if *n* is specified). If you do not specify LAST, then the OUT= data set contains values from the first observation (or the first *n* observations, if *n* is specified). The OUT= data set might contain several observations because in addition to the value of the last (first) observation, the OUT= data set contains values from the last (first) observation of each subgroup level that is defined by combinations of class variable values.

Interaction When you specify MIN or MAX and when multiple observations contain the same extreme values, PROC MEANS uses the observation number to resolve which observation to save to the OUT= data set. If you specify LAST, then PROC MEANS uses the later observations to resolve any ties. If you do not specify LAST, then PROC MEANS uses the earlier observations to resolve any ties.

MISSING

specifies that missing values be used in selection criteria.

Alias MISS

OBS

includes an _OBS_ variable in the OUT= data set that contains the number of the observation in the input data set where the extreme value was found.

Interactions If you use WHERE processing, then the value of _OBS_ might not correspond to the location of the observation in the input data set.

If you use [*n*] to write multiple extreme values to the output, then PROC MEANS creates *n* _OBS_ variables and uses the suffix *n* to create the variable names, where *n* is a sequential integer from 1 to *n*.

[*n*]

specifies the number of extreme values for each variable in *id-variable-list* to include in the OUT= data set. PROC MEANS creates *n* new variables and

uses the suffix _*n* to create the variable names, where *n* is a sequential integer from 1 to *n*.

By default, PROC MEANS determines one extreme value for each level of each requested type. If *n* is greater than one, then *n* extremes are generated for each level of each type. When *n* is greater than one and you request extreme value selection, the time complexity is $O(T * N \log_2 n)$, where T is the number of types requested and N is the number of observations in the input data set. By comparison, to group the entire data set, the time complexity is $O(N \log_2 N)$.

Default 1

Range an integer between 1 and 100

Example For example, to generate two minimum extreme values for each variable, use

```
idgroup(min(x) out[2](x y z)=MinX MinY MinZ);
```

The OUT= data set contains the variables MinX_1, MinX_2, MinY_1, MinY_2, MinZ_1, and MinZ_2.

(id-variable-list)

identifies one or more input data set variables whose values PROC MEANS includes in the OUT= data set. PROC MEANS determines which observations to generate by the selection criteria that you specify (MIN, MAX, and LAST).

Alias IDGRP

Requirement You must specify the MIN | MAX selection criteria first and OUT(*id-variable-list*)= after the suboptions MISSING, OBS, and LAST.

Tips You can use *id-group-specification* to mimic the behavior of the ID statement and a *maximum-id-specification* or *minimum-id-specification* in the OUTPUT statement.

When you want the output data set to contain extreme values along with other ID variables, it is more efficient to include them in the *id-variable-list* than to request separate statistics. For example, the statement `output idgrp(max(x) out(x a b)= );` is more efficient than the statement `output idgrp(max(x) out(a b)= ) max(x)=;`

See "Example 8: Computing Output Statistics" on page 1537

"Example 12: Identifying the Top Three Extreme Values with the Output Statistics" on page 1547

name(s)

specifies one or more names for variables in the OUT= data set.

Default If you omit *name*, then PROC MEANS uses the names of variables in the *id-variable-list*.

Tip Use the AUTONAME option to automatically resolve naming conflicts.

CAUTION

The IDGROUP syntax enables you to create output variables with the same name. When this action happens, only the first variable appears in the output data set. Use the AUTONAME option to automatically resolve these naming conflicts.

Note: If you specify fewer new variable names than the combination of analysis variables and identification variables, then the remaining output variables use the corresponding names of the ID variables as soon as PROC MEANS exhausts the list of new variable names.

maximum-id-specification(s)

specifies that one or more identification variables be associated with the maximum values of the analysis variables. The form of the *maximum-id-specification* is

MAXID <(*variable-1* <(*id-variable-list-1*)> <...*variable-n* <(*id-variable-list-n*)>>)> = *name(s)*

variable

identifies the numeric analysis variable whose maximum values PROC MEANS determines. PROC MEANS can determine several maximum values for a variable because, in addition to the overall maximum value, subgroup levels, which are defined by combinations of class variables values, also have maximum values.

Tip If you use an ID statement and omit *variable*, then PROC MEANS uses all analysis variables.

id-variable-list

identifies one or more variables whose values identify the observations with the maximum values of the analysis variable.

Default the ID statement variables

name(s)

specifies the names for new variables that contain the values of the identification variable associated with the maximum value of each analysis variable.

Note If multiple observations contain the maximum value within a class level, then PROC MEANS saves the value of the ID variable for only the first of those observations in the output data set.

Tips If you use an ID statement, and omit *variable* and *id-variable*, then PROC MEANS associates all ID statement variables with each analysis variable. Thus, for each analysis variable, the number of variables that are created in the output data set equals the number of variables that you specify in the ID statement.

Use the AUTONAME option to automatically resolve naming conflicts.

See "Example 11: Identifying an Extreme Value with the Output Statistics" on page 1544

CAUTION

The MAXID syntax enables you to create output variables with the same name. When this action happens, only the first variable appears in the output data set. Use the AUTONAME option to automatically resolve these naming conflicts.

Note: If you specify fewer new variable names than the combination of analysis variables and identification variables, then the remaining output variables use the corresponding names of the ID variables as soon as PROC MEANS exhausts the list of new variable names.

minimum-id-specification

See the description of maximum-id-specification. This option behaves in exactly the same way, except that PROC MEANS determines the minimum values instead of the maximum values. The form of the *minid-specification* is

MINID<(*variable-1* <(*id-variable-list-1*)> <...*variable-n* <(*id-variable-list-n*)>>)> = *name(s)*

When MINID is used without an explicit variable list, it is similar to the following more advanced IDGROUP syntax example:

IDGRP(min(x) missing out(id_variable)=idminx) idgrp(min(y) missing out(id_variable)=idminy)

If one or more of the analysis variables has a missing value, the id_variable value corresponds to the observation with the missing value not the observation with the value for the MIN statistic.

option

can be one of the following items:

AUTOLABEL

specifies that PROC MEANS appends the statistic name to the end of the variable label. If an analysis variable has no label, then PROC MEANS creates a label by appending the statistic name to the analysis variable name.

See "Example 12: Identifying the Top Three Extreme Values with the Output Statistics" on page 1547

AUTONAME

specifies that PROC MEANS creates a unique variable name for an output statistic when you do not assign the variable name in the OUTPUT statement. This action is accomplished by appending to the *statistic-keyword* to the end of the input variable name from which the statistic was derived.

For example, the statement `output min(x)=/autoname;` produces the x_Min variable in the output data set.

AUTONAME activates the SAS internal mechanism to automatically resolve conflicts in the variable names in the output data set. Duplicate variables do not generate errors.

As a result, the statement `output min(x)= min(x)=/autoname;` produces two variables, x_Min and x_Min2, in the output data set.

If the new variable name exceeds 32 characters, then the variable-name portion is truncated.

See "Example 12: Identifying the Top Three Extreme Values with the Output Statistics" on page 1547

KEEPLEN

specifies that statistics in the output data set inherit the length of the analysis variable that PROC MEANS uses to derive them.

CAUTION

You permanently lose numeric precision when the length of the analysis variable causes PROC MEANS to truncate or round the value of the statistic. However, the precision of the statistic matches that of the input.

LEVELS

includes a variable named _LEVEL_ in the output data set. This variable contains a value from 1 to *n* that indicates a unique combination of the values of class variables (the values of _TYPE_ variable).

See "Output Data Set" on page 1514

"Example 8: Computing Output Statistics" on page 1537

NOINHERIT

specifies that the variables in the output data set that contain statistics do not inherit the attributes (label and format) of the analysis variables that are used to derive them.

Interaction When no option is used (implied INHERIT) then the statistics inherit the attributes, label and format, of the input analysis variable(s). If the INHERIT option is used in the OUTPUT statement, then the statistics inherit the length of the input analysis variable(s), the label and format.

Tip By default, the output data set includes an output variable for each analysis variable and for five observations that contain N, MIN, MAX, MEAN, and STDDEV. Unless you specify NOINHERIT, this variable inherits the format of the analysis variable, which can be invalid for the N statistic (for example, datetime formats).

WAYS
includes a variable named _WAY_ in the output data set. This variable contains a value from 1 to the maximum number of class variables that indicates how many class variables PROC MEANS combines to create the TYPE value.

See "Output Data Set" on page 1514

"WAYS Statement" on page 1509

"Example 8: Computing Output Statistics" on page 1537

TYPES Statement

Identifies which of the possible combinations of class variables to generate.

Requirement: CLASS statement

See: "Output Data Set" on page 1514

Examples: "Example 2: Computing Descriptive Statistics with Class Variables" on page 1518

"Example 5: Using Multilabel Value Formats with Class Variables" on page 1526

"Example 12: Identifying the Top Three Extreme Values with the Output Statistics" on page 1547

Syntax

TYPES *request(s)*;

Required Argument

request(s)
specifies which of the 2^k combinations of class variables PROC MEANS uses to create the types, where k is the number of class variables. A request includes one class variable name, several class variable names separated by asterisks, or ().

To request class variable combinations quickly, use a grouping syntax by placing parentheses around several variables and joining other variables or variable combinations. For example, the following statements illustrate grouping syntax:

Request	Equivalent to
`types A*(B C);`	`types A*B A*C;`
`types (A B)*(C D);`	`types A*C A*D B*C B*D;`

```
types (A B C)*D;          types A*D B*D C*D;
```

Interaction The CLASSDATA= option places constraints on the NWAY type. PROC MEANS generates all other types as if derived from the resulting NWAY type.

Tips Use ( ) to request the overall total (_TYPE_=0).

If you do not need all types in the output data set, then use the TYPES statement to specify particular subtypes rather than applying a WHERE clause to the data set. Doing so saves time and computer memory.

Details

Order of Analyses in the Output

The analyses are written to the output in order of increasing values of the _TYPE_ variable, which is calculated by PROC MEANS. The _TYPE_ variable has a unique value for each combination of class variables; the values are determined by how you specify the CLASS statement, not the TYPES statement. Therefore, if you specify

```
class A B C;
types (A B)*C;
```

then the B*C analysis (_TYPE_=3) is written first, followed by the A*C analysis (_TYPE_=5). However, if you specify

```
class B A C;
types (A B)*C;
```

then the A*C analysis comes first.

The _TYPE_ variable is calculated even if no output data set is requested. For more information about the _TYPE_ variable, see “Output Data Set” on page 1514.

VAR Statement

Identifies the analysis variables and their order in the output.

Default: If you omit the VAR statement, then PROC MEANS analyzes all numeric variables that are not listed in the other statements. When all variables are character variables, PROC MEANS produces a simple count of observations.

Tip: You can use multiple VAR statements.

See: Chapter 69, “SUMMARY Procedure,” on page 2455

Example: “Example 1: Computing Specific Descriptive Statistics” on page 1516

Syntax

VAR *variable(s)* </ WEIGHT=*weight-variable*>;

Required Argument

variable(s)
identifies the analysis variables and specifies their order in the results.

Optional Argument

WEIGHT=*weight-variable*
specifies a numeric variable whose values weight the values of the variables that are specified in the VAR statement. The variable does not have to be an integer. The following table describes how PROC MEANS treats various values of the WEIGHT variable.

Weight Value	PROC MEANS Response
0	Counts the observation in the total number of observations
Less than 0	Converts the value to zero and counts the observation in the total number of observations
Missing	Excludes the observation

To exclude observations that contain negative and zero weights from the analysis, use EXCLNPWGT. Note that most SAS/STAT procedures, such as PROC GLM, exclude negative and zero weights by default.

The weight variable does not change how the procedure determines the range, extreme values, or number of missing values.

Restrictions To compute weighted quantiles, use QMETHOD=OS in the PROC statement.

Skewness and kurtosis are not available with the WEIGHT option.

Note Prior to Version 7 of SAS, the procedure did not exclude the observations with missing weights from the count of observations.

Tips When you use the WEIGHT option, consider which value of the VARDEF= option is appropriate. See the discussion of VARDEF=.

Use the WEIGHT option in multiple VAR statements to specify different weights for the analysis variables.

WAYS Statement

Specifies the number of ways to make unique combinations of class variables.

Tip: Use the TYPES statement to specify additional combinations of class variables.

Example: "Example 6: Using Preloaded Formats with Class Variables" on page 1531

Syntax

WAYS *list*;

Required Argument

list

specifies one or more integers that define the number of class variables to combine to form all the unique combinations of class variables. For example, you can specify 2 for all possible pairs and 3 for all possible triples. The *list* can be specified in the following ways:

- *m*
- *m1 m2 ... mn*
- *m1,m2,...,mn*
- *m* TO *n* <BY *increment*>
- *m1,m2* TO *m3* <BY *increment*>, *m4*

Range: 0 to maximum number of class variables

See: WAYS option

Example: The following code is an example of creating two-way types for the classification variables A, B, and C. This WAYS statement is equivalent to specifying a*b, a*c, and b*c in the TYPES statement.

```
class A B C ; ways 2;
```

WEIGHT Statement

Specifies weights for observations in the statistical calculations.

See: For information about how to calculate weighted statistics and for an example that uses the WEIGHT statement, see "WEIGHT" on page 82.

Syntax

WEIGHT *variable*;

Required Argument

variable
specifies a numeric variable whose values weight the values of the analysis variables. The values of the variable do not have to be integers. The following table describes how PROC MEANS treats various values of the WEIGHT variable.

Weight Value	PROC MEANS Response
0	Counts the observation in the total number of observations
Less than 0	Converts the value to zero and counts the observation in the total number of observations
Missing	Excludes the observation

To exclude observations that contain negative and zero weights from the analysis, use EXCLNPWGT. Note that most SAS/STAT procedures, such as PROC GLM, exclude negative and zero weights by default.

CAUTION
Single extreme weight values can cause inaccurate results. When one (and only one) weight value is many orders of magnitude larger than the other weight values (for example, 49 weight values of 1 and one weight value of 1×10^{14}), certain statistics might not be within acceptable accuracy limits. The affected statistics are based on the second moment (such as standard deviation, corrected sum of squares, variance, and standard error of the mean). Under certain circumstances, no warning is written to the SAS log.

Restrictions To compute weighted quantiles, use QMETHOD=OS in the PROC statement.

Skewness and kurtosis are not available with the WEIGHT statement.

PROC MEANS does not compute MODE when a weight variable is active. Instead, try using the UNIVARIATE procedure when MODE needs to be computed and a weight variable is active.

Interaction If you use the WEIGHT= option in a VAR statement to specify a weight variable, then PROC MEANS uses this variable instead to weight those VAR statement variables.

Note Prior to Version 7 of SAS, the procedure did not exclude the observations with missing weights from the count of observations.

Tip When you use the WEIGHT statement, consider which value of the VARDEF= option is appropriate. See the discussion of VARDEF= and the calculation of weighted statistics in "Keywords and Formulas" on page 2700 for more information.

Usage: MEANS Procedure

Computation of Moment Statistics

PROC MEANS uses single-pass algorithms to compute the moment statistics (such as mean, variance, skewness, and kurtosis). See "Keywords and Formulas" on page 2700 for the statistical formulas.

The computational details for confidence limits, hypothesis test statistics, and quantile statistics follow.

Confidence Limits

With the keywords CLM, LCLM, and UCLM, you can compute confidence limits for the mean. A confidence limit is a range, constructed around the value of a sample statistic, that contains the corresponding true population value with given probability (ALPHA=) in repeated sampling.

A two-sided $100(1-\alpha)$ % confidence interval for the mean has upper and lower limits

$$\overline{x} \pm t_{(1-\alpha/2;n-1)}\frac{s}{\sqrt{n}}$$

where s is $\sqrt{\frac{1}{n-1}\Sigma\,(x_i-\overline{x})^2}$ and $t_{(1-\alpha/2;n-1)}$ is the ($1-\alpha/2$) critical value of the Student's t statistics with $n-1$ degrees of freedom.

A one-sided $100(1-\alpha)$ % confidence interval is computed as

$$\overline{x} + t_{(1-\alpha;n-1)}\frac{s}{\sqrt{n}} \quad \text{(upper)}$$

$$\overline{x} - t_{(1-\alpha;n-1)}\frac{s}{\sqrt{n}} \quad \text{(lower)}$$

If you use the WEIGHT statement or WEIGHT= in a VAR statement and the default value of VARDEF=, which is DF, the $100(1-\alpha)$ % confidence interval for the weighted mean has upper and lower limits

$$\overline{y}_w \pm t_{(1-\alpha/2)} \frac{s_w}{\sqrt{\sum_{i=1}^{n} w_i}}$$

where $\overline{y}_w$ is the weighted mean, s_w is the weighted standard deviation, w_i is the weight for ith observation, and $t_{(1-\alpha/2)}$ is the $(1-\alpha/2)$ critical value for the Student's t distribution with $n-1$ degrees of freedom.

Student's t Test

PROC MEANS calculates the t statistic as

$$t = \frac{\overline{x} - \mu_0}{s/\sqrt{n}}$$

where $\overline{x}$ is the sample mean, n is the number of nonmissing values for a variable, and s is the sample standard deviation. Under the null hypothesis, the population mean equals μ_0 . When the data values are approximately normally distributed, the probability under the null hypothesis of a t statistic as extreme as, or more extreme than, the observed value (the p-value) is obtained from the t distribution with $n-1$ degrees of freedom. For large n , the t statistic is asymptotically equivalent to a z test.

When you use the WEIGHT statement or WEIGHT= in a VAR statement and the default value of VARDEF=, which is DF, the Student's t statistic is calculated as

$$t_w = \frac{\overline{y}_w - \mu_0}{s_w/\sqrt{\sum_{i=1}^{n} w_i}}$$

where $\overline{y}_w$ is the weighted mean, s_w is the weighted standard deviation, and w_i is the weight for ith observation. The t_w statistic is treated as having a Student's t distribution with $n-1$ degrees of freedom. If you specify the EXCLNPWGT option in the PROC statement, then n is the number of nonmissing observations when the value of the WEIGHT variable is positive. By default, n is the number of nonmissing observations for the WEIGHT variable.

Quantiles

The options QMETHOD=, QNTLDEF=, and QMARKERS= determine how PROC MEANS calculates quantiles. QNTLDEF= deals with the mathematical definition of a quantile. See "Quantile and Related Statistics" on page 2706. QMETHOD= deals with the mechanics of how PROC MEANS handles the input data. The two methods are

OS
reads all data into memory and sorts it by unique value.

P2
accumulates all data into a fixed sample size that is used to approximate the quantile.

If data set A has 100 unique values for a numeric variable X and data set B has 1000 unique values for numeric variable X, then QMETHOD=OS for data set B takes 10 times as much memory as it does for data set A. If QMETHOD=P2, then both data sets A and B requires the same memory space to generate quantiles.

The QMETHOD=P2 technique is based on the piecewise-parabolic (P^2) algorithm invented by Jain and Chlamtac (1985). P^2 is a one-pass algorithm to determine quantiles for a large data set. It requires a fixed amount of memory for each variable for each level within the type. However, using simulation studies, reliable estimations of some quantiles (P1, P5, P95, P99) cannot be possible for some data sets such as data sets with heavily tailed or skewed distributions.

If the number of observations is less than the QMARKERS= value, then QMETHOD=P2 produces the same results as QMETHOD=OS when QNTLDEF=5. To compute weighted quantiles, you must use QMETHOD=OS.

Results: MEANS Procedure

Missing Values

PROC MEANS excludes missing values for the analysis variables before calculating statistics. Each analysis variable is treated individually; a missing value for an observation in one variable does not affect the calculations for other variables. The statements handle missing values as follows:

- If a class variable has a missing value for an observation, then PROC MEANS excludes that observation from the analysis unless you use the MISSING option in the PROC statement or CLASS statement.
- If a BY or ID variable value is missing, then PROC MEANS treats it like any other BY or ID variable value. The missing values form a separate BY group.
- If a FREQ variable value is missing or nonpositive, then PROC MEANS excludes the observation from the analysis.
- If a WEIGHT variable value is missing, then PROC MEANS excludes the observation from the analysis.

PROC MEANS tabulates the number of the missing values. Before the number of missing values are tabulated, PROC MEANS excludes observations with frequencies that are nonpositive when you use the FREQ statement and

observations with weights that are missing or nonpositive (when you use the EXCLNPWGT option) when you use the WEIGHT statement. To report this information in the procedure output use the NMISS statistical keyword in the PROC statement.

Column Width for the Output

You control the column width for the displayed statistics with the FW= option in the PROC statement. Unless you assign a format to a numeric class or an ID variable, PROC MEANS uses the value of the FW= option. When you assign a format to a numeric class or an ID variable, PROC MEANS determines the column width directly from the format. If you use the PRELOADFMT option in the CLASS statement, then PROC MEANS determines the column width for a class variable from the assigned format.

The N Obs Statistic

By default when you use a CLASS statement, PROC MEANS displays an additional statistic called N Obs. This statistic reports the total number of observations or the sum of the observations of the FREQ variable that PROC MEANS processes for each class level. PROC MEANS might omit observations from this total because of missing values in one or more class variables or because of the effect of the EXCLUSIVE option when you use it with the PRELOADFMT option or the CLASSDATA= option. Because of this action and the exclusion of observations when the WEIGHT variable contains missing values, there is not always a direct relationship between N Obs, N, and NMISS.

In the output data set, the value of N Obs is stored in the _FREQ_ variable. Use the NONOBS option in the PROC statement to suppress this information in the displayed output.

Output Data Set

PROC MEANS can create one or more output data sets. The procedure does not print the output data set. Use PROC PRINT, PROC REPORT, or another SAS reporting tool to display the output data set.

Note: By default the statistics in the output data set automatically inherit the analysis variable's format and label. However, statistics computed for N, NMISS, SUMWGT, USS, CSS, VAR, CV, T, PROBT, PRT,SKEWNESS, and KURTOSIS do not inherit the analysis variable's format because this format can be invalid for these statistics. Use the NOINHERIT option in the OUTPUT statement to prevent the other statistics from inheriting the format and label attributes.

The output data set can contain these variables:

- the variables specified in the BY statement.
- the variables specified in the ID statement.
- the variables specified in the CLASS statement.
- the variable _TYPE_ that contains information about the class variables. By default _TYPE_ is a numeric variable. If you specify CHARTYPE in the PROC statement, then _TYPE_ is a character variable. When you use more than 32 class variables, _TYPE_ is automatically a character variable.
- the variable _FREQ_ that contains the number of observations that a given output level represents.
- the variables requested in the OUTPUT statement that contain the output statistics and extreme values.
- the variable _STAT_ that contains the names of the default statistics if you omit statistic keywords.
- the variable _LEVEL_ if you specify the LEVEL option.
- the variable _WAY_ if you specify the WAYS option.

The value of _TYPE_ indicates which combination of the class variables PROC MEANS uses to compute the statistics. The character value of _TYPE_ is a series of zeros and ones, where each value of one indicates an active class variable in the type. For example, with three class variables, PROC MEANS represents type 1 as 001, type 5 as 101, and so on.

Usually, the output data set contains one observation per level per type. However, if you omit statistical keywords in the OUTPUT statement, then the output data set contains five observations per level (six if you specify a WEIGHT variable). Therefore, the total number of observations in the output data set is equal to the sum of the levels for all the types that you request multiplied by 1, 5, or 6, whichever is applicable.

If you omit the CLASS statement (_TYPE_= 0), then there is always exactly one level of output per BY group. If you use a CLASS statement, then the number of levels for each type that are requested have an upper bound equal to the number of observations in the input data set. By default, PROC MEANS generates all possible types. In this case the total number of levels for each BY group has an upper bound equal to

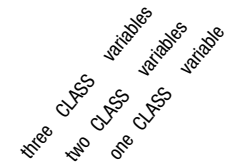
$$m \cdot \left(2^k - 1\right) \cdot n + 1$$

where k is the number of class variables and n is the number of observations for the given BY group in the input data set and m is 1, 5, or 6.

PROC MEANS determines the actual number of levels for a given type from the number of unique combinations of each active class variable. A single level consists of all input observations whose formatted class values match.

The following figure shows the values of _TYPE_ and the number of observations in the data set when you specify one, two, and three class variables.

Figure 40.1 *The Effect of Class Variables on the OUTPUT Data Set*



C	B	A	_WAY_	_TYPE_	Subgroup defined by	Number of observations of this _TYPE_ and _WAY_ in the data set	Total number of observations in the data set
0	0	0	0	0	Total	1	
0	0	1	1	1	A	a	1+a
0	1	0	1	2	B	b	
0	1	1	2	3	A*B	a*b	1+a+b+a*b
1	0	0	1	4	C	c	
1	0	1	2	5	A*C	a*c	
1	1	0	2	6	B*C	b*c	1+a+b+a*b+c
1	1	1	3	7	A *B*C	a*b*c	+a*c+b*c+a*b*c
Character binary equivalent of _TYPE_ (CHARTYPE option)					A , B ,C=CLASS variables	a, b, c,=number of levels of A, B, C, respectively	

Examples: MEANS Procedure

Example 1: Computing Specific Descriptive Statistics

Features: PROC MEANS statement options
statistic keywords
FW=
VAR statement

Data set: CAKE

Details

This example does the following:

- specifies the analysis variables
- computes the statistics for the specified keywords and displays them in order
- specifies the field width of the statistics

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

data cake;
   input LastName $ 1-12 Age 13-14 PresentScore 16-17
         TasteScore 19-20 Flavor $ 23-32 Layers 34 ;
   datalines;
Orlando     27 93 80  Vanilla    1
Ramey       32 84 72  Rum        2
Goldston    46 68 75  Vanilla    1
Roe         38 79 73  Vanilla    2
Larsen      23 77 84  Chocolate  .
Davis       51 86 91  Spice      3
Strickland  19 82 79  Chocolate  1
Nguyen      57 77 84  Vanilla    .
Hildenbrand 33 81 83  Chocolate  1
Byron       62 72 87  Vanilla    2
Sanders     26 56 79  Chocolate  1
Jaeger      43 66 74             1
Davis       28 69 75  Chocolate  2
Conrad      69 85 94  Vanilla    1
Walters     55 67 72  Chocolate  2
Rossburger  28 78 81  Spice      2
Matthew     42 81 92  Chocolate  2
Becker      36 62 83  Spice      2
Anderson    27 87 85  Chocolate  1
Merritt     62 73 84  Chocolate  1
;

proc means data=cake n mean max min range std fw=8;

   var PresentScore TasteScore;

   title 'Summary of Presentation and Taste Scores';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Create the CAKE data set. CAKE contains data from a cake-baking contest: each participant's last name, age, score for presentation, score for taste, cake flavor, and

number of cake layers. The number of cake layers is missing for two observations. The cake flavor is missing for another observation.

```
data cake;
   input LastName $ 1-12 Age 13-14 PresentScore 16-17
         TasteScore 19-20 Flavor $ 23-32 Layers 34 ;
   datalines;
Orlando     27 93 80  Vanilla    1
Ramey       32 84 72  Rum        2
Goldston    46 68 75  Vanilla    1
Roe         38 79 73  Vanilla    2
Larsen      23 77 84  Chocolate  .
Davis       51 86 91  Spice      3
Strickland  19 82 79  Chocolate  1
Nguyen      57 77 84  Vanilla    .
Hildenbrand 33 81 83  Chocolate  1
Byron       62 72 87  Vanilla    2
Sanders     26 56 79  Chocolate  1
Jaeger      43 66 74             1
Davis       28 69 75  Chocolate  2
Conrad      69 85 94  Vanilla    1
Walters     55 67 72  Chocolate  2
Rossburger  28 78 81  Spice      2
Matthew     42 81 92  Chocolate  2
Becker      36 62 83  Spice      2
Anderson    27 87 85  Chocolate  1
Merritt     62 73 84  Chocolate  1
;
```

Specify the statistics and the statistic options. The statistic keywords specify the statistics and their order in the output. FW= uses a field width of eight to display the statistics.

```
proc means data=cake n mean max min range std fw=8;
```

Specify the analysis variables. The VAR statement specifies that PROC MEANS calculate statistics on the PresentScore and TasteScore variables.

```
   var PresentScore TasteScore;
```

Specify the title.

```
   title 'Summary of Presentation and Taste Scores';
run;
```

Example 2: Computing Descriptive Statistics with Class Variables

Features: PROC MEANS statement option
MAXDEC=
CLASS statement
TYPES statement

Data set: GRADE

Details

This example does the following:

- analyzes the data for the two-way combination of class variables and across all observations
- limits the number of decimal places for the displayed statistics

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

data grade;
   input Name $ 1-8 Gender $ 11 Status $13 Year $ 15-16
         Section $ 18 Score 20-21 FinalGrade 23-24;
   datalines;
Abbott    F 2 97 A 90 87
Branford  M 1 98 A 92 97
Crandell  M 2 98 B 81 71
Dennison  M 1 97 A 85 72
Edgar     F 1 98 B 89 80
Faust     M 1 97 B 78 73
Greeley   F 2 97 A 82 91
Hart      F 1 98 B 84 80
Isley     M 2 97 A 88 86
Jasper    M 1 97 B 91 93
;

proc means data=grade maxdec=3;

   var Score;

   class Status Year;

   types () status*year;

   title 'Final Exam Grades for Student Status and Year of Graduation';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Create the GRADE data set. GRADE contains each student's last name, gender, status of either undergraduate (1) or graduate (2), expected year of graduation, class section (A or B), final exam score, and final grade for the course.

```
data grade;
   input Name $ 1-8 Gender $ 11 Status $13 Year $ 15-16
         Section $ 18 Score 20-21 FinalGrade 23-24;
   datalines;
Abbott    F 2 97 A 90 87
Branford  M 1 98 A 92 97
Crandell  M 2 98 B 81 71
Dennison  M 1 97 A 85 72
Edgar     F 1 98 B 89 80
Faust     M 1 97 B 78 73
Greeley   F 2 97 A 82 91
Hart      F 1 98 B 84 80
Isley     M 2 97 A 88 86
Jasper    M 1 97 B 91 93
;
```

Generate the default statistics and specify the analysis options. Because no statistics are specified in the PROC MEANS statement, all default statistics (N, MEAN, STD, MIN, MAX) are generated. MAXDEC= limits the displayed statistics to three decimal places.

```
proc means data=grade maxdec=3;
```

Specify the analysis variable. The VAR statement specifies that PROC MEANS calculate statistics on the Score variable.

```
   var Score;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis into subgroups. Each combination of unique values for Status and Year represents a subgroup.

```
   class Status Year;
```

Specify which subgroups to analyze. The TYPES statement requests that the analysis be performed on all the observations in the GRADE data set as well as the two-way combination of Status and Year, which results in four subgroups (because Status and Year each have two unique values).

```
   types () status*year;
```

Specify the title.

```
   title 'Final Exam Grades for Student Status and Year of Graduation';
run;
```

Output

PROC MEANS displays the default statistics for all the observations (_TYPE_=0) and the four class levels of the Status and Year combination (Status=1, Year=97; Status=1, Year=98; Status=2, Year=97; Status=2, Year=98).

Output 40.4 *Final Exam Grades*

Final Exam Grades for Student Status and Year of Graduation

The MEANS Procedure

Analysis Variable : Score					
N Obs	N	Mean	Std Dev	Minimum	Maximum
10	10	86.000	4.714	78.000	92.000

Analysis Variable : Score							
Status	Year	N Obs	N	Mean	Std Dev	Minimum	Maximum
1	97	3	3	84.667	6.506	78.000	91.000
	98	3	3	88.333	4.041	84.000	92.000
2	97	3	3	86.667	4.163	82.000	90.000
	98	1	1	81.000	.	81.000	81.000

Example 3: Using the BY Statement with Class Variables

Features: PROC MEANS statement option
statistic keywords
BY statement
CLASS statement
SORT procedure

Data set: GRADE

Details

This example does the following:

- separates the analysis for the combination of class variables within BY values
- shows the sort order requirement for the BY statement
- calculates the minimum, maximum, and median

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

proc sort data=Grade out=GradeBySection;
   by section;
run;

proc means data=GradeBySection min max median;

   by Section;

   var Score;

   class Status Year;

   title1 'Final Exam Scores for Student Status and Year of
Graduation';
   title2 ' Within Each Section';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Sort the GRADE data set. PROC SORT sorts the observations by the variable Section. Sorting is required in order to use Section as a BY variable in the PROC MEANS step.

```
proc sort data=Grade out=GradeBySection;
   by section;
run;
```

Specify the analyses. The statistic keywords specify the statistics and their order in the output.

```
proc means data=GradeBySection min max median;
```

Divide the data set into BY groups. The BY statement produces a separate analysis for each value of Section.

```
   by Section;
```

Specify the analysis variable. The VAR statement specifies that PROC MEANS calculate statistics on the Score variable.

```
   var Score;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by the values of Status and Year. Because there is no TYPES statement in this program, analyses are performed for each subgroup, within each BY group.

```
   class Status Year;
```

Specify the titles.

```
   title1 'Final Exam Scores for Student Status and Year of
Graduation';
   title2 ' Within Each Section';
run;
```

Output

Output 40.5 *Final Exam Scores*

Final Exam Scores for Student Status and Year of Graduation
Within Each Section

The MEANS Procedure

Section=A

Analysis Variable : Score					
Status	**Year**	**N Obs**	**Minimum**	**Maximum**	**Median**
1	97	1	85.0000000	85.0000000	85.0000000
	98	1	92.0000000	92.0000000	92.0000000
2	97	3	82.0000000	90.0000000	88.0000000

Section=B

Analysis Variable : Score					
Status	**Year**	**N Obs**	**Minimum**	**Maximum**	**Median**
1	97	2	78.0000000	91.0000000	84.5000000
	98	2	84.0000000	89.0000000	86.5000000
2	98	1	81.0000000	81.0000000	81.0000000

Example 4: Using a CLASSDATA= Data Set with Class Variables

Features: PROC MEANS statement options
- CLASSDATA=
- EXCLUSIVE
- FW=
- MAXDEC=
- PRINTALLTYPES

CLASS statement

Data sets: CAKE
CAKETYPE

Details

This example does the following:

- specifies the field width and decimal places of the displayed statistics
- uses only the values in CLASSDATA= data set as the levels of the combinations of class variables
- calculates the range, median, minimum, and maximum
- displays all combinations of the class variables in the analysis

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

data caketype;
   input Flavor $ 1-10  Layers 12;
   datalines;
Vanilla    1
Vanilla    2
Vanilla    3
Chocolate  1
Chocolate  2
Chocolate  3
;

proc means data=cake range median min max fw=7 maxdec=0
           classdata=caketype exclusive printalltypes;

   var TasteScore;


   class flavor layers;

   title 'Taste Score For Number of Layers and Cake Flavor';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Create the CAKETYPE data set. CAKETYPE contains the cake flavors and number of layers that must occur in the PROC MEANS output.

```
data caketype;
   input Flavor $ 1-10  Layers 12;
   datalines;
Vanilla    1
Vanilla    2
Vanilla    3
Chocolate  1
Chocolate  2
Chocolate  3
;
```

Specify the analyses and the analysis options. The FW= option uses a field width of seven and the MAXDEC= option uses zero decimal places to display the statistics. CLASSDATA= and EXCLUSIVE restrict the class levels to the values that are in the CAKETYPE data set. PRINTALLTYPES displays all combinations of class variables in the output.

```
proc means data=cake range median min max fw=7 maxdec=0
           classdata=caketype exclusive printalltypes;
```

Specify the analysis variable. The VAR statement specifies that PROC MEANS calculate statistics on the TasteScore variable.

```
   var TasteScore;
```

Specify subgroups for analysis. The CLASS statement separates the analysis by the values of Flavor and Layers. Note that these variables, and only these variables, must appear in the CAKETYPE data set.

```
   class flavor layers;
```

Specify the title.

```
   title 'Taste Score For Number of Layers and Cake Flavor';
run;
```

Output

PROC MEANS calculates statistics for the 13 chocolate and vanilla cakes. Because the CLASSDATA= data set contains 3 as the value of Layers, PROC MEANS uses 3 as a class value even though the frequency is zero.

Output 40.6 *Taste Score*

Taste Score For Number of Layers and Cake Flavor

The MEANS Procedure

Analysis Variable : TasteScore				
N Obs	Range	Median	Minimum	Maximum
13	22	80	72	94

Analysis Variable : TasteScore					
Layers	N Obs	Range	Median	Minimum	Maximum
1	8	19	82	75	94
2	5	20	75	72	92
3	0	.	.	.	.

Analysis Variable : TasteScore					
Flavor	N Obs	Range	Median	Minimum	Maximum
Chocolate	8	20	81	72	92
Vanilla	5	21	80	73	94

Analysis Variable : TasteScore						
Flavor	Layers	N Obs	Range	Median	Minimum	Maximum
Chocolate	1	5	6	83	79	85
	2	3	20	75	72	92
	3	0	.	.	.	.
Vanilla	1	3	19	80	75	94
	2	2	14	80	73	87
	3	0	.	.	.	.

Example 5: Using Multilabel Value Formats with Class Variables

Features: PROC MEANS statement options
statistic keywords
FW=
NONOBS

CLASS statement options
MLF
ORDER=
TYPES statement
FORMAT procedure
FORMAT statement

Data set: CAKE

Details

This example does the following:

- computes the statistics for the specified keywords and displays them in order
- specifies the field width of the statistics
- suppresses the column with the total number of observations
- analyzes the data for the one-way combination of cake flavor and the two-way combination of cake flavor and participant's age
- assigns user-defined formats to the class variables
- uses multilabel formats as the levels of class variables
- orders the levels of the cake flavors by the descending frequency count and orders the levels of age by the ascending formatted values

Program

```
options nodate pageno=1 linesize=80 pagesize=64;

proc format;
   value $flvrfmt
                'Chocolate'='Chocolate'
                'Vanilla'='Vanilla'
                'Rum','Spice'='Other Flavor';
   value agefmt (multilabel)
                  15 - 29='below 30 years'
                  30 - 50='between 30 and 50'
                  51 - high='over 50 years'
                  15 - 19='15 to 19'
                  20 - 25='20 to 25'
                  25 - 39='25 to 39'
                  40 - 55='40 to 55'
                  56 - high='56 and above';
run;

proc means data=cake fw=6 n min max median nonobs;

   class flavor/order=data;
   class  age /mlf order=fmt;
```

```
    types flavor flavor*age;
   var TasteScore;
   format age agefmt. flavor $flvrfmt.;
   title 'Taste Score for Cake Flavors and Participant''s Age';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=64;
```

Create the $FLVRFMT. and AGEFMT. formats. PROC FORMAT creates user-defined formats to categorize the cake flavors and ages of the participants. MULTILABEL creates a multilabel format for Age. A multilabel format is one in which multiple labels can be assigned to the same value, in this case because of overlapping ranges. Each value is represented in the output for each range in which it occurs.

```
proc format;
   value $flvrfmt
                'Chocolate'='Chocolate'
                'Vanilla'='Vanilla'
                'Rum','Spice'='Other Flavor';
   value agefmt (multilabel)
                  15 - 29='below 30 years'
                  30 - 50='between 30 and 50'
                  51 - high='over 50 years'
                  15 - 19='15 to 19'
                  20 - 25='20 to 25'
                  25 - 39='25 to 39'
                  40 - 55='40 to 55'
                  56 - high='56 and above';
run;
```

Specify the analyses and the analysis options. FW= uses a field width of six to display the statistics. The statistic keywords specify the statistics and their order in the output. NONOBS suppresses the N Obs column.

```
proc means data=cake fw=6 n min max median nonobs;
```

Specify subgroups for the analysis. The CLASS statements separate the analysis by values of Flavor and Age. ORDER=DATA orders values according to their order in the input data set. ORDER=FMT orders the levels of Age by ascending formatted values. MLF specifies that multilabel value formats be used for Age.

```
   class flavor/order=data;
   class  age /mlf order=fmt;
```

Specify which subgroups to analyze. The TYPES statement requests the analysis for the one-way combination of Flavor and the two-way combination of Flavor and Age.

```
 types flavor flavor*age;
```

Specify the analysis variable. The VAR statement specifies that PROC MEANS calculate statistics on the TasteScore variable.

```
var TasteScore;
```

Format the output. The FORMAT statement assigns user-defined formats to the Age and Flavor variables for this analysis.

```
format age agefmt. flavor $flvrfmt.;
```

Specify the title.

```
title 'Taste Score for Cake Flavors and Participant''s Age';
run;
```

Output

The one-way combination of class variables appears before the two-way combination. A field width of six truncates the statistics to four decimal places. For the two-way combination of Age and Flavor, the total number of observations is greater than the one-way combination of Flavor. This situation arises because of the multilabel format for age, which maps one internal value to more than one formatted value. The order of the levels of Flavor is based on the frequency count for each level. The order of the levels of Age is based on the order of the user-defined formats.

Output 40.7 *Taste Score for Cake Flavors*

Taste Score for Cake Flavors and Participant's Age

The MEANS Procedure

Analysis Variable : TasteScore				
Flavor	N	Minimum	Maximum	Median
Vanilla	6	73.00	94.00	82.00
Other Flavor	4	72.00	91.00	82.00
Chocolate	9	72.00	92.00	83.00

Analysis Variable : TasteScore					
Flavor	Age	N	Minimum	Maximum	Median
Vanilla	25 to 39	2	73.00	80.00	76.50
	40 to 55	1	75.00	75.00	75.00
	56 and above	3	84.00	94.00	87.00
	below 30 years	1	80.00	80.00	80.00
	between 30 and 50	2	73.00	75.00	74.00
	over 50 years	3	84.00	94.00	87.00
Other Flavor	25 to 39	3	72.00	83.00	81.00
	40 to 55	1	91.00	91.00	91.00
	below 30 years	1	81.00	81.00	81.00
	between 30 and 50	2	72.00	83.00	77.50
	over 50 years	1	91.00	91.00	91.00
Chocolate	15 to 19	1	79.00	79.00	79.00
	20 to 25	1	84.00	84.00	84.00
	25 to 39	4	75.00	85.00	81.00
	40 to 55	2	72.00	92.00	82.00
	56 and above	1	84.00	84.00	84.00
	below 30 years	5	75.00	85.00	79.00
	between 30 and 50	2	83.00	92.00	87.50
	over 50 years	2	72.00	84.00	78.00

Example 6: Using Preloaded Formats with Class Variables

Features:

PROC MEANS statement options
- COMPLETETYPES
- FW=
- MISSING
- NONOBS

CLASS statement options
- EXCLUSIVE
- ORDER=
- PRELOADFMT

WAYS statement

FORMAT procedure

FORMAT statement

Data set: CAKE

Details

This example does the following:

- specifies the field width of the statistics
- suppresses the column with the total number of observations
- includes all possible combinations of class variables values in the analysis even if the frequency is zero
- considers missing values as valid class levels
- analyzes the one-way and two-way combinations of class variables
- assigns user-defined formats to the class variables
- uses only the preloaded range of user-defined formats as the levels of class variables
- orders the results by the value of the formatted data

Program

```
options nodate pageno=1 linesize=80 pagesize=64;

proc format;
   value layerfmt 1='single layer'
```

```
                  2-3='multi-layer'
                  .='unknown';
   value $flvrfmt (notsorted)
                  'Vanilla'='Vanilla'
                  'Orange','Lemon'='Citrus'
                  'Spice'='Spice'
                  'Rum','Mint','Almond'='Other Flavor';
run;

proc means data=cake fw=7 completetypes missing nonobs;

   class flavor layers/preloadfmt exclusive order=data;

   ways 1 2;

   var TasteScore;

   format layers layerfmt. flavor $flvrfmt.;

   title 'Taste Score For Number of Layers and Cake Flavors';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=64;
```

Create the LAYERFMT. and $FLVRFMT. formats. PROC FORMAT creates user-defined formats to categorize the number of cake layers and the cake flavors. NOTSORTED keeps $FLVRFMT unsorted to preserve the original order of the format values.

```
proc format;
   value layerfmt 1='single layer'
                  2-3='multi-layer'
                  .='unknown';
   value $flvrfmt (notsorted)
                  'Vanilla'='Vanilla'
                  'Orange','Lemon'='Citrus'
                  'Spice'='Spice'
                  'Rum','Mint','Almond'='Other Flavor';
run;
```

Generate the default statistics and specify the analysis options. FW= uses a field width of seven to display the statistics. COMPLETETYPES includes class levels with a frequency of zero. MISSING considers missing values valid values for all class variables. NONOBS suppresses the N Obs column. Because no specific analyses are requested, all default analyses are performed.

```
proc means data=cake fw=7 completetypes missing nonobs;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by values of Flavor and Layers. PRELOADFMT and EXCLUSIVE restrict the levels

to the preloaded values of the user-defined formats. ORDER=DATA orders the levels of Flavor and Layer by formatted data values.

```
class flavor layers/preloadfmt exclusive order=data;
```

Specify which subgroups to analyze. The WAYS statement requests one-way and two-way combinations of class variables.

```
ways 1 2;
```

Specify the analysis variable. The VAR statement specifies that PROC MEANS calculate statistics on the TasteScore variable.

```
var TasteScore;
```

Format the output. The FORMAT statement assigns user-defined formats to the Flavor and Layers variables for this analysis.

```
format layers layerfmt. flavor $flvrfmt.;
```

Specify the title.

```
    title 'Taste Score For Number of Layers and Cake Flavors';
run;
```

Output

The one-way combination of class variables appears before the two-way combination. PROC MEANS reports only the level values that are listed in the preloaded range of user-defined formats even when the frequency of observations is zero (in this case, citrus). PROC MEANS rejects entire observations based on the exclusion of any single class value in a given observation. Therefore, when the number of layers is unknown, statistics are calculated for only one observation. The other observation is excluded because the flavor chocolate was not included in the preloaded user-defined format for Flavor. The order of the levels is based on the order of the user-defined formats. PROC FORMAT automatically sorted the Layers format and did not sort the Flavor format.

Output 40.8 *Taste Score for Number of Layers*

Taste Score For Number of Layers and Cake Flavors

The MEANS Procedure

Analysis Variable : TasteScore					
Layers	N	Mean	Std Dev	Minimum	Maximum
unknown	1	84.000	.	84.000	84.000
single layer	3	83.000	9.849	75.000	94.000
multi-layer	6	81.167	7.548	72.000	91.000

Analysis Variable : TasteScore					
Flavor	N	Mean	Std Dev	Minimum	Maximum
Vanilla	6	82.167	7.834	73.000	94.000
Citrus	0	.	.	.	.
Spice	3	85.000	5.292	81.000	91.000
Other Flavor	1	72.000	.	72.000	72.000

Analysis Variable : TasteScore						
Flavor	Layers	N	Mean	Std Dev	Minimum	Maximum
Vanilla	unknown	1	84.000	.	84.000	84.000
	single layer	3	83.000	9.849	75.000	94.000
	multi-layer	2	80.000	9.899	73.000	87.000
Citrus	unknown	0	.	.	.	.
	single layer	0	.	.	.	.
	multi-layer	0	.	.	.	.
Spice	unknown	0	.	.	.	.
	single layer	0	.	.	.	.
	multi-layer	3	85.000	5.292	81.000	91.000
Other Flavor	unknown	0	.	.	.	.
	single layer	0	.	.	.	.
	multi-layer	1	72.000	.	72.000	72.000

Example 7: Computing a Confidence Limit for the Mean

Features: PROC MEANS statement options
- ALPHA=
- FW=
- MAXDEC=

CLASS statement

Data set: Charity

Details

This example does the following:

- specifies the field width and number of decimal places of the statistics
- computes a two-sided 90% confidence limit for the mean values of MoneyRaised and HoursVolunteered for the three years of data

If this data is representative of a larger population of volunteers, then the confidence limits provide ranges of likely values for the true population means.

Program

```
data charity;
   input School $ 1-7 Year 9-12 Name $ 14-20 MoneyRaised 22-26
         HoursVolunteered 28-29;
   datalines;
Monroe  2016 Allison 31.65 19
Monroe  2016 Barry   23.76 16
Monroe  2016 Candace 21.11  5

     . . . more data lines . . .
Kennedy 2018 Sid     27.45 25
Kennedy 2018 Will    28.88 21
Kennedy 2018 Morty   34.44 25;

proc means data=charity fw=8 maxdec=2 alpha=0.1 clm mean std;

   class Year;

   var MoneyRaised HoursVolunteered;

   title 'Confidence Limits for Fund Raising Statistics';
   title2 '20016-18';
run;
```

Program Description

Create the CHARITY data set. CHARITY contains information about high-school students' volunteer work for a charity. The variables give the name of the high school, the year of the fund-raiser, the first name of each student, the amount of money each student raised, and the number of hours each student volunteered. A DATA step creates this data set.

```
data charity;
   input School $ 1-7 Year 9-12 Name $ 14-20 MoneyRaised 22-26
         HoursVolunteered 28-29;
   datalines;
Monroe  2016 Allison 31.65 19
Monroe  2016 Barry   23.76 16
Monroe  2016 Candace 21.11  5

     . . . more data lines . . .
Kennedy 2018 Sid     27.45 25
Kennedy 2018 Will    28.88 21
Kennedy 2018 Morty   34.44 25;
```

Specify the analyses and the analysis options. FW= uses a field width of eight and MAXDEC= uses two decimal places to display the statistics. ALPHA=0.1 specifies a 90% confidence limit, and the CLM keyword requests two-sided confidence limits. MEAN and STD request the mean and the standard deviation, respectively.

```
proc means data=charity fw=8 maxdec=2 alpha=0.1 clm mean std;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by values of Year.

```
   class Year;
```

Specify the analysis variables. The VAR statement specifies that PROC MEANS calculate statistics on the MoneyRaised and HoursVolunteered variables.

```
   var MoneyRaised HoursVolunteered;
```

Specify the titles.

```
   title 'Confidence Limits for Fund Raising Statistics';
   title2 '20016-18';
run;
```

Output

PROC MEANS displays the lower and upper confidence limits for both variables for each year.

Output 40.9 *Confidence Limits*

Confidence Limits for Fund Raising Statistics
2016-18

The MEANS Procedure

Year	N Obs	Variable	Lower 90% CL for Mean	Upper 90% CL for Mean	Mean	Std Dev
2016	34	MoneyRaised	25.69	32.29	28.99	11.37
		HoursVolunteered	17.68	22.73	20.21	8.71
2017	29	MoneyRaised	24.61	31.61	28.11	11.09
		HoursVolunteered	15.67	20.19	17.93	7.17
2018	46	MoneyRaised	26.73	33.78	30.26	14.23
		HoursVolunteered	19.68	22.63	21.15	5.96

Example 8: Computing Output Statistics

Features:

PROC MEANS statement option
- NOPRINT

CLASS statement

OUTPUT statement options
- statistic keywords
- IDGROUP
- LEVELS
- WAYS

PRINT procedure

Data set: GRADE

Details

This example does the following:

- suppresses the display of PROC MEANS output
- stores the average final grade in a new variable
- stores the name of the student with the best final exam scores in a new variable
- stores the number of class variables that are combined in the _WAY_ variable
- stores the value of the class level in the _LEVEL_ variable
- displays the output data set

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

proc means data=Grade noprint;

   class Status Year;

   var FinalGrade;

   output out=sumstat mean=AverageGrade
          idgroup (max(score) obs out (name)=BestScore)
          / ways levels;
run;

proc print data=sumstat noobs;
   title1 'Average Undergraduate and Graduate Course Grades';
   title2 'For Two Years';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Specify the analysis options. NOPRINT suppresses the display of all PROC MEANS output.

```
proc means data=Grade noprint;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by values of Status and Year.

```
   class Status Year;
```

Specify the analysis variable. The VAR statement specifies that PROC MEANS calculate statistics on the FinalGrade variable.

```
   var FinalGrade;
```

Specify the output data set options. The OUTPUT statement creates the SUMSTAT data set and writes the mean value for the final grade to the new variable AverageGrade. IDGROUP writes the name of the student with the top exam score to the variable BestScore and the observation number that contained the top score. WAYS and LEVELS write information about how the class variables are combined.

```
   output out=sumstat mean=AverageGrade
          idgroup (max(score) obs out (name)=BestScore)
          / ways levels;
run;
```

Print the output data set WORK.SUMSTAT. The NOOBS option suppresses the observation numbers.

```
proc print data=sumstat noobs;
   title1 'Average Undergraduate and Graduate Course Grades';
   title2 'For Two Years';
run;
```

Output

The first observation contains the average course grade and the name of the student with the highest exam score over the two-year period. The next four observations contain values for each class variable value. The remaining four observations contain values for the Year and Status combination. The variables _WAY_, _TYPE_, and _LEVEL_ show how PROC MEANS created the class variable combinations. The variable _OBS_ contains the observation number in the GRADE data set that contained the highest exam score.

Output 40.10 *Average Course Grades*

Average Undergraduate and Graduate Course Grades
For Two Years

Status	Year	_WAY_	_TYPE_	_LEVEL_	_FREQ_	AverageGrade	BestScore	_OBS_
		0	0	1	10	83.0000	Branford	2
	97	1	1	1	6	83.6667	Jasper	10
	98	1	1	2	4	82.0000	Branford	2
1		1	2	1	6	82.5000	Branford	2
2		1	2	2	4	83.7500	Abbott	1
1	97	2	3	1	3	79.3333	Jasper	10
1	98	2	3	2	3	85.6667	Branford	2
2	97	2	3	3	3	88.0000	Abbott	1
2	98	2	3	4	1	71.0000	Crandell	3

Example 9: Computing Different Output Statistics for Several Variables

Features:

PROC MEANS statement options
- DESCEND
- NOPRINT

CLASS statement

OUTPUT statement options

statistic keywords
PRINT procedure
WHERE= data set option

Data set: GRADE

Details

This example does the following:

- suppresses the display of PROC MEANS output
- stores the statistics for the class level and combinations of class variables that are specified by WHERE= in the output data set
- orders observations in the output data set by descending _TYPE_ value
- stores the mean exam scores and mean final grades without assigning new variables names
- stores the median final grade in a new variable
- displays the output data set

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

proc means data=Grade noprint descend;

   class Status Year;

   var Score FinalGrade;

   output out=Sumdata (where=(status='1' or _type_=0))
          mean= median(finalgrade)=MedianGrade;
run;

proc print data=Sumdata;
   title 'Exam and Course Grades for Undergraduates Only';
   title2 'and for All Students';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Specify the analysis options. NOPRINT suppresses the display of all PROC MEANS output. DESCEND orders the observations in the OUT= data set by descending _TYPE_ value.

```
proc means data=Grade noprint descend;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by values of Status and Year.

```
   class Status Year;
```

Specify the analysis variables. The VAR statement specifies that PROC MEANS calculate statistics on the Score and FinalGrade variables.

```
   var Score FinalGrade;
```

Specify the output data set options. The OUTPUT statement writes the mean for Score and FinalGrade to variables of the same name. The median final grade is written to the variable MedianGrade. The WHERE= data set option restricts the observations in SUMDATA. One observation contains overall statistics (_TYPE_=0). The remainder must have a status of 1.

```
   output out=Sumdata (where=(status='1' or _type_=0))
          mean= median(finalgrade)=MedianGrade;
run;
```

Print the output data set WORK.SUMDATA.

```
proc print data=Sumdata;
   title 'Exam and Course Grades for Undergraduates Only';
   title2 'and for All Students';
run;
```

Output

The first three observations contain statistics for the class variable levels with a status of 1. The last observation contains the statistics for all the observations (no subgroup). Score contains the mean test score and FinalGrade contains the mean final grade.

Output 40.11 *Exam and Course Grades*

Exam and Course Grades for Undergraduates Only and for All Students

Obs	Status	Year	_TYPE_	_FREQ_	Score	FinalGrade	MedianGrade
1	1	97	3	3	84.6667	79.3333	73
2	1	98	3	3	88.3333	85.6667	80
3	1		2	6	86.5000	82.5000	80
4			0	10	86.0000	83.0000	83

Example 10: Computing Output Statistics with Missing Class Variable Values

Features:

PROC MEANS statement options
- CHARTYPE
- NOPRINT
- NWAY

CLASS statement options
- ASCENDING
- MISSING
- ORDER=

OUTPUT statement

PRINT procedure

Data set: CAKE

Details

This example does the following:

- suppresses the display of PROC MEANS output
- considers missing values as valid level values for only one class variable
- orders observations in the output data set by the ascending frequency for a single class variable
- stores observations for only the highest _TYPE_ value
- stores _TYPE_ as binary character values
- stores the maximum taste score in a new variable
- displays the output data set

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

proc means data=cake chartype nway noprint;

   class flavor /order=freq ascending;
   class layers /missing;

   var TasteScore;

   output out=cakestat max=HighScore;
run;
```

```
proc print data=cakestat;
   title 'Maximum Taste Score for Flavor and Cake Layers';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Specify the analysis options. NWAY prints observations with the highest _TYPE_ value. NOPRINT suppresses the display of all PROC MEANS output.

```
proc means data=cake chartype nway noprint;
```

Specify subgroups for the analysis. The CLASS statements separate the analysis by Flavor and Layers. ORDER=FREQ and ASCENDING order the levels of Flavor by ascending frequency. MISSING uses missing values of Layers as a valid class level value.

```
   class flavor /order=freq ascending;
   class layers /missing;
```

Specify the analysis variable. The VAR statement specifies that PROC MEANS calculate statistics on the TasteScore variable.

```
   var TasteScore;
```

Specify the output data set options. The OUTPUT statement creates the CAKESTAT data set and generates the maximum value for the taste score to the new variable HighScore.

```
   output out=cakestat max=HighScore;
run;
```

Print the output data set WORK.CAKESTAT.

```
proc print data=cakestat;
   title 'Maximum Taste Score for Flavor and Cake Layers';
run;
```

Output

The CAKESTAT output data set contains only observations for the combination of the two class variables, Flavor and Layers. Therefore, the value of _TYPE_ is 11 for all observations. The observations are ordered by ascending frequency of Flavor. The missing value in Layers is a valid value for this class variable. PROC MEANS excludes the observation with the missing flavor because it is an invalid value for Flavor.

Output 40.12 *Maximum Taste Score*

Maximum Taste Score for Flavor and Cake Layers

Obs	Flavor	Layers	_TYPE_	_FREQ_	HighScore
1	Rum	2	11	1	72
2	Spice	2	11	2	83
3	Spice	3	11	1	91
4	Vanilla	.	11	1	84
5	Vanilla	1	11	3	94
6	Vanilla	2	11	2	87
7	Chocolate	.	11	1	84
8	Chocolate	1	11	5	85
9	Chocolate	2	11	3	92

Example 11: Identifying an Extreme Value with the Output Statistics

Features:
- CLASS statement
- OUTPUT statement options
  - statistic keyword
  - MAXID
- PRINT procedure

Data set: Charity

Details

This example does the following:

- identifies the observations with maximum values for two variables
- creates new variables for the maximum values
- displays the output data set

Program

```
proc means data=Charity n mean range chartype;
   class School Year;
   var MoneyRaised HoursVolunteered;
   output out=Prize maxid(MoneyRaised(name)
          HoursVolunteered(name))= MostCash MostTime
          max= ;

   title 'Summary of Volunteer Work by School and Year';
run;
proc print data=Prize;
   title 'Best Results: Most Money Raised and Most Hours Worked';
run;
```

Program Description

Specify the analyses. The statistic keywords specify the statistics and their order in the output. CHARTYPE writes the _TYPE_ values as binary characters in the output data set

```
proc means data=Charity n mean range chartype;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by School and Year.

```
   class School Year;
```

Specify the analysis variables. The VAR statement specifies that PROC MEANS calculate statistics on the MoneyRaised and HoursVolunteered variables.

```
   var MoneyRaised HoursVolunteered;
```

Specify the output data set options. The OUTPUT statement writes the new variables, MostCash, and MostTime, which contain the names of the students who collected the most money and volunteered the most time, respectively, to the PRIZE data set.

```
   output out=Prize maxid(MoneyRaised(name)
          HoursVolunteered(name))= MostCash MostTime
          max= ;
```

Specify the title.

```
   title 'Summary of Volunteer Work by School and Year';
run;
```

Print the WORK.PRIZE output data set.

```
proc print data=Prize;
   title 'Best Results: Most Money Raised and Most Hours Worked';
run;
```

Output

The first page of output shows the output from PROC MEANS with the statistics for six class levels: one for Monroe High for the years 1992, 1993, and 1994; and one for Kennedy High for the same three years.

Output 40.13 *Summary of Volunteer Work*

Summary of Volunteer Work by School and Year

The MEANS Procedure

School	Year	N Obs	Variable	N	Mean	Range
Kennedy	2007	18	MoneyRaised	18	29.3811111	39.7500000
			HoursVolunteered	18	21.4444444	30.0000000
	2008	17	MoneyRaised	17	28.1564706	23.5600000
			HoursVolunteered	17	19.4117647	20.0000000
	2009	18	MoneyRaised	18	31.5794444	65.4400000
			HoursVolunteered	18	24.2777778	15.0000000
Monroe	2007	16	MoneyRaised	16	28.5450000	48.2700000
			HoursVolunteered	16	18.8125000	38.0000000
	2008	12	MoneyRaised	12	28.0500000	52.4600000
			HoursVolunteered	12	15.8333333	21.0000000
	2009	28	MoneyRaised	28	29.4100000	73.5300000
			HoursVolunteered	28	19.1428571	26.0000000

The output from PROC PRINT shows the maximum MoneyRaised and HoursVolunteered values and the names of the students who are responsible for them. The first observation contains the overall results, the next three contain the results by year, the next two contain the results by school, and the final six contain the results by School and Year.

Output 40.14 *Best Results*

Best Results: Most Money Raised and Most Hours Worked

Obs	School	Year	_TYPE_	_FREQ_	MostCash	MostTime	MoneyRaised	HoursVolunteered
1		.	00	109	Willard	Tonya	78.65	40
2		2007	01	34	Tonya	Tonya	55.16	40
3		2008	01	29	Cameron	Amy	65.44	31
4		2009	01	46	Willard	L.T.	78.65	33
5	Kennedy	.	10	53	Luther	Jay	72.22	35
6	Monroe	.	10	56	Willard	Tonya	78.65	40
7	Kennedy	2007	11	18	Thelma	Jay	52.63	35
8	Kennedy	2008	11	17	Bill	Amy	42.23	31
9	Kennedy	2009	11	18	Luther	Che-Min	72.22	33
10	Monroe	2007	11	16	Tonya	Tonya	55.16	40
11	Monroe	2008	11	12	Cameron	Myrtle	65.44	26
12	Monroe	2009	11	28	Willard	L.T.	78.65	33

Example 12: Identifying the Top Three Extreme Values with the Output Statistics

Features:

PROC MEANS statement option
- NOPRINT

CLASS statement

OUTPUT statement options
- statistic keywords
- AUTOLABEL
- AUTONAME
- IDGROUP

TYPES statement

FORMAT procedure

FORMAT statement

PRINT procedure

RENAME= data set option

Data set: Charity

Details

This example does the following:

- suppresses the display of PROC MEANS output
- analyzes the data for the one-way combination of the class variables and across all observations
- stores the total and average amount of money raised in new variables
- stores in new variables the top three amounts of money raised, the names of the three students who raised the money, the years when it occurred, and the schools the students attended
- automatically resolves conflicts in the variable names when names are assigned to the new variables in the output data set
- appends the statistic name to the label of the variables in the output data set that contain statistics that were computed for the analysis variable
- assigns a format to the analysis variable so that the statistics that are computed from this variable inherit the attribute in the output data set
- renames the _FREQ_ variable in the output data set
- displays the output data set and its contents

Program

```
proc format;
   value yrFmt . = " All";
   value $schFmt ' ' = "All    ";
run;

proc means data=Charity noprint;

   class School Year;

   types () school year;

   var MoneyRaised;

   output out=top3list(rename=(_freq_=NumberStudents))sum= mean=
          idgroup( max(moneyraised) out[3] (moneyraised name
            school year)=)/autolabel autoname;

   label MoneyRaised='Amount Raised';
   format year yrfmt. school $schfmt.
          moneyraised dollar8.2;
  run;

proc print data=top3list;
   title1 'School Fund Raising Report';
   title2 'Top Three Students';
run;
```

```
proc datasets library=work nolist;
   contents data=top3list;
   title1 'Contents of the PROC MEANS Output Data Set';
run;
```

Program Description

Create the YRFMT. and $SCHFMT. formats. PROC FORMAT creates user-defined formats that assign the value of **All** to the missing levels of the class variables.

```
proc format;
   value yrFmt . = " All";
   value $schFmt ' ' = "All    ";
run;
```

Generate the default statistics and specify the analysis options. NOPRINT suppresses the display of all PROC MEANS output.

```
proc means data=Charity noprint;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by values of School and Year.

```
   class School Year;
```

Specify which subgroups to analyze. The TYPES statement requests the analysis across all the observations and for each one-way combination of School and Year.

```
   types () school year;
```

Specify the analysis variable. The VAR statement specifies that PROC MEANS calculate statistics on the MoneyRaised variable.

```
   var MoneyRaised;
```

Specify the output data set options. The OUTPUT statement creates the TOP3LIST data set. RENAME= renames the _FREQ_ variable that contains the frequency count for each class level. SUM= and MEAN= specify that the sum and mean of the analysis variable (MoneyRaised) are written to the output data set. IDGROUP writes 12 variables that contain the top three amounts of money raised and the three corresponding students, schools, and years. AUTOLABEL appends the analysis variable name to the label for the output variables that contain the sum and mean. AUTONAME resolves naming conflicts for these variables.

```
   output out=top3list(rename=(_freq_=NumberStudents))sum= mean=
          idgroup( max(moneyraised) out[3] (moneyraised name
            school year)=)/autolabel autoname;
```

Format the output. The LABEL statement assigns a label to the analysis variable MoneyRaised. The FORMAT statement assigns user-defined formats to the Year and School variables and a SAS dollar format to the MoneyRaised variable.

```
   label MoneyRaised='Amount Raised';
   format year yrfmt. school $schfmt.
          moneyraised dollar8.2;
  run;
```

Print the output data set WORK.TOP3LIST.

```
proc print data=top3list;
   title1 'School Fund Raising Report';
   title2 'Top Three Students';
run;
```

Display information about the TOP3LIST data set. PROC DATASETS displays the contents of the TOP3LIST data set. NOLIST suppresses the directory listing for the WORK data library.

```
proc datasets library=work nolist;
   contents data=top3list;
   title1 'Contents of the PROC MEANS Output Data Set';
run;
```

Output

The output from PROC PRINT shows the top three values of MoneyRaised, the names of the students who raised these amounts, the schools the students attended, and the years when the money was raised. The first observation contains the overall results, the next three contain the results by year, and the final two contain the results by school. The missing class levels for School and Year are replaced with the value ALL. The labels for the variables that contain statistics that were computed from MoneyRaised include the statistic name at the end of the label.

Output 40.15 *School Fund Raising*

Results Viewer - SAS Output

School Fund Raising Report
Top Three Students

MoneyRaised_Sum	MoneyRaised_Mean	MoneyRaised_1	MoneyRaised_2	MoneyRaised_3	Name_1	Name_2	Name_3	School_1
$3192.75	$29.29	$78.65	$72.22	$65.44	Willard	Luther	Cameron	Monroe
$892.92	$28.80	$55.16	$53.76	$52.63	Tonya	Edward	Thelma	Monroe
$907.92	$28.37	$65.44	$47.33	$42.23	Cameron	Myrtle	Bill	Monroe
$1391.91	$30.26	$78.65	$72.22	$56.87	Willard	Luther	L.T.	Monroe
$1575.95	$29.73	$72.22	$52.63	$43.89	Luther	Thelma	Jenny	Kennedy
$1616.80	$28.87	$78.65	$65.44	$56.87	Willard	Cameron	L.T.	Monroe

See the TEMPLATE procedure in *SAS Output Delivery System: User's Guide* for an example of how to create a custom table template for this output data set.

Output 40.16 *PROC MEANS Output Data Set*

School Fund Raising Report
Top Three Students

Obs	School	Year	_TYPE_	NumberStudents	MoneyRaised_Sum	MoneyRaised_Mean	MoneyRaised_1	MoneyRaised_2	MoneyRaised_3	Name_1
1	All	All	0	109	$3192.75	$29.29	$78.65	$72.22	$65.44	Willard
2	All	2007	1	34	$985.58	$28.99	$55.16	$53.76	$52.63	Tonya
3	All	2008	1	29	$815.26	$28.11	$65.44	$47.33	$42.23	Cameron
4	All	2009	1	46	$1391.91	$30.26	$78.65	$72.22	$56.87	Willard
5	Kenn	All	2	53	$1575.95	$29.73	$72.22	$52.63	$43.89	Luther
6	Monr	All	2	56	$1616.80	$28.87	$78.65	$65.44	$56.87	Willard

Contents of the PROC MEANS Output Data Set

The DATASETS Procedure

Data Set Name	WORK.TOP3LIST	**Observations**	6
Member Type	DATA	**Variables**	18
Engine	V9	**Indexes**	0
Created	Tuesday, July 05, 2011 10:24:55 AM	**Observation Length**	144
Last Modified	Tuesday, July 05, 2011 10:24:55 AM	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label			
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	12288
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	85
Obs in First Data Page	6
Number of Data Set Repairs	0
Filename	C:\DOCUME~1\lirezn\LOCALS~1\Temp\SAS Temporary Files_TD3456_d21560_\top3list.sas7bdat
Release Created	9.0301M0
Host Created	XP_PRO

Alphabetic List of Variables and Attributes					
#	Variable	Type	Len	Format	Label
7	MoneyRaised_1	Num	8	DOLLAR8.2	Amount Raised
8	MoneyRaised_2	Num	8	DOLLAR8.2	Amount Raised
9	MoneyRaised_3	Num	8	DOLLAR8.2	Amount Raised
6	MoneyRaised_Mean	Num	8	DOLLAR8.2	Amount Raised_Mean
5	MoneyRaised_Sum	Num	8	DOLLAR8.2	Amount Raised_Sum
10	Name_1	Char	7		
11	Name_2	Char	7		
12	Name_3	Char	7		
4	NumberStudents	Num	8		
1	School	Char	7	$SCHFMT.	
13	School_1	Char	7	$SCHFMT.	
14	School_2	Char	7	$SCHFMT.	
15	School_3	Char	7	$SCHFMT.	
2	Year	Num	8	YRFMT.	
16	Year_1	Num	8	YRFMT.	
17	Year_2	Num	8	YRFMT.	
18	Year_3	Num	8	YRFMT.	
3	_TYPE_	Num	8		

Example 13: Using the STACKODSOUTPUT Option to Control Data

Features: PROC PRINT
PROC CONTENTS

The first example does not use the STACKODSOUTPUT option. The second example uses the STACKODSOUTPUT option.

Program

```
proc means data=sashelp.class;
class sex;
var weight height;
ods output summary=default;
run;

proc print data=default; run;
proc contents data=default; run;
```

Program Description

This code processes the data without using the STACKODSOUTPUT option.

```
proc means data=sashelp.class;
class sex;
var weight height;
ods output summary=default;
run;
```

Prints the data using PROC PRINT. Print the contents of the procedure using PROC CONTENTS.

```
proc print data=default; run;
proc contents data=default; run;
```

OUTPUT

The following outputs show the difference in processing data using the STACKODSOUTPUT option and then not using the option.

This output is generated without the STACKODSOUTPUT option.

Output 40.17 *Output without Using the STACKODSOUTPUT Option*

The SAS System

The MEANS Procedure

Sex	N Obs	Variable	N	Mean	Std Dev	Minimum	Maximum
F	9	Weight	9	90.1111111	19.3839137	50.5000000	112.5000000
		Height	9	60.5888889	5.0183275	51.3000000	66.5000000
M	10	Weight	10	108.9500000	22.7271864	83.0000000	150.0000000
		Height	10	63.9100000	4.9379370	57.3000000	72.0000000

The SAS System

Obs	Sex	NObs	VName_Weight	Weight_N	Weight_Mean	Weight_StdDev	Weight_Min	Weight_Max	VName_H
1	F	9	Weight	9	90.111111111	19.38391372	50.5	112.5	Height
2	M	10	Weight	10	108.95	22.727186363	83	150	Height

The SAS System

The CONTENTS Procedure

Data Set Name	WORK.DEFAULT	**Observations**	2
Member Type	DATA	**Variables**	14
Engine	V9	**Indexes**	0
Created	Sunday, January 23, 2011 02:48:10 PM	**Observation Length**	104
Last Modified	Sunday, January 23, 2011 02:48:10 PM	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label	Summary statistics		
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	12288
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	117
Obs in First Data Page	2
Number of Data Set Repairs	0
Filename	C:\DOCUME~1\lirezn\LOCALS~1\Temp\SAS Temporary Files_TD3828_d21560_\default.sas7bdat
Release Created	9.0301B0
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
14	Height_Max	Num	8	BEST12.	Maximum
11	Height_Mean	Num	8	BEST12.	Mean
13	Height_Min	Num	8	BEST12.	Minimum
10	Height_N	Num	8	BEST2.	N
12	Height_StdDev	Num	8	BEST12.	Std Dev
2	NObs	Num	8	BEST2.	N Obs
1	Sex	Char	1		
9	VName_Height	Char	6		Variable
3	VName_Weight	Char	6		Variable
8	Weight_Max	Num	8	BEST12.	Maximum
5	Weight_Mean	Num	8	BEST12.	Mean
7	Weight_Min	Num	8	BEST12.	Minimum
4	Weight_N	Num	8	BEST2.	N
6	Weight_StdDev	Num	8	BEST12.	Std Dev

This code processes the data using the STACKODSOUTPUT option.

```
proc means data=sashelp.class STACKODSOUTPUT;
```

```
class sex;
var weight height;
ods output summary=stacked;
run;
```

Print the data using PROC PRINT. Print the contents of the procedure using PROC CONTENTS.

```
proc print data=stacked; run;
proc contents data=stacked; run;
```

This output is generated with the STACKODSOUTPUT option.

Output 40.18 *Output Using the STACKODSOUTPUT Option*

The SAS System

The MEANS Procedure

Sex	N Obs	Variable	N	Mean	Std Dev	Minimum	Maximum
F	9	Weight	9	90.111111	19.383914	50.500000	112.500000
		Height	9	60.588889	5.018328	51.300000	66.500000
M	10	Weight	10	108.950000	22.727186	83.000000	150.000000
		Height	10	63.910000	4.937937	57.300000	72.000000

The SAS System

Obs	Sex	NObs	_control_	Variable	N	Mean	StdDev	Min	Max
1	F	9		Weight	9	90.111111	19.383914	50.500000	112.500000
2	F	9		Height	9	60.588889	5.018328	51.300000	66.500000
3	M	10	1	Weight	10	108.950000	22.727186	83.000000	150.000000
4	M	10		Height	10	63.910000	4.937937	57.300000	72.000000

The SAS System

The CONTENTS Procedure

Data Set Name	WORK.STACKED	**Observations**	4
Member Type	DATA	**Variables**	9
Engine	V9	**Indexes**	0
Created	Sunday, January 23, 2011 03:19:07 PM	**Observation Length**	56
Last Modified	Sunday, January 23, 2011 03:19:07 PM	**Deleted Observations**	0
Protection		**Compressed**	NO
Data Set Type		**Sorted**	NO
Label	Summary statistics		
Data Representation	WINDOWS_32		
Encoding	wlatin1 Western (Windows)		

Engine/Host Dependent Information	
Data Set Page Size	8192
Number of Data Set Pages	1
First Data Page	1
Max Obs per Page	145
Obs in First Data Page	4
Number of Data Set Repairs	0
Filename	C:\DOCUME~1\lirezn\LOCALS~1\Temp\SAS Temporary Files_TD5560_d21560_\stacked.sas7bdat
Release Created	9.0301B0
Host Created	XP_PRO

Alphabetic List of Variables and Attributes

#	Variable	Type	Len	Format	Label
9	Max	Num	8	D12.3	Maximum
6	Mean	Num	8	D12.3	
8	Min	Num	8	D12.3	Minimum
5	N	Num	8	BEST2.	
2	NObs	Num	8	BEST2.	N Obs
1	Sex	Char	1		
7	StdDev	Num	8	D12.3	Std Dev
4	Variable	Char	6		
3	_control_	Char	1		

References

Jain R., and I. Chlamtac. 1985. “The P² Algorithm for Dynamic Calculation of Quantiles and Histograms without Sorting Observations.” *Communications of the Association of Computing Machinery* 28 (10): 1076–0185.

41

MIGRATE Procedure

Overview: MIGRATE Procedure

What Does the MIGRATE Procedure Do?

The MIGRATE procedure migrates members in a SAS library to the current SAS version.

The procedure migrates a library from most SAS 6, SAS 7, SAS 8, and SAS®9 operating environments to the current release of SAS. The migration must occur within the same engine family. For example, V6, V7, or V8 can migrate to V9, but V6TAPE must migrate to V9TAPE.

The procedure migrates the following library members:

- data sets with alternate collating sequence, audit trails, compression, created and modified datetimes, deleted observations, encryption (except AES encryption), extended attributes, generations, indexes, integrity constraints, and passwords
- in many cases, views, catalogs, item stores, and multidimensional databases (MDDBs) (see Concepts: MIGRATE Procedure on page 1560)

The procedure does not support stored compiled DATA step programs or stored compiled macros. (Instead, move the source code to the target, where you can compile and store it.) The procedure does not support SAS program files. The procedure does not support Scalable Performance Data (SPD) engine data sets. (See *SAS Scalable Performance Data Engine: Reference*.) The procedure does not support the extended observation count attribute.

Concepts: MIGRATE Procedure

Data Sets

PROC MIGRATE retains alternate collating sequence, compression, created and modified datetimes, deleted observations, encryption, extended attributes, indexes,

integrity constraints, and passwords. See several important restrictions at the beginning of the syntax on page 1563.

The audit trail and generations are also migrated. Indexes and integrity constraints are rebuilt on the member in the target library. See "Migrating a Data Set with Audit Trails, Generations, Indexes, or Integrity Constraints" on page 1567.

Migrated data sets take on the data representation and encoding attributes of the target library. When you migrate a data set to an encoding where the characters are represented by more bytes, truncation might occur if the column length does not accommodate the larger character size. For example, a character might be represented in Wlatin1 encoding as one byte but in UTF-8 as two bytes. The best solution is to expand the column length with the CVP engine and PROC COPY before you migrate. (PROC MIGRATE does not currently support the CVP engine.) The CVPMULTIPLIER=2.5 value is usually sufficient to avoid truncation. If your data contains Asian characters, CVPMULTIPLIER=4 is recommended. For more information, read about the CVPMULTIPLIER= option and avoiding character data truncation in *SAS National Language Support (NLS): Reference Guide*. See also the paper "Multilingual Computing with SAS® 9.4" on support.sas.com.

For SAS data sets that use the ASCII-OEM character set, PROC MIGRATE does not translate non-English characters. This issue is very uncommon. To migrate a SAS data set with ASCII-OEM characters, use the CPORT and CIMPORT procedures with the TRANTAB option. Specify the appropriate TRANTAB values for the source and target data sets.

Views

As with data sets, migrated data views take on the data representation and encoding attributes of the target library. When you migrate a library that contains DATA step views to a different operating environment, and the views were created prior to SAS 9.2, you might need to set the proper encoding. In releases prior to SAS 9.2, DATA step views did not save encoding information. Therefore, if the view has a different encoding than the target session, you must specify the INENCODING= option for the source library's LIBNAME statement. Here is an example:

```
libname Srclib 'source-library-pathname' inencoding="OPEN_ED-1047";
libname Lib1 'target-library-pathname';
proc migrate in=Srclib out=Lib1;
run;
```

In addition, embedded librefs associated with a view are not updated during migration. The following example illustrates the issue. In this example, Lib1.MyView contains a view of the data set Lib1.MyData:

```
data Lib1.MyData;x=1;
run;
proc sql;
   create view Lib1.MyView as select * from Lib1.MyData;
quit;
```

After you migrate Lib1 to Lib2, you have Lib2.MyView and Lib2.MyData. However, because Lib2.MyView was originally created with an embedded libref of Lib1, it still

references the data set Lib1.MyData, not Lib2.MyData. The following example fails with an error message that Lib1 cannot be found:

```
proc print data=Lib2.MyView;
run;
```

PROC MIGRATE supports three types of views: DATA step views, SQL views, and SAS/ACCESS views:

DATA Step Views
: When you create a DATA step view, you can specify the SOURCE= option to store the DATA step code along with the view. PROC MIGRATE supports DATA step views with stored code. The stored code is recompiled the first time the DATA step view is accessed by SAS in the target environment. PROC MIGRATE does not support DATA step views that were created prior to SAS 8 or DATA step views without stored code. For DATA step views without stored code, use the DESCRIBE statement in the source session to recover the DATA step code. Then submit the DATA step code in the target session and recompile it.

PROC SQL Views
: PROC MIGRATE supports PROC SQL views with no known issues.

SAS/ACCESS Views
: PROC MIGRATE supports SAS/ACCESS views that were written with the Oracle, SAP, or DB2 engine. PROC MIGRATE automatically uses the CV2VIEW procedure, which converts SAS/ACCESS views into SQL views. Migrating SAS/ACCESS views to a different operating environment is not supported. For more information about the conversion, see the overview of the CV2VIEW procedure in *SAS/ACCESS for Relational Databases: Reference*.

Catalogs

To migrate catalogs, PROC MIGRATE calls PROC CPORT and PROC CIMPORT. You might notice that CPORT and CIMPORT notes are written to the SAS log during migration. PROC CPORT and CIMPORT restrictions apply. For example, catalogs in sequential libraries are not migrated. Stored compiled macros that are stored in catalogs are not supported. (Instead, move the source code to the target, where you can compile and store it.) Catalog entries might need to be updated after migrating (for example, code that contains hardcoded pathnames).

IMPORTANT PROC MIGRATE is not supported for SAS 6 AIX catalogs. Use PROC CPORT and PROC CIMPORT instead. See "Additional Steps for Unsupported Catalogs or Libraries" on page 1573.

IMPORTANT If cross-environment data access (CEDA) processing is invoked, and if the IN= source library contains catalogs, then you must specify a SAS/CONNECT or SAS/SHARE libref in the IN= option or in the SLIBREF= option. To determine whether to specify the libref in the IN= or SLIBREF= argument, see "Using a SAS/CONNECT or SAS/SHARE Server" on

page 1571. If the catalogs were created in SAS 6 or SAS 8, SLIBREF= must be assigned through a SAS 8 server.

MDDBs

PROC MIGRATE supports MDDBs with no known issues.

Items Stores

PROC MIGRATE supports item stores unless you migrate from a 32-bit to a 64-bit environment. Migrations from 32-bit to 64-bit environments use Remote Library Services (RLS), which does not support item stores. In that case, an error message is not written to the SAS log, but item stores might not work correctly in the target library.

Not Supported

PROC MIGRATE does not support stored compiled DATA step programs or stored compiled macros. (Instead, move the source code to the target, where you can compile and store it.) PROC MIGRATE does not support SAS program files. PROC MIGRATE does not support SPD Engine data sets. (See *SAS Scalable Performance Data Engine: Reference*.) See also restrictions above for each member type.

Syntax: MIGRATE Procedure

Restrictions:

SAS data set options are not supported with PROC MIGRATE.

The CVP engine is not currently supported with PROC MIGRATE. You can use the CVP engine with the COPY procedure (or the COPY statement of the DATASETS procedure) to expand column lengths in the source library before you use PROC MIGRATE.

The source and target libraries must be in different physical locations.

When PROC MIGRATE creates a member in the target library, the member does not retain its permissions from the source library. It has the permissions that are associated with the user ID of the person who ran PROC MIGRATE.

SAS 8.2 source libraries from the following operating environments are not supported: CMS, OS/2, OpenVMS VAX, or 64-bit AIX. See "Additional Steps for Unsupported Catalogs or Libraries" on page 1573.

Catalogs that were created under a Tru64 UNIX source environment are not supported for a Linux for x64 or a Solaris for x64 target environment. To migrate catalogs under those conditions, see "Additional Steps for Unsupported Catalogs or Libraries" on page 1573.

SAS files that were created prior to SAS 6.12 (SAS 6.09E for z/OS) must be converted to SAS 6.12 before they can be migrated to the current release of SAS. Some SAS 6 source environments are not supported; see "Migrating a SAS 6 Library" on page 1568.

This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Interaction: The International Components for Unicode (ICU) version is used to sort data sets with a linguistic collating sequence. If a linguistically sorted data set has a different ICU version number than that of the current SAS session, the following occurs: PROC MIGRATE retains the data set's sort order in the OUT= destination library. However, the data set is no longer marked as sorted, and a message is written to the SAS log. For more information about linguistic sorting, see Chapter 64, "SORT Procedure," on page 2355.

Tips: Assign the OUT= target library to an empty location. If a member already exists in the target library that has the same name and member type as a member in the source library, the member is not migrated. An error message is written to the SAS log, and PROC MIGRATE continues with the next member. Note that members in a sequential library are an exception, because PROC MIGRATE does not read the entire tape to determine existence.

For encoding and transcoding issues, see the *SAS National Language Support (NLS): Reference Guide*.

PROC MIGRATE IN=*libref-1* OUT=*libref-2* <*options*>;

Statement	Task	Example
PROC MIGRATE	Migrate members in a SAS library to the current SAS version	Ex. 1, Ex. 2, Ex. 3

PROC MIGRATE Statement

Migrates a SAS library forward to the current release of SAS.

Syntax

PROC MIGRATE IN=*libref-1* OUT=*libref-2*
<BUFSIZE=KEEPSIZE | *n* | *n*K | *n*M | *n*G>

<MOVE>
<SLIBREF=*libref*>
<KEEPNODUPKEY>;

Required Arguments

IN=*libref-1*
names the source SAS library from which to migrate members.

Restriction Concatenated libraries are not supported. See SAS Note 24539 at https://support.sas.com/kb/24/539.html.

Requirements If you use a server, such as SAS/CONNECT or SAS/SHARE, the server must be SAS 9.1.3 or later.

If cross-environment data access (CEDA) processing is invoked, and if the IN= source library contains catalogs, then you must specify a SAS/CONNECT libref or a SAS/SHARE libref in the IN= option or in the SLIBREF= option. To determine whether to specify the libref in the IN= or the SLIBREF= argument, see "Using a SAS/CONNECT or SAS/SHARE Server" on page 1571.

If CATALOG is the only member type in the library and you are using the SLIBREF= option, then omit the IN= argument.

OUT=*libref-2*
names the target SAS library to contain the migrated members.

Restriction Do not assign the OUT= target library to a server, such as SAS/CONNECT or SAS/SHARE. The REMOTE engine is not supported for the target library. The following example causes an error:

```
libname Lib1 'source-library-pathname';
libname Lib2 server=server id;
proc migrate in=Lib1 out=Lib2;
run;
```

Requirement Assign the OUT= target library to a different physical location than the IN= source library.

Interaction PROC MIGRATE can use the LIBNAME option OUTREP= for DATA, VIEW, ACCESS, MDDB, and DMDB member types. If you specify the OUTREP= option, you might also want to specify the EXTENDOBSCOUNTER= option. These options are appropriate in the LIBNAME statement for the OUT= library. See *SAS DATA Step Statements: Reference*.

Tip Assign the target library to an empty location. If a member already exists in the target library that has the same name and member type as a member in the source library, the member is not migrated. An error message is written to the SAS log, and PROC MIGRATE continues with the next member. Note that members in

a sequential library are an exception, because PROC MIGRATE does not read the entire tape to determine existence.

Optional Arguments

BUFSIZE=KEEPSIZE | *n* | *n*K | *n*M | *n*G

specifies the buffer page size of the members that are written to the target library. For example, a value of `10000` specifies a page size of 10,000 bytes, and a value of `4k` specifies a page size of 4096 bytes. A value of `0` results in the default. Setting the page size can help optimize SAS performance. In SAS 9.4M3, the BUFSIZE default is changed. The new default is the buffer page size of the current session. To continue using the previous behavior, which is to clone the page size of the members from the source library, specify BUFSIZE=KEEPSIZE.

For more details about the BUFSIZE= data set option or system option, see the documentation for your operating environment.

KEEPSIZE
retains (clones) the page size of members from the source library.

n
specifies the number of bytes.

***n*K**
specifies the number of kilobytes.

***n*M**
specifies the number of megabytes.

***n*G**
specifies the number of gigabytes.

Default the buffer page size of the current session

MOVE

deletes the original members from the source library. If a member already exists in the target library, the member is not deleted from the source library and a message is sent to the SAS log. If a catalog already exists in the target library, then no catalogs are deleted from the source library and a message is sent to the log. If a data set has referential integrity constraints, the data set is not deleted from the source library and an error is sent to the log.

Restriction The engine that is associated with the IN= source library must support the deletion of tables. Sequential engines do not support the deletion of tables.

Tip Use the MOVE option only if your system is space-constrained. It is preferable to verify the migration of the member before it is deleted.

SLIBREF=*libref*

specifies a libref that is assigned through a SAS/CONNECT or SAS/SHARE server. If cross-environment data access (CEDA) processing is invoked, and if the IN= source library contains catalogs, then you must specify a SAS/CONNECT or SAS/SHARE libref in the IN= option or in the SLIBREF=

option. To determine whether to specify the libref in the IN= or SLIBREF= argument, see "Using a SAS/CONNECT or SAS/SHARE Server" on page 1571.

Requirements If the catalogs were created in SAS 6 or SAS 8, SLIBREF= must be assigned through a SAS 8 server.

The SLIBREF= server must be running on the same type of operating environment as the source library. For example, if the source session is running under UNIX, then the server must be running under UNIX.

Interactions If CATALOG is the only member type in the library and you are using the SLIBREF= option, then omit the IN= argument.

If you are migrating from a SAS®9 release or later (for example, migrating from SAS 9.1.3 to SAS 9.4), then SLIBREF= is not required. If you have incompatible catalogs, specify the SAS/CONNECT or SAS/SHARE server libref in the IN= argument and omit the SLIBREF= argument. For the IN= argument, the server must be SAS 9.1.3 or later.

KEEPNODUPKEY
specifies to retain the NODUPKEY sort order. See "Migrating a SAS Data Set with NODUPKEY Sort Indicator" on page 1568.

Usage: MIGRATE Procedure

Migrating a Data Set with Audit Trails, Generations, Indexes, or Integrity Constraints

In all cases, the data set migrates first, and then the audit trails, generations, index, or integrity constraints are applied. Errors are handled in the following ways:

- If an error occurs while an index is created for a migrated data set, the data set might migrate without the index, or processing might stop. A message is written to the SAS log. If an index fails to migrate, resolve the error and re-create the index in the target library.

  If an index is missing from the source library, then depending on the environment and system options, SAS might try to repair the data set during migration by re-creating the index. If the data set is incompatible with the session encoding or data representation, re-creating the index produces an error. To resolve the error, re-create the index in the source library using the original operating system or move the index from its original location, and submit the PROC MIGRATE again. The error can occur when a customer has

moved a data set using the operating system and failed to include an index in the move.

- If an error occurs while integrity constraints are applied to a migrated data set, or while an audit trail or generations are migrated, the data set is removed from the target library. A note is written to the SAS log. If the MOVE option is specified, it does not delete the data set from the source library.
- For a data set with referential integrity constraints, the MOVE option does not delete any members in the source library, even when the migration is successful. You must remove referential integrity constraints before the member can be deleted. An error message is written to the SAS log.

Migrating a SAS Data Set with NODUPKEY Sort Indicator

When you migrate a SAS data set that was sorted with the NODUPKEY option, you can either use the default behavior or specify the KEEPNODUPKEY option.

Under the default behavior (without the KEEPNODUPKEY option), the SAS data set retains its sort indicator in the target library. However, the NODUPKEY attribute is removed, and a warning message is written to the SAS log. This is the default behavior because SAS data sets that were sorted with the NODUPKEY option in previous releases might retain observations with duplicate keys. You can re-sort the migrated SAS data set by the key variables in PROC SORT so that observations with duplicate keys are eliminated and the correct attributes are recorded.

If you specify the KEEPNODUPKEY option, you must examine your migrated data to determine whether observations with duplicate keys exist. If so, you must re-sort the SAS data set to have the data and NODUPKEY sort attribute match.

Migrating a SAS 6 Library

For SAS 6 source libraries, the following operating environments are supported. Find your source operating environment in the first column and read across the row for information about the supported target operating environments.

If your catalogs or libraries are not supported, see “Additional Steps for Unsupported Catalogs or Libraries” on page 1573. For important information about the SLIBREF= option, see “Using a SAS/CONNECT or SAS/SHARE Server” on page 1571.

Table 41.1 Supported SAS 6 Libraries

Source Library	Target Library	Instructions for Libraries with Catalogs
SAS 6.12 AIX, HP-UX, or Solaris SPARC	AIX, HP-UX, or Solaris SPARC	PROC MIGRATE does not support catalogs from SAS 6 AIX. For HP-UX or Solaris libraries that contain catalogs, specify the SLIBREF= option.
SAS 6.12 Windows	32-bit Windows	Catalogs are supported. Do not use the SLIBREF= option.
SAS 6.12 Windows	64-bit Windows	For libraries that contain catalogs, specify the SLIBREF= option.
SAS 6.09E z/OS	z/OS	Catalogs are supported. Do not use the SLIBREF= option.

SAS files that were created prior to SAS 6.12 (SAS 6.09E for z/OS) must be converted to SAS 6.12 before they can be migrated to the current release of SAS. See "Additional Steps for Unsupported Catalogs or Libraries" on page 1573.

Migrating Files with Short Extensions on PC Operating Environments

Overview

In SAS 7 and 8, the SHORTFILEEXT option creates a file with a shortened, three-character extension on PC operating environments only. This feature is necessary for operating systems that use a file allocation table (FAT) file system. The FAT file system is also referred to as 8.3 because a file name can include up to eight characters and a file extension can include up to three characters. These files are created on PC environments. They are not usable by SAS on other environments.

Note: SAS 6 files all have three-character extensions but are not affected by this issue. You can distinguish SAS 6 files because their extensions do not contain the number 7.

Below is a table of the short and standard extensions for SAS 7 and 8 files. To determine whether a library contains files with short extensions, look at the file names in the SAS Explorer or use the file management tools of your operating environment.

Table 41.2 *Short and Standard File Extensions for SAS 7 and 8 Files*

Memtype	Short Extension	Standard Extension
ACCESS	sa7	sas7bacs
AUDIT	st7	sas7baud
CATALOG	sc7	sas7bcat
DATA	sd7	sas7bdat
DMDB	s7m	sas7bdmd
FDB	sf7	sas7bfdb
INDEX	si7	sas7bndx
ITEMSTOR	sr7	sas7bitm
MDDB	sm7	sas7bmdb
PROGRAM	ss7	sas7bpgm
PUTILITY	sp7	sas7bput
UTILITY	su7	sas7butl
VIEW	sv7	sas7bvew

SAS®9 Compatibility with Short-Extension Files

Read-Only access is supported for short-extension files from earlier releases. You can migrate your library to the current release of SAS by using PROC MIGRATE. You must specify the SHORTFILEEXT option in the LIBNAME statement for the source library. The files are written to the target library with standard extensions; the files support full access.

For example, a library named MyLib contains two files with short extensions: a SAS data set named MyData.sd7 and a catalog named MyCat.sc7. Use the following code to migrate the library to SAS®9:

```
libname MyLib v8 'source-library-pathname' shortfileext;
libname NewLib v9 'target-library-pathname';

proc migrate in=MyLib out=NewLib;
run;
```

After migration, the target library NewLib contains two files with standard extensions: a SAS data set named MyData.sas7bdat and a catalog named MyCat.sas7bcat.

If your library also contains standard-extension files, then perform an additional migration without the SHORTFILEEXT option in the LIBNAME statement to migrate those files. Make sure that no short-extension files have the same name as a standard-extension file. In the target library, all files have a standard extension. If a short-extension file and a standard-extension file have the same name and same member type in the target library, the second one fails to migrate.

Using a SAS/CONNECT or SAS/SHARE Server

When to Use a SAS/CONNECT or SAS/SHARE Server

Here are two reasons to use a SAS/CONNECT or SAS/SHARE server:

- You can use a server to migrate across computers when you do not have direct access.
- You are required to use a server if the following two conditions are both met:
  - the source library contains catalogs
  - processing would invoke CEDA on the target session

  In general, CEDA is invoked when you migrate to an incompatible operating environment. For more information, see "Cross-Environment Data Access" in *SAS Programmer's Guide: Essentials*.

Here are two ways to determine whether a SAS library contains catalogs:

- Use operating system tools to examine the file system. The file extension for SAS catalogs is `.sas7bcat`.
- Submit a DATASETS procedure with MEMTYPE=CAT. Examine the SAS log for a list of catalogs.

When to Specify the Server in the IN= Option or in the SLIBREF= Option

Specify the SAS/CONNECT or SAS/SHARE server libref in the IN= option when the source library contains catalogs that were created in SAS 9.1.3 or later. See "Example 1: Migrating from a SAS®9 Release by Using SAS/CONNECT" on page 1574.

Specify the SAS/CONNECT or SAS/SHARE server libref in the SLIBREF= option when the source library contains catalogs that were created prior to SAS 9.1.3. See "Example 3: Migrating with Incompatible Catalogs When the SLIBREF= Option Is Required" on page 1577.

For SAS 6 files, use the SLIBREF= option for SAS 6 HP-UX or Solaris libraries that contain catalogs. See "Migrating a SAS 6 Library" on page 1568.

Requirements for the SAS/CONNECT or SAS/SHARE Server

The SAS/CONNECT or SAS/SHARE server must be running on the same type of operating environment as the source library. For example, if the source session is running under UNIX, then the server must be running under UNIX.

If the catalogs were created in SAS 6 or SAS 8, SLIBREF= must be assigned through a SAS 8 server. (Note that this is not the same server that you assign through the IN= argument. If you assign a server through the IN= argument, the IN= server must be SAS 9.1.3 or later.)

If you cannot meet these requirements, use the alternate method described in "Additional Steps for Unsupported Catalogs or Libraries" on page 1573.

Restrictions for the SLIBREF= Option

If CATALOG is the only member type in the library and you are using the SLIBREF= option, then omit the IN= argument.

When you use the SLIBREF= option for a SAS 8.2 library, multilabel formats are not supported. If a catalog contains a multilabel format, the format is not created on the target and an error is printed to the log. See SAS Note 20052, which is available from SAS customer support.

Additional Steps for Unsupported Catalogs or Libraries

When to Use Additional Steps

PROC MIGRATE is not supported for libraries that were created under the following source environments:

- SAS 8.2 libraries from CMS, OS/2, OpenVMS VAX, or 64-bit AIX.
- any unsupported SAS 6 operating environment. For a list of supported SAS 6 operating environments, see "Migrating a SAS 6 Library" on page 1568.

PROC MIGRATE is not supported for migrating catalogs under the following circumstances:

- SAS 6 AIX catalogs to any target library.
- Tru64 UNIX catalogs to either Linux for x64 or Solaris for x64 target library.
- stored compiled macros, which are stored in a catalog.
- incompatible catalogs if SAS/CONNECT or SAS/SHARE software is required, and you do not have access to the software. See "Using a SAS/CONNECT or SAS/SHARE Server" on page 1571.

You can use additional steps for just the catalogs, if unsupported catalogs are the only issue. By using PROC MIGRATE for other members of the library, you can retain those members' attributes.The CPORT and CIMPORT method below has some limitations. For example, when transcoding to a new encoding, truncation can occur. If truncation occurs, you must expand variable lengths. You can either use the CVP engine with PROC CPORT or use the EXTENDVAR= option with PROC CIMPORT.

Process

1. In the source session, create a transport file with PROC CPORT. (See Chapter 16, "CPORT Procedure," on page 537.)
2. Move the transport file to the target environment. Do not use RLS (a feature of SAS/CONNECT and SAS/SHARE software) to move catalogs, or you will encounter errors. You must use binary FTP, the DOWNLOAD procedure, Network File System (NFS), or another method of directly accessing files.
3. In the target session, use CIMPORT to import the transport file. (See Chapter 12, "CIMPORT Procedure," on page 389.)

Process for a Formats Catalog When Encoding Is Not Compatible

Catalog entries do not include encoding in the metadata. SAS assumes that any imported catalog entries have the session encoding or a compatible encoding.

If a catalog entry contains 7-bit ASCII characters only, then the catalog entry can be used in any other ASCII session, including UTF-8. (7-bit ASCII characters include the letters of the English alphabet, digits, and symbols that are frequently used in punctuation or SAS syntax.)

See these examples that change the encoding of a formats catalog:

- "Example: Migrate Catalogs to Avoid CEDA Limitations" in *SAS V9 LIBNAME Engine: Reference*
- "Example: Avoid Truncation in Formats When Migrating Catalogs" in *SAS V9 LIBNAME Engine: Reference*

The CVP engine can help avoid truncation when you re-create a formats catalog in an encoding where the characters are represented by more bytes. Truncation might occur if a format length does not accommodate the larger character size. In the target session, specify the CVPMULT= option in the source LIBNAME statement. Note that the CVP engine cannot increase the values of the START, MIN, MAX, or LABEL variables in the CNTLOUT= data set. In addition, when you use CNTLIN= to import catalogs, you might experience transcoding errors that are not written to the log. For example, a character might not be available in the target encoding, or the code point could be used for a different character in the target encoding. If you continue to experience transcoding problems, re-create the format in the target session. If you do not have access to the SAS program statements that were used to create the original format, you can print the CNTLOUT= data set in the source session and use that information as a guide.

For an overview of potential transcoding errors, see "Transcoding Considerations" in *SAS National Language Support (NLS): Reference Guide*.

Examples: MIGRATE Procedure

Example 1: Migrating from a SAS®9 Release by Using SAS/CONNECT

Features: PROC MIGRATE statement options

IN=
OUT=

Details

In this example, the following is demonstrated:

- A spawner starts a session on the SAS/CONNECT server to access remote SAS data. Here are two reasons to use a SAS/CONNECT or SAS/SHARE server:
  - You can use a server to migrate across machines when you do not have direct access.
  - You are required to use a server if both of the following conditions are met:
    - The source library contains catalogs.
    - Processing would invoke CEDA in the target session.

      In general, CEDA is invoked when you migrate to an incompatible operating environment. For more information about CEDA, see "Cross-Environment Data Access" in *SAS Programmer's Guide: Essentials*.
- The SLIBREF= argument is not used. (To learn whether SLIBREF= is required, see "Using a SAS/CONNECT or SAS/SHARE Server" on page 1571.)
- The IN= argument accesses all of the supported file types in the source library, including incompatible catalogs, by using SAS/CONNECT or SAS/SHARE software. This example uses SAS/CONNECT software. The SAS/CONNECT or SAS/SHARE server that you assign to the IN= argument must be SAS 9.1.3 or later.

Program

```
options comamid=tcp;
%let myserver=host.name.com;
signon myserver.__1234 user=userid password='mypw';

libname source 'source-library-pathname' server=myserver.__1234;
libname target 'target-library-pathname';

proc migrate in=source out=target <options>;
run;
signoff myserver.__1234;
```

Program Description

In the target session, submit the following code to invoke a SAS/CONNECT spawner. The COMAMID= system option specifies TCP/IP as the communications access method. The `myserver` macro variable is assigned to the host name of the

remote SAS/CONNECT server. The SIGNON statement references the `myserver` macro variable followed by the port number that the SAS/CONNECT spawner is listening on. If your port number or service name is defined in the macro variable, then omit it from the SIGNON.

```
options comamid=tcp;
%let myserver=host.name.com;
signon myserver.__1234 user=userid password='mypw';
```

Assign the source and target libraries. Substitute your library paths, and specify the `myserver` macro variable for SERVER= in the source library. Include the port number if it is specified in the SIGNON statement.

```
libname source 'source-library-pathname' server=myserver.__1234;
libname target 'target-library-pathname';
```

Submit PROC MIGRATE, and include any options you want.

```
proc migrate in=source out=target <options>;
run;
signoff myserver.__1234;
```

Log Messages

The following SAS log messages indicate that a data set and a formats catalog are migrated. PROC MIGRATE calls the CPORT and CIMPORT procedures to migrate catalogs. Normally CEDA does not support catalogs, but using a SAS/CONNECT server avoids CEDA restrictions. The server must have the same data representation and encoding as the data.

```
NOTE: Migrating SOURCE.TEST to TARGET.TEST (memtype=DATA).
NOTE: There were 3 observations read from the data set SOURCE.TEST.
NOTE: The data set TARGET.TEST has 3 observations and 2 variables.
NOTE: PROC CPORT begins to transport catalog SOURCE.FORMATS
NOTE: Entry MYFMT.FORMAT has been transported.
NOTE: Entry MYABC.FORMATC has been transported.
```

Example 2: Migrating with Direct Access and No Incompatible Catalogs

Features: PROC MIGRATE statement options
- IN=
- OUT=

Details

In this example, the following is demonstrated:

- The source and target libraries are directly accessible by the target computer. For example, you might use NFS, which is a standard protocol of UNIX operating environments. See the documentation for NFS and for your operating environment.
- A SAS/CONNECT or SAS/SHARE server is not used. To learn whether a server is required, see "Using a SAS/CONNECT or SAS/SHARE Server" on page 1571.
- If CEDA processing is not invoked, then any catalogs in the library are included in the migration. If CEDA is invoked, then catalogs are not migrated.

Program

From a session in the current release of SAS, submit the following.

```
libname Source 'source-library-pathname';
libname Target 'target-library-pathname';

proc migrate in=Source out=Target;
run;
```

Example 3: Migrating with Incompatible Catalogs When the SLIBREF= Option Is Required

Features:

PROC MIGRATE statement options
IN=
OUT=
SLIBREF=

Details

In this example, the following is demonstrated:

- The source and target libraries are on different computers.
- The SLIBREF= argument accesses the catalogs in the source library. (To learn whether SLIBREF= is required, see "Using a SAS/CONNECT or SAS/SHARE Server" on page 1571.) The SLIBREF= argument must be assigned to a

SAS/CONNECT or SAS/SHARE server running in a session of SAS that can access the catalogs. For example, if the source library contains SAS 8.2 catalogs created by 32-bit Solaris, SLIBREF= must be assigned to a SAS 8.2 32-bit Solaris server. If catalogs were created in SAS 6, SLIBREF= must be assigned through a SAS 8.2 server that is compatible with the data representation of the SAS 6 catalogs.

- The IN= argument accesses the rest of the supported file types in the source library. You can assign the source library to the IN= argument in one of the following two ways:
  - directly via a Network File System (NFS)
  - via a SAS/CONNECT or SAS/SHARE server

  This example uses NFS, which is a standard protocol of UNIX operating environments. See the documentation for NFS and for your operating environment.

Program

```
signon v8srv sascmd='my-v8-sas-invocation-command';

rsubmit;
libname Srclib <engine> 'source-library-pathname';
endrsubmit;

libname Source <engine> '/nfs/v8machine-name/source-library-pathname';

libname Srclib <engine> server=v8srv;

libname Target <engine> 'target-library-pathname';

proc migrate in=Source out=Target slibref=Srclib <options>;
run;

proc migrate out=Target slibref=Srclib <options>;
run;
```

Program Description

From a session in the current release of SAS, submit the SIGNON command to invoke a SAS/CONNECT server session. Note that because you are working across computers, you might specify a machine name in the server ID.

```
signon v8srv sascmd='my-v8-sas-invocation-command';
```

Within this remote SAS 8.2 session, assign a libref to the source library that contains the library members to be migrated. Use the RSUBMIT and ENDRSUBMIT commands for SAS/CONNECT.

```
rsubmit;
libname Srclib <engine> 'source-library-pathname';
endrsubmit;
```

In the local (client) session in the current release, assign to the same source library through NFS.

```
libname Source <engine> '/nfs/v8machine-name/source-library-pathname';
```

Assign the same libref to the same source libref as in step 2 (in this example, Srclib). But do not assign the libref to a physical location. Instead, specify the SERVER= option with the server ID (in this example, V8SRV) that you assigned in the SIGNON command in step 1.

```
libname Srclib <engine> server=v8srv;
```

Assign the target library.

```
libname Target <engine> 'target-library-pathname';
```

Use PROC MIGRATE with the SLIBREF= option. For the IN= and OUT= options, specify the usual source and target librefs (in this example, Source and Target, respectively). Set SLIBREF= to the libref that uses the SERVER= option (in this example, Srclib).

```
proc migrate in=Source out=Target slibref=Srclib <options>;
run;
```

Alternatively, if CATALOG is the only member type in the library and you are using the SLIBREF= option, then omit the IN= argument.

```
proc migrate out=Target slibref=Srclib <options>;
run;
```

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OPTIONS Procedure

Overview: OPTIONS Procedure

What Does the OPTIONS Procedure Do?

The OPTIONS procedure lists the current settings of SAS system options in the SAS log.

SAS system options control how SAS formats output, handles files, processes data sets, interacts with the operating environment, and does other tasks that are not specific to a single SAS program or data set. You use the OPTIONS procedure to obtain information about an option or a group of options. Here is some of the information that the OPTIONS procedure provides:

- the current value of an option and how it was set
- a description of an option
- valid syntax for the option, valid option values, and the range of values
- where you can set the system option
- if the option can be restricted by your site administrator
- if the option has been restricted
- system options that belong to a system option group
- system options that are specific for an operating environment
- if an option value has been modified by the INSERT or APPEND system options
- system options that can be saved by the OPTSAVE procedure or the DMOPTSAVE command (not valid in SAS Viya)

For additional information about SAS system options, see *SAS System Options: Reference*.

Syntax: OPTIONS Procedure

Note: SAS system options are documented in several publications. You can access all system options from "SAS System Options Documented in Other SAS Publications" in *SAS System Options: Reference*.

See: "OPTIONS Procedure: UNIX" in *SAS Companion for UNIX Environments*

"OPTIONS Procedure: Windows" in *SAS Companion for Windows*

"OPTIONS Procedure Statement: z/OS" in *SAS Companion for z/OS*

PROC OPTIONS <*options*>;

Statement	Task	Example
PROC OPTIONS	List the current system option settings to the SAS Log	Ex. 1, Ex. 2, Ex. 3, Ex. 4

PROC OPTIONS Statement

Lists the current settings of SAS system options in the SAS log.

Examples:

Syntax

PROC OPTIONS <*options*>;

Summary of Optional Arguments

LISTGROUPS
: lists the system option groups as well as a description of each group.

Choose the format of the listing

DEFINE
: displays the short description of the option, the option group, and the option type.

EXPAND
: when displaying a character option, replaces an environment variable in the option value with the value of the environment variable. EXPAND is ignored if the option is a Boolean option, such as CENTER or NOCENTER, or if the value of the option is numeric.

HEXVALUE
: displays system option character values as hexadecimal values.

LOGNUMBERFORMAT
: displays numeric system option values using locale-specific punctuation.

LONG
: lists each system option on a separate line with a description.

NOEXPAND
: when displaying a path, displays the path using environment variable(s) and not the value of the environment variable(s). This is the default.

NOLOGNUMBERFORMAT
: displays numeric system option values without using punctuation, such as a comma or a period. This is the default.

SHORT
: specifies to display a compressed listing of options without descriptions.

VALUE
: displays the option's value and scope, as well as how the value was set.

Restrict the number of options displayed

GROUP=*group-name*

GROUP=*(group-name–1 ... group-name-n)*
: displays the options in one or more groups specified by *group-name*.

HOST
: displays only host options.

LISTINSERTAPPEND
: lists the system options whose value can be modified by the INSERT and APPEND system options.

LISTOPTSAVE
: lists the system options that can be saved with PROC OPTSAVE or the DMOPTSAVE command.

LISTRESTRICT
: lists the system options that can be restricted by your site administrator.

NOHOST
: displays only portable options.

OPTION=*option-name*

OPTION=(*option-name-1 ... option-name-n*)
: displays information about one or more system options.

RESTRICT
: displays system options that the site administrator has restricted from being updated.

Optional Arguments

DEFINE
displays the short description of the option, the option group, and the option type. SAS displays information about when the option can be set, whether an option can be restricted, the valid values for the option, and whether the OPTSAVE procedure will save the option.

Restriction Saving and loading system options is not valid in SAS Viya. Information about whether the option can be saved or loaded is displayed only for SAS 9.4.

Interaction This option is ignored when SHORT is specified.

Example "Example 2: Displaying the Setting of a Single Option" on page 1599

EXPAND
when displaying a character option, replaces an environment variable in the option value with the value of the environment variable. EXPAND is ignored if the option is a Boolean option, such as CENTER or NOCENTER, or if the value of the option is numeric.

Restriction Variable expansion is valid only in the Windows and UNIX operating environments.

Tip By default, some option values are displayed with expanded variables. Other options require the EXPAND option in the PROC OPTIONS statement. Use the DEFINE option in the PROC OPTIONS statement to determine whether an option value expands variables by default or if the EXPAND option is required. If the output from PROC OPTIONS DEFINE shows the following information, you must use the EXPAND option to expand variable values:

```
Expansion: Environment variables, within the option value,
```

```
are not expanded
```

See "NOEXPAND" on page 1586 option to view paths that display the environment variable

Example "Example 3: Displaying Expanded Path Environment Variables" on page 1600

GROUP=*group-name*
GROUP=*(group-name-1 ... group-name-n)*
displays the options in one or more groups specified by *group-name*.

Requirement When you specify more than one group, enclose the group names in parenthesis and separate the group names by a space.

See "Display Information about System Option Groups" on page 1591

HEXVALUE
displays system option character values as hexadecimal values.

HOST
displays only host options.

See "NOHOST" on page 1586 option to display only portable options.

LISTINSERTAPPEND
lists the system options whose value can be modified by the INSERT and APPEND system options. The INSERT option specifies a value that is inserted as the first value of a system option value list. The APPEND option specifies a value that is appended as the last value of a system option value list. Use the LISTINERTAPPEND option to display which system options can have values inserted at the beginning or appended at the end of their value lists.

See "INSERT= System Option" in *SAS System Options: Reference*

"APPEND= System Option" in *SAS System Options: Reference*

Example "Example 4: List the Options That Can Be Specified by the INSERT and APPEND Options" on page 1601

LISTGROUPS
lists the system option groups as well as a description of each group.

See "Display Information about System Option Groups" on page 1591

LISTOPTSAVE
lists the system options that can be saved with PROC OPTSAVE or the DMOPTSAVE command.

Restriction This option is not valid in SAS Viya. PROC OPTSAVE and the DMOPTSAVE command are not valid in SAS Viya.

LISTRESTRICT
lists the system options that can be restricted by your site administrator.

See "RESTRICT" on page 1587 option to list options that have been restricted by the site administrator

LONG
lists each system option on a separate line with a description. This is the default. Alternatively, you can create a compressed listing without descriptions.

See "SHORT" on page 1587 option to produce a compressed listing without descriptions

Example "Example 1: Producing the Short Form of the Options Listing" on page 1598

LOGNUMBERFORMAT
displays numeric system option values using locale-specific punctuation.

See "NOLOGNUMBERFORMAT" on page 1586 option to display numeric option values without using commas

Example "Example 2: Displaying the Setting of a Single Option" on page 1599

NOEXPAND
when displaying a path, displays the path using environment variable(s) and not the value of the environment variable(s). This is the default.

See "EXPAND" on page 1584 option to display a path by expanding the value of environment variables

NOHOST
displays only portable options.

Alias PORTABLE or PORT

See "HOST" on page 1585 option to display only host options

NOLOGNUMBERFORMAT
displays numeric system option values without using punctuation, such as a comma or a period. This is the default.

See "LOGNUMBERFORMAT" on page 1586 option to display numeric system options using commas

OPTION=*option-name*
OPTION=(*option-name-1 ... option-name-n*)
displays a short description and the value (if any) of the option specified by *option-name*. DEFINE and VALUE options provide additional information about the option.

option-name
specifies the option to use as input to the procedure.

Requirement If a SAS system option uses an equal sign, such as PAGESIZE=, do not include the equal sign when specifying the option to OPTION=.

Example "Example 2: Displaying the Setting of a Single Option" on page 1599

RESTRICT

displays the system options that have been set by your site administrator in a restricted options configuration file. These options cannot be changed by the user. For each option that is restricted, the RESTRICT option displays the option's value, scope, and how it was set.

If your site administrator has not restricted any options, then the following message appears in the SAS log:

```
Your Site Administrator has not restricted any SAS options.
```

See "LISTRESTRICT" on page 1585 option to list options that can be restricted by the site administrator

SHORT

specifies to display a compressed listing of options without descriptions.

See "LONG" on page 1586 option to create a listing with descriptions of the options.

VALUE

displays the option's value and scope, as well as how the value was set. If the value was set using a configuration file, the SAS log displays the name of the configuration file. If the option was set using the INSERT or APPEND system options, the SAS log displays the value that was inserted or appended.

Interactions This option has no effect when SHORT is specified.

When the option is in the Threaded Kernel (TK) system options group, the value of **How option value set** is displayed as `Internal`

Note SAS options that are passwords, such as EMAILPW and METAPASS, return the value xxxxxxxx and not the actual password.

Example "Example 2: Displaying the Setting of a Single Option" on page 1599

Usage: OPTIONS Procedure

Display a List of System Options

The log that results from running PROC OPTIONS can show the system options for the options that are available for all operating environment and those that are specific to a single operating environment. Options that are available for all operating environments are referred to as portable options. Options that are specific to a single operating environment are referred to as host options.

The following example shows a partial log that displays the settings of portable options.

```
proc options;
run;
```

Example Code 42.1 *The SAS Log Showing a Partial Listing of SAS System Options*

```
Portable Options:

 NOACCESSIBLECHECK Do not detect and log ODS output that is not accessible.
 NOACCESSIBLEGRAPH Do not create accessible ODS graphics by default.
 NOACCESSIBLEPDF   Do not create accessible PDF files by default.
 NOACCESSIBLETABLE Do not create accessible tables for enabled procedures, by default.

 ANIMATION=STOP    Specifies whether to start or stop animation.
 ANIMDURATION=MIN  Specifies the number of seconds that each animation frame displays.
 ANIMLOOP=YES      Specifies the number of iterations that animated images repeat.
 ANIMOVERLAY       Specifies that animation frames are overlaid in order to view all frames.
 APPEND=           Specifies an option=value pair to insert the value at the end of the existing
                   option value.
 APPLETLOC=site-specific-path
                   Specifies the location of Java applets, which is typically a URL.
 ARMAGENT=         Specifies an ARM agent (which is an executable module or keyword, such as
                   LOG4SAS) that contains a specific implementation of the ARM API.
 ARMLOC=ARMLOG.LOG Specifies the location of the ARM log.
 ARMSUBSYS=(ARM_NONE)
                   Specifies the SAS ARM subsystems to enable or disable.
 AUTOCORRECT       Automatically corrects misspelled procedure names and keywords, and global
                   statement names.
```

The log displays both portable and host options when you submit `proc options;`.

To view only host options, use this version of the OPTIONS procedure:

```
proc options host;
run;
```

Example Code 42.2 *The SAS Log Showing a Partial List of Host Options*

```
Host Options:

 ACCESSIBILITY=STANDARD
                   Specifies whether accessibility features are enabled in the Customize Tool
                   dialog box and in some Properties dialog boxes.
 ALIGNSASIOFILES   Aligns SAS files on a page boundary for improved performance.
 ALTLOG=           Specifies the location for a copy of the SAS log when SAS is running in batch
                   mode.
 ALTPRINT=         Specifies the location for a copy of the SAS procedure output when SAS is
                   running in batch mode.
 AUTHPROVIDERDOMAIN=
                   Specifies the authentication provider that is associated with a domain.
 AUTHSERVER=       Specifies the domain server that finds and authenticates secure server logins.
 AWSCONTROL=(SYSTEMMENU MINMAX TITLE)
                   Specifies whether the main SAS window includes a title bar, a system control
                   menu, and minimize and maximize buttons.
 AWSDEF=(0 0 79 80)
                   Specifies the location and dimensions of the main SAS window when SAS
                   initializes.
 AWSMENU           Displays the menu bar in the main SAS window.
```

Display Information about One or More Options

To view the setting of one or more particular options, you can use the OPTION= and DEFINE options in the PROC OPTIONS statement. The following example shows a log that PROC OPTIONS produces for a single SAS system option.

```
proc options option=errorcheck define;
run;
```

Example Code 42.3 *The Setting of a Single SAS System Option*

```
5    proc options option=errorcheck define;
6    run;

    SAS (r) Proprietary Software Release 9.4  TS1M6

 ERRORCHECK=NORMAL
Option Definition Information for SAS Option ERRORCHECK
    Group= ERRORHANDLING
    Group Description: Error messages and error conditions settings
    Description: Specifies whether SAS enters syntax-check mode when errors are found in the
                 LIBNAME, FILENAME,  %INCLUDE, and LOCK statements.
    Type: The option value is of type CHARACTER
          Maximum Number of Characters: 10
          Casing: The option value is retained uppercased
          Quotes: If present during "set", start and end quotes are removed
          Parentheses: The option value does not require enclosure within parentheses. If
          present, the parentheses are retained.
          Expansion: Environment variables, within the option value, are not expanded
          Number of valid values: 2
               Valid value: NORMAL
               Valid value: STRICT
    When Can Set: Startup or anytime during the SAS Session
    Restricted: Your Site Administrator can restrict modification of this option
    Optsave: PROC Optsave or command Dmoptsave will save this option
```

To view the settings for more than one option, enclose the options in parentheses and separate the options with a space:

```
proc options option=(pdfsecurity pdfpassword) define;
run;
```

Example Code 42.4 *The Settings of Two SAS System Options*

```
7    proc options option=(pdfsecurity pdfpassword) define;
8    run;

    SAS (r) Proprietary Software Release 9.4  TS1M6

 PDFSECURITY=NONE
Option Definition Information for SAS Option PDFSECURITY
    Group= PDF
    Group Description: PDF settings
    Group= SECURITY
    Group Description: Security settings
    Description: Specifies the level of encryption to use for PDF documents.
    Type: The option value is of type CHARACTER
          Maximum Number of Characters: 4
          Casing: The option value is retained uppercased
          Quotes: If present during "set", start and end quotes are removed
          Parentheses: The option value does not require enclosure within parentheses. If
          present, the parentheses are retained.
          Expansion: Environment variables, within the option value, are not expanded
          Number of valid values: 3
               Valid value: HIGH
               Valid value: LOW
               Valid value: NONE
    When Can Set: Startup or anytime during the SAS Session
    Restricted: Your Site Administrator can restrict modification of this option
    Optsave: PROC Optsave or command Dmoptsave will save this option
```

```
 PDFPASSWORD=xxxxxxxx
Option Definition Information for SAS Option PDFPASSWORD
    Group= PDF
    Group Description: PDF settings
    Group= SECURITY
    Group Description: Security settings
    Description: Specifies the password to use to open a PDF document and the password used by a
                 PDF document owner.
    Type: The option value is of type CHARACTER
          Maximum Number of Characters: 2048
          Casing: The option value is retained with original casing
          Quotes: If present during "set", start and end quotes are removed
          Parentheses: The option value must be enclosed within parentheses. The parentheses are
          retained.
          Expansion: Environment variables, within the option value, are not expanded
          Number of valid values: 2
               Valid value: OPEN
               Valid value: OWNER
    When Can Set: Startup or anytime during the SAS Session
    Restricted: Your Site Administrator cannot restrict modification of this option
    Optsave: PROC Optsave or command Dmoptsave will not save this option
```

Display Information about System Option Groups

Each SAS system option belongs to one or more groups, which are based on functionality, such as error handling or sorting. You can display a list of system-option groups and the system options that belong to one or more of the groups.

Use the LISTGROUPS option to display a list of system-option groups.

```
proc options listgroups;
run;
```

Example Code 42.5 *List of SAS System Option Groups*

```
26   proc options listgroups;
27   run;

    SAS (r) Proprietary Software Release 9.4  TS1M6


    Option Groups
       GROUP=ADABAS                ADABAS

       GROUP=ANIMATION             Animation

       GROUP=CAS                   CAS Options

       GROUP=CODEGEN               Code generation

       GROUP=COMMUNICATIONS        Networking and encryption

       GROUP=DATACOM               Datacom

       GROUP=DATAQUALITY           Data Quality

       GROUP=DB2                   DB2

       GROUP=EMAIL                 E-mail

       GROUP=ENVDISPLAY            Display
```

```
GROUP=ENVFILES              Files
GROUP=ERRORHANDLING         Error handling
GROUP=EXECMODES             Initialization and operation
GROUP=EXTFILES              External files
GROUP=GRAPHICS              Driver settings
GROUP=HELP                  Help
GROUP=IDMS                  IDMS
GROUP=IMS                   IMS
GROUP=INPUTCONTROL          Data Processing
GROUP=INSTALL               Installation
GROUP=ISPF                  ISPF
GROUP=LANGUAGECONTROL       Language control
GROUP=LISTCONTROL           Procedure output
GROUP=LOGCONTROL            SAS log
GROUP=LOG_LISTCONTROL       SAS log and procedure output
GROUP=MACRO                 SAS macro
GROUP=MEMORY                Memory
GROUP=META                  Metadata
GROUP=ODSPRINT              ODS Printing
GROUP=PDF                   PDF
GROUP=PERFORMANCE           Performance
GROUP=REXX                  REXX
GROUP=SASFILES              SAS Files
GROUP=SECURITY              Security
GROUP=SMF                   SMF
GROUP=SORT                  Procedure options
GROUP=SQL                   SQL
GROUP=SVG                   SVG
GROUP=TK                    TK
```

Use the GROUP= option to display system options that belong to a particular group. You can specify one or more groups.

```
proc options group=(svg graphics);
run;
```

Example Code 42.6 *Sample Output Using the GROUP= Option*

```
5    proc options group=(svg graphics);
6    run;

    SAS (r) Proprietary Software Release 9.4  TS1M6


Group=SVG
 ANIMATION=STOP    Specifies whether to start or stop animation.
 ANIMDURATION=MIN  Specifies the number of seconds that each animation frame displays.
 ANIMLOOP=YES      Specifies the number of iterations that animated images repeat.
 ANIMOVERLAY       Specifies that animation frames are overlaid in order to view all frames.
 SVGAUTOPLAY       Starts animation when the page is loaded in the browser.
 NOSVGCONTROLBUTTONS
                   Does not display the paging control buttons and an index in a multipage SVG
                   document.
 SVGFADEIN=0       Specifies the number of seconds for the fade-in effect for a graph.
 SVGFADEMODE=OVERLAP
                   Specifies whether to use sequential frames or to overlap frames for the
                   fade-in effect of a graph.
 SVGFADEOUT=0      Specifies the number of seconds for a graph to fade out of view.
 SVGHEIGHT=        Specifies the height of the viewport. Specifies the value of the height
                   attribute of the outermost SVG element.
 NOSVGMAGNIFYBUTTON
                   Disables the SVG magnifier tool.
 SVGPRESERVEASPECTRATIO=
                   Specifies whether to force uniform scaling of SVG output. Specifies the
                   preserveAspectRatio attribute on the outermost SVG element.
 SVGTITLE=         Specifies the text in the title bar of the SVG output. Specifies the value of
                   the TITLE element in the SVG file.
 SVGVIEWBOX=       Specifies the coordinates, width, and height that are used to set the viewBox
                   attribute on the outermost SVG element.
 SVGWIDTH=         Specifies the width of the viewport. Specifies the value of the width
                   attribute of the outermost SVG element.
 SVGX=             Specifies the x-axis coordinate of one corner of the rectangular region for
                   an embedded SVG element. Specifies the x attribute in the outermost SVG
                   element.
 SVGY=             Specifies the y-axis coordinate of one corner of the rectangular region for
                   an embedded SVG element. Specifies the y attribute in the outermost SVG
                   element.

Group=GRAPHICS
 DEVICE=           Specifies the device driver to which SAS/GRAPH sends procedure output.
 GSTYLE            Uses ODS styles to generate graphs that are stored as GRSEG catalog entries.
 GWINDOW           Displays SAS/GRAPH output in the GRAPH window.
 MAPS=("!sasroot\path-to-maps")
                   Specifies the location of SAS/GRAPH map data sets.
 MAPSGFK=(          "!sasroot\path-to-maps"  )
                   Specifies the location of GfK maps.
 MAPSSAS=(          "!sasroot\path-to-maps"  )
                   Specifies the location of SAS map data sets.
 FONTALIAS=        Assigns a Windows font to one of the SAS fonts.
```

You can use the following group names as values for the GROUP= option to list the system options in a group:

ANIMATION	GRAPHICS	META
CAS	HELP	ODSPRINT
COMMUNICATIONS	INPUTCONTROL	PDF
DATAQUALITY	INSTALL	PERFORMANCE
EMAIL	LANGUAGECONTROL	SASFILES

ENVDISPLAY	LISTCONTROL	SECURITY
ENVFILES	LOGCONTROL	SORT
ERRORHANDLING	LOG_LISTCONTROL	SQL
EXECMODES	MACRO	SVG
EXTFILES	MEMORY	TK

You can use the following groups to list operating environment–specific values that might be available when you use the GROUP= option with PROC OPTIONS.

ADABAS	IDMS	REXX
CODEGEN	IMS	SMF
DATACOM	ISPF	
DB2	ORACLE	

Operating Environment Information: Refer to the SAS documentation for your operating environment for more information about these host-specific options.

Display Restricted Options

Your site administrator can restrict some system options so that your SAS session conforms to options that are set for your site. Restricted options can be modified only by your site administrator. The OPTIONS procedure provides two options that display information about restricted options. The RESTRICT option lists the system options that your site administrator has restricted. The LISTRESTRICT option lists the options that can be restricted by your site administrator. For a listing of options that cannot be restricted, see "System Options That Cannot Be Restricted" in *SAS System Options: Reference*.

The following SAS logs shows the output when the RESTRICT option is specified and partial output when the LISTRESTRICT option is specified.

Example Code 42.7 *A List of Options That Have Been Restricted by the Site Administrator*

```
1
   proc options restrict;
2    run;
    SAS (r) Proprietary Software Release 9.4  TS1M6

Option Value Information For SAS Option CMPOPT
    Option Value: (NOEXTRAMATH NOMISSCHECK NOPRECISE NOGUARDCHECK
NOGENSYMNAMES NOFUNCDIFFERENCING)
    Option Scope: SAS Session
    How option value set:  Site Administrator Restricted
```

Example Code 42.8 *A Partial Log That Lists Options That Can Be Restricted*

```
13   proc options listrestrict;
14   run;

    SAS (r) Proprietary Software Release 9.4  TS1M6


    Your Site Administrator can restrict the ability to modify the following Portable Options:

     ACCESSIBLECHECK    Detect and log ODS output that is not accessible.
     ACCESSIBLEGRAPH    Create accessible ODS graphics by default.
     ACCESSIBLEPDF      Create accessible PDF files by default.
     ACCESSIBLETABLE    Create accessible tables for enabled procedures, by default.
     ANIMATION          Specifies whether to start or stop animation.
     ANIMDURATION       Specifies the number of seconds that each animation frame displays.
     ANIMLOOP           Specifies the number of iterations that animated images repeat.
     ANIMOVERLAY        Specifies that animation frames are overlaid in order to view all frames.
     APPLETLOC          Specifies the location of Java applets, which is typically a URL.
     ARMAGENT           Specifies an ARM agent (which is an executable module or keyword, such
                        as LOG4SAS) that contains a specific implementation of the ARM API.
     ARMLOC             Specifies the location of the ARM log.
     ARMSUBSYS          Specifies the SAS ARM subsystems to enable or disable.
     AUTOCORRECT        Automatically corrects misspelled procedure names and keywords, and
                        global statement names.
     AUTOSAVELOC        Specifies the location of the Program Editor auto-saved file.
```

Display Options That Can Be Saved

Many system options can be saved by using PROC OPTSAVE or the DMOPTSAVE command. The options can later be restored by using PROC OPTLOAD or the DMOPTLOAD command. You can list the system options that can be saved and later restored by using the LISTOPTSAVE option on PROC OPTIONS.

Note: PROC OPTSAVE does not save these types of system options:

- SAS invocation options
- SAS environment variable options
- SAS system options that include passwords
- SAS system options that are read-only and cannot be set

Note: PROC OPTSAVE and PROC OPTLOAD, as well as the DMOPTSAVE and DMOPTLOAD commands are valid only in SAS 9.4. They are not valid in SAS Viya.

The following SAS log shows a partial list of the options that can be saved by using PROC OPTSAVE or the DMOPTSAVE command:

Example Code 42.9 *A Partial List of System Options That Can Be Saved*

```
11   proc options listoptsave;
     run;

    SAS (r) Proprietary Software Release 9.4  TS1M6


    Core options that can be saved with OPTSAVE

     ACCESSIBLECHECK    Detect and log ODS output that is not accessible.
     ACCESSIBLEGRAPH    Create accessible ODS graphics by default.
     ACCESSIBLEPDF      Create accessible PDF files by default.
     ACCESSIBLETABLE    Create accessible tables for enabled procedures, by default.
     ANIMATION          Specifies whether to start or stop animation.
     ANIMDURATION       Specifies the number of seconds that each animation frame displays.
     ANIMLOOP           Specifies the number of iterations that animated images repeat.
     ANIMOVERLAY        Specifies that animation frames are overlaid in order to view all frames.
     APPLETLOC          Specifies the location of Java applets, which is typically a URL.
     AUTOCORRECT        Automatically corrects misspelled procedure names and keywords, and
                        global statement names.
     AUTOSAVELOC        Specifies the location of the Program Editor auto-saved file.
     AUTOSIGNON         Enables a SAS/CONNECT client to automatically submit the SIGNON command
                        remotely with the RSUBMIT command.
     BINDING            Specifies the binding edge type of duplexed printed output.
     BOMFILE            Writes the byte order mark (BOM) prefix when a Unicode-encoded file is
                        written to an external file.
     BOTTOMMARGIN       Specifies the size of the margin at the bottom of a printed page.
     BUFNO              Specifies the number of buffers for processing SAS data sets.
     BUFSIZE            Specifies the size of a buffer page for output SAS data sets.
```

Results: OPTIONS Procedure

View PROC OPTIONS Output in the SAS Log

SAS writes the options list to the SAS log.

SAS system options of the form *option* | NO*option* are listed as either *option* or NO*option*, depending on the current setting. They are always sorted by the positive form. For example, NOCAPS would be listed under the Cs.

The OPTIONS procedure displays passwords in the SAS log as eight Xs, regardless of the actual password length.

Operating Environment Information: PROC OPTIONS produces additional information that is specific to the environment under which you are running SAS. For more information about this and for descriptions of host-specific options, refer to the SAS documentation for your operating environment.

See Also

- *SAS Companion for UNIX Environments*
- *SAS Companion for Windows*
- *SAS Companion for z/OS*

Examples: OPTIONS Procedure

Example 1: Producing the Short Form of the Options Listing

Features: PROC OPTIONS statement option
SHORT

Details

This example shows how to generate the short form of the listing of SAS system option settings. Compare this short form with the long form that is shown in "Display a List of System Options" on page 1588.

Program

List all options and their settings. SHORT lists the SAS system options and their settings without any descriptions.

```
proc options short;
run;
```

Log

Example Code 42.10 *Partial Listing of the SHORT Option*

```
6    proc options short;
7    run;
    SAS (r) Proprietary Software Release 9.4  TS1M6

Portable Options:

 NOACCESSIBLECHECK NOACCESSIBLEGRAPH NOACCESSIBLEPDF NOACCESSIBLETABLE ANIMATION=STOP
ANIMDURATION=MIN ANIMLOOP=YES ANIMOVERLAY APPEND=
APPLETLOC=//bb03smb01/sasgen/dev/mva-v940m6/avdobj/jar/wx6no ARMAGENT= ARMLOC=ARMLOG.LOG
ARMSUBSYS=(ARM_NONE) AUTOCORRECT AUTOEXEC= AUTOSAVELOC= NOAUTOSIGNON BINDING=DEFAULT BOMFILE
BOTTOMMARGIN=0.000 IN BUFNO=1 BUFSIZE=0 BYERR BYLINE BYSORTED NOCAPS NOCARDIMAGE CASAUTHINFO=
CASDATALIMIT=100M CASHOST= CASLIB= CASNCHARMULTIPLIER=1 CASNWORKERS=ALL CASPORT=0 CASSESSOPTS=
CASTIMEOUT=60 CASUSER= CATCACHE=0 CBUFNO=0 CENTER CGOPTIMIZE=3 NOCHARCODE NOCHKPTCLEAN CLEANUP
NOCMDMAC CMPLIB= CMPMODEL=BOTH CMPOPT=(NOEXTRAMATH NOMISSCHECK NOPRECISE NOGUARDCHECK
NOGENSYMNAMES NOFUNCDIFFERENCING SHORTCIRCUIT NOPROFILE) NOCOLLATE COLOPHON= COLORPRINTING
```

Example 2: Displaying the Setting of a Single Option

Features: PROC OPTIONS statement option
- OPTION=
- DEFINE
- LOGNUMBERFORMAT
- VALUE

Details

This example shows how to display the setting of a single SAS system option. The log shows the current setting of the SAS system option MEMBLKSZ. The DEFINE and VALUE options display additional information. The LOGNUMBERFORMAT displays the value using commas.

Program

Specify the MEMBLKSZ SAS system option. OPTION=MEMBLKSZ displays option value information. DEFINE and VALUE display additional information. LOGNUMBERFORMAT specifies to format the value using commas.

```
proc options option=memblksz define value lognumberformat;
```

```
run;
```

Log

Example Code 42.11 *Log Output from Specifying the MEMBLKSZ Option*

```
13   proc options option=memblksz define value lognumberformat;
14   run;

    SAS (r) Proprietary Software Release 9.4 TS1M6

Option Value Information For SAS Option MEMBLKSZ
    Value: 16,777,216
    Scope: Default
    How option value set: Shipped Default


Option Definition Information for SAS Option MEMBLKSZ
    Group= MEMORY
    Group Description: Memory settings
    Description: Specifies the memory block size for Windows memory-based libraries.
    Type: The option value is of type INTMAX
          Range of Values: The minimum is 0 and the maximum is 9223372036854775807
          Valid Syntax(any casing): MIN|MAX|n|nK|nM|nG|nT|hexadecimal
    Numeric Format: Usage of LOGNUMBERFORMAT impacts the value format
    When Can Set: Session startup (command line or config) only
    Restricted: Your Site Administrator can restrict modification of this option
    Optsave: PROC Optsave or command Dmoptsave will not save this option
```

Example 3: Displaying Expanded Path Environment Variables

Features: PROC OPTIONS statement options
- OPTION=
- EXPAND
- NOEXPAND
- HOST

Details

This example shows the value of an environment variable when the path is displayed.

Program

Show the value of the environment variables: The EXPAND option causes the values of environment variables to display in place of the environment variable. The NOEXPAND option causes the environment variable to display. In this example, the environment variable is !sasroot

```
proc options option=msg expand;
run;
proc options option=msg noexpand;
run;
```

Log

Example Code 42.12 *Displaying an Expanded and Nonexpanded Pathname Using the OPTIONS Procedure*

```
6    proc options option=msg expand;
7    run;
    SAS (r) Proprietary Software Release 9.4  TS1M6

 MSG=( 'C:\Program Files\SASHome\SASFoundation\9.4\sasmsg' )
                  The path to the sasmsg directory
NOTE: PROCEDURE OPTIONS used (Total process time):
      real time           0.01 seconds
      cpu time            0.00 seconds

8    proc options option=msg noexpand;
9    run;
    SAS (r) Proprietary Software Release 9.4  TS1M6
0

 MSG=( '!sasroot\sasmsg')
                  The path to the sasmsg directory
```

Example 4: List the Options That Can Be Specified by the INSERT and APPEND Options

Features: PROC OPTIONS statement option
LISTINSERTAPPEND

Details

This example shows how to display the options that can be specified by the INSERT and APPEND system options.

Program

List all options that can be specified by the INSERT and APPEND options in SAS 9.4. The LISTINSERTAPPEND option provides a list and a description of these options.

```
proc options listinsertappend;
run;
```

Log

Example Code 42.13 *Displaying the Options That Can Be Specified by the INSERT and APPEND Options*

```
9    proc options listinsertappend;
10   run;

     SAS (r) Proprietary Software Release 9.4   TS1M6
p

     Core options that can utilize INSERT and APPEND

      AUTOEXEC           Specifies the location of the SAS AUTOEXEC files.
      CMPLIB             Specifies one or more SAS data sets that contain compiler subroutines to
                         include during compilation.
      FMTSEARCH          Specifies the order in which format catalogs are searched.
      MAPS               Specifies the location of SAS/GRAPH map data sets
      MAPSGFK            Specifies the location of GfK maps.
.
      SASAUTOS           Specifies the location of one or more autocall libraries.
      SASHELP            Specifies the location of the Sashelp library.
      SASSCRIPT          Specifies one or more locations of SAS/CONNECT server sign-on script
                         files.

     Host options that can utilize INSERT and APPEND

      HELPLOC            Specifies the location of the text and index files for the facility that
                         is used to view the online SAS Help and Documentation.
      MSG                Specifies the path to the library that contains SAS error messages.
      SET                Defines a SAS environment variable.
```

43

OPTLOAD Procedure

Overview: OPTLOAD Procedure

What Does the OPTLOAD Procedure Do?

The OPTLOAD procedure reads SAS system option settings that are stored in the SAS registry or a SAS data set and puts them into effect.

You can load SAS system option settings from a SAS data set or registry key by using one of these methods:

- the DMOPTLOAD command from a command line in the SAS windowing environment. For example, the command loads system options from the registry: DMOPTLOAD key= “core\options”.
- the PROC OPTLOAD statement.

When an option is restricted by the site administrator, and the option value that is being set by PROC OPTLOAD differs from the option value that was established by the site administrator, SAS issues a warning message to the log.

Syntax: OPTLOAD Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

PROC OPTLOAD <*options*>;

Statement	Task	Example
PROC OPTLOAD	Use SAS system option settings that are stored in the SAS registry or in a SAS data set	Ex. 1

PROC OPTLOAD Statement

Loads saved setting of SAS system options that are stored in the SAS registry or in a SAS data set.

Syntax

PROC OPTLOAD <*options*>;

Summary of Optional Arguments

DATA=*libref.dataset*
: Load SAS system option settings from an existing data set.

KEY="*SAS registry key*"
: Load SAS system option settings from an existing registry key.

Optional Arguments

DATA=*libref.dataset*
specifies the library and data set name from where SAS system option settings are loaded. The SAS variable OPTNAME contains the character value of the SAS system option name, and the SAS variable OPTVALUE contains the character value of the SAS system option setting.

Default: If you omit the DATA= option and the KEY= option, the procedure will use the default SAS library and data set. The default library is where the current user profile resides. Unless you specify a library,

the default library is SASUSER. If SASUSER is being used by another active SAS session, then the temporary WORK library is the default location from which the data set is loaded. The default data set name is MYOPTS.

Requirement The SAS library and data set must exist.

KEY="*SAS registry key*"
specifies the location in the SAS registry of stored SAS system option settings. The registry is retained in SASUSER. If SASUSER is not available, then the temporary WORK library is used. For example, KEY="OPTIONS" loads system options from the OPTIONS registry key.

Requirements "*SAS registry key*" must be an existing SAS registry key.

You must use quotation marks around the "*SAS registry key*" name. Separate the names in a sequence of key names with a backslash (\). For example, KEY="CORE\OPTIONS" loads system options from the CORE\OPTIONS registry key.

Example: Load a Data Set of Saved System Options

Features: PROC OPTLOAD statement option
DATA=

Details

This example saves the current system option settings using the OPTSAVE procedure, modifies the YEARCUTOFF system option, and then loads the original set of system options.

Program

```
libname mysas "c:\mysas";

proc options option=yearcutoff;
run;

proc optsave out=mysas.options;
run;
```

```
options yearcutoff=2000;

proc options option=yearcutoff;
run;

proc optload data=mysas.options;
run;


proc options option=yearcutoff;
run;
```

Program Description

These statements and procedures were submitted one at a time and not run as a SAS program to allow the display of the YEARCUTOFF option.

Assign the libref.

```
libname mysas "c:\mysas";
```

Display the value of the YEARCUTOFF= system option.

```
proc options option=yearcutoff;
run;
```

Save the current system option settings in mysas.options.

```
proc optsave out=mysas.options;
run;
```

Use the OPTIONS statement to set the YEARCUTOFF= system option to the value 2000.

```
options yearcutoff=2000;
```

Display the value of the YEARCUTOFF= system option.

```
proc options option=yearcutoff;
run;
```

Load the saved system option settings.

```
proc optload data=mysas.options;
run;
```

Display the value of the YEARCUTOFF= system option. After loading the saved system option settings, the value of the YEARCUTOFF= option has been restored to the original value.

```
proc options option=yearcutoff;
run;
```

Log

Example Code 43.1 *The SAS Log Shows the YEARCUTOFF= Value After Loading Options Using PROC OPTLOAD*

```
1    libname mysas "c:\mysas";
NOTE: Libref MYSAS was successfully assigned as follows:
      Engine:        V9
      Physical Name: c:\mysas

2    proc options option=yearcutoff;
3    run;

    SAS (r) Proprietary Software Release 9.4  TS1M6

 YEARCUTOFF=1926   Specifies the first year of a 100-year span that is used by date
informats
                   and functions to read a two-digit year.

NOTE: PROCEDURE OPTIONS used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


4    proc optsave out=mysas.options;
5    run;

NOTE: The data set MYSAS.OPTIONS has 259 observations and 2 variables.
NOTE: PROCEDURE OPTSAVE used (Total process time):
      real time           0.03 seconds
      cpu time            0.03 seconds

6    options yearcutoff=2000;

7    proc options option=yearcutoff;
8    run;

    SAS (r) Proprietary Software Release 9.4  TS1M6

 YEARCUTOFF=2000   Specifies the first year of a 100-year span that is used by date
informats
                   and functions to read a two-digit year.

NOTE: PROCEDURE OPTIONS used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


9    proc optload data=mysas.options;
10   run;

NOTE: PROCEDURE OPTLOAD used (Total process time):
      real time           0.06 seconds
      cpu time            0.01 seconds
```

```
11   proc options option=yearcutoff;
12   run;

    SAS (r) Proprietary Software Release 9.4  TS1M6

 YEARCUTOFF=1926   Specifies the first year of a 100-year span that is used by date
informats
                   and functions to read a two-digit year.

NOTE: PROCEDURE OPTIONS used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds
```

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OPTSAVE Procedure

Overview: OPTSAVE Procedure

What Does the OPTSAVE Procedure Do?

PROC OPTSAVE saves the current SAS system option settings in the SAS registry or in a SAS data set.

SAS system options can be saved across SAS sessions. You can save the settings of the SAS system options in a SAS data set or registry key by using one of these methods:

- the DMOPTSAVE command from a command line in the SAS windowing environment. Use the command like this: DMOPTSAVE <*save-location*>.
- the PROC OPTSAVE statement.

Syntax: OPTSAVE Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

PROC OPTSAVE <*options* >;

Statement	Task	Example
PROC OPTSAVE	Save the current SAS system option settings to the SAS registry or to a SAS data set	Ex. 1

PROC OPTSAVE Statement

Saves the current SAS system option settings in the SAS registry or in a SAS data set.

Syntax

PROC OPTSAVE <*options* >;

Summary of Optional Arguments

KEY="*SAS registry key*"
: Save SAS system option settings to a registry key.

OUT=*libref.dataset*
: Save SAS system option settings to a SAS data set.

Optional Arguments

KEY="*SAS registry key*"
specifies the location in the SAS registry of stored SAS system option settings. The registry is retained in SASUSER. If SASUSER is not available, then the temporary WORK library is used. For example, KEY="OPTIONS" saves the system options in the OPTIONS registry key.

Restriction "*SAS registry key*" names cannot span multiple lines.

Requirements Separate the names in a sequence of key names with a backslash (\). Individual key names can contain any character except a backslash.

The length of a key name cannot exceed 255 characters (including the backslashes).

You must use quotation marks around the "*SAS registry key*" name.

Tip To specify a subkey, enter multiple key names starting with the root key.

CAUTION **If the key already exists, it will be overwritten.** If the specified key does not already exist in the current SAS registry, then the key is automatically created when option settings are saved in the SAS registry.

OUT=*libref.dataset*
specifies the names of the library and data set where SAS system option settings are saved. The SAS variable OPTNAME contains the character value of the SAS system option name. The SAS variable OPTVALUE contains the character value of the SAS system option setting.

Default If you omit the OUT= and the KEY= options, the procedure will use the default SAS library and data set. The default SAS library is where the current user profile resides. Unless you specify a SAS library, the default library is SASUSER. If SASUSER is in use by another active SAS session, then the temporary WORK library is the default location where the data set is saved. The default data set name is MYOPTS.

CAUTION **If the data set already exists, it will be overwritten.**

Usage: OPTSAVE Procedure

Determine If a Single Option Can Be Saved

You can specify DEFINE in the OPTIONS procedure to determine whether an option can be saved. In the log output, the line beginning with **Optsave:** indicates whether the option can be saved.

```
proc options option=pageno define;
run;
```

Example Code 44.1 *The SAS Log Displaying Output for the Option Procedure DEFINE Option*

```
8    proc options option=pageno define;
9    run;

    SAS (r) Proprietary Software Release 9.4  TS1M6

 PAGENO=1
Option Definition Information for SAS Option PAGENO
    Group= LISTCONTROL
    Group Description: Procedure output and display settings
    Description: Resets the SAS output page number.
    Type: The option value is of type LONG
          Range of Values: The minimum is 1 and the maximum is 2147483647
          Valid Syntax(any casing): MIN|MAX|n|nK|nM|nG|nT|hexadecimal
    Numeric Format: Usage of LOGNUMBERFORMAT impacts the value format
    When Can Set: Startup or anytime during the SAS Session
    Restricted: Your Site Administrator can restrict modification of this option
    Optsave: PROC Optsave or command Dmoptsave will save this option
```

Create a List of Options That Can Be Saved

Some system options cannot be saved. To create a list of options that can be saved, submit this SAS code:

```
proc options listoptsave;
run;
```

Note: PROC OPTSAVE does not save these types of system options:

- SAS invocation options
- SAS environment variable options
- SAS system options that include passwords
- SAS system options that are read-only and cannot be set

Here is a partial listing of options that can be saved:

Example Code 44.2 *A Partial Listing of Options That Can Be Saved*

```
51   proc options listoptsave;
52   run;

    SAS (r) Proprietary Software Release 9.4  TS1M6


    Core options that can be saved with OPTSAVE

     ACCESSIBLECHECK    Detect and log ODS output that is not accessible.
     ACCESSIBLEGRAPH    Create accessible ODS graphics by default.
     ACCESSIBLEPDF      Create accessible PDF files by default.
     ACCESSIBLETABLE    Create accessible tables for enabled procedures, by default.
     ANIMATION          Specifies whether to start or stop animation.
     ANIMDURATION       Specifies the number of seconds that each animation frame
displays.
     ANIMLOOP           Specifies the number of iterations that animated images
repeat.
     ANIMOVERLAY        Specifies that animation frames are overlaid in order to
view all frames.
     APPLETLOC          Specifies the location of Java applets, which is typically a
URL.
     AUTOCORRECT        Automatically corrects misspelled procedure names and
keywords, and
                        global statement names.
     AUTOSAVELOC        Specifies the location of the Program Editor auto-saved file.
     AUTOSIGNON         Enables a SAS/CONNECT client to automatically submit the
SIGNON command
                        remotely with the RSUBMIT command.
     BINDING            Specifies the binding edge type of duplexed printed output.
     BOMFILE            Writes the byte order mark (BOM) prefix when a Unicode-
encoded file is
                        written to an external file.
     BOTTOMMARGIN       Specifies the size of the margin at the bottom of a printed
page.
     BUFNO              Specifies the number of buffers for processing SAS data sets.
     BUFSIZE            Specifies the size of a buffer page for output SAS data sets.
     BYERR              SAS issues an error message and stops processing if the SORT
procedure
                        attempts to sort a _NULL_ data set.
     BYLINE             Prints the BY line above each BY group.
     BYSORTED           Requires observations in one or more data sets to be sorted
in
                        alphabetic or numeric order.
     CAPS               Converts certain types of input, and all data lines, into
uppercase
                        characters.
     CARDIMAGE          Processes SAS source code and data lines as 80-byte records.
     CBUFNO             Specifies the number of extra page buffers to allocate for
each open SAS
                        catalog.
     CENTER             Center SAS procedure output.
```

Example: Saving System Options in a Data Set

Features: PROC OPTSAVE statement option
OUT=

Details

This example saves the current system option settings using the OPTSAVE procedure.

Program

```
libname mysas "c:\mysas";

proc optsave out=mysas.options;
run;
```

Program Description

Create a libref.

```
libname mysas "c:\mysas";
```

Save the current system option settings.

```
proc optsave out=mysas.options;
run;
```

Log

Example Code 44.3 *The SAS Log Shows Processing of PROC OPTSAVE*

```
1    libname mysas "c:\mysas";
NOTE: Libref MYSAS was successfully assigned as follows:
      Engine:        V9
      Physical Name: c:\mysas

2    proc optsave out=mysas.options;
3    run;

NOTE: The data set MYSAS.OPTIONS has 289 observations and 2 variables.
NOTE: PROCEDURE OPTSAVE used (Total process time):
      real time           0.03 seconds
      cpu time            0.03 seconds
```

45

PLOT Procedure

Overview: PLOT Procedure

What Does the PLOT Procedure Do?

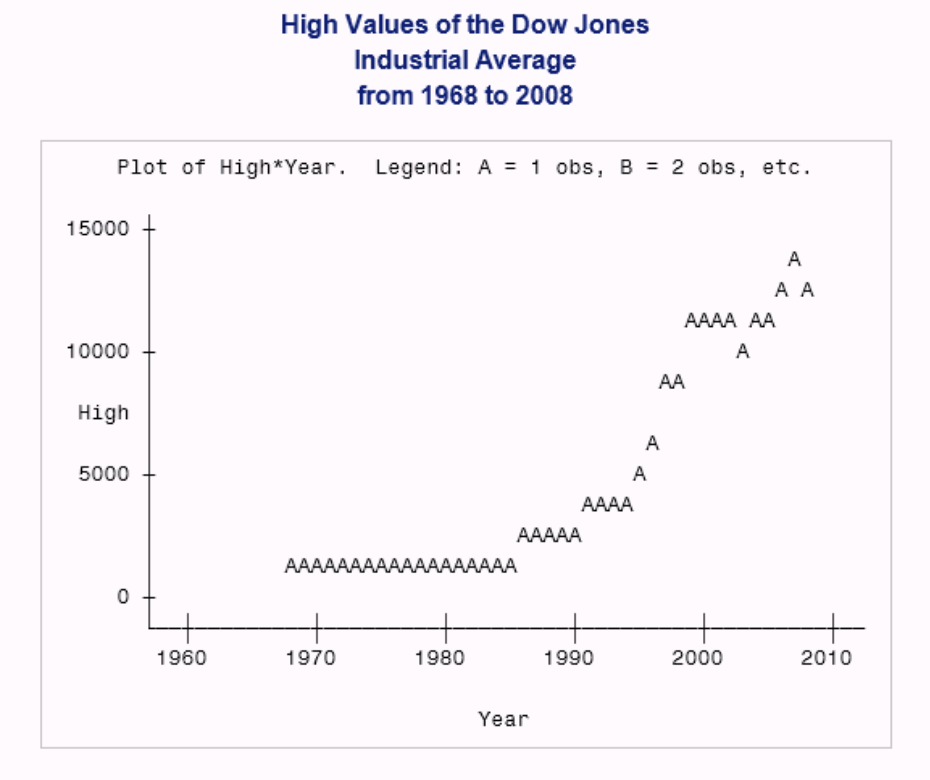
The PLOT procedure plots the values of two variables for each observation in an input SAS data set. The coordinates of each point on the plot correspond to the two variables' values in one or more observations of the input data set.

The following output is a simple plot of the high values of the Dow Jones Industrial Average between 1968 and 2008. PROC PLOT determines the plotting symbol and the scales for the axes. Here are the statements that produce the output:

```
options nodate pageno=1 linesize=64
   pagesize=25;

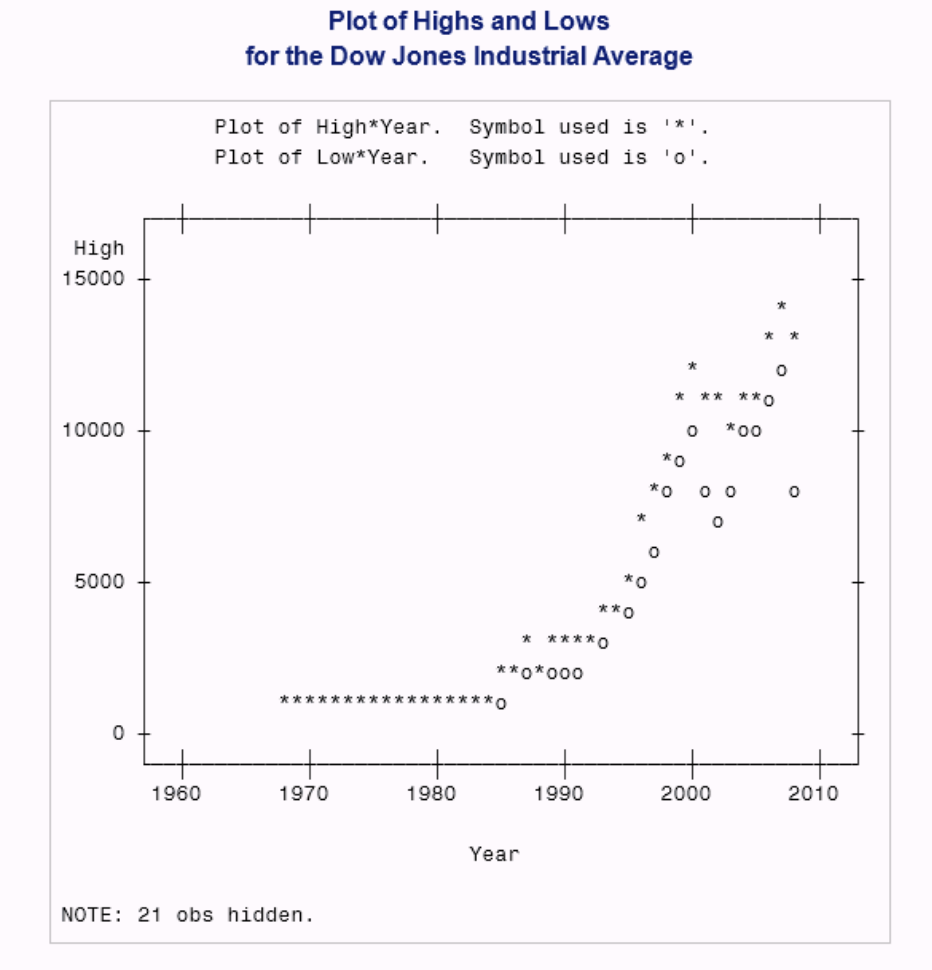
proc plot data=djia;
   plot high*year;
   title 'High Values of the Dow Jones';
   title2 'Industrial Average';
   title3 'from 1968 to 2008';
run;
```

Output 45.1 *A Simple Plot*



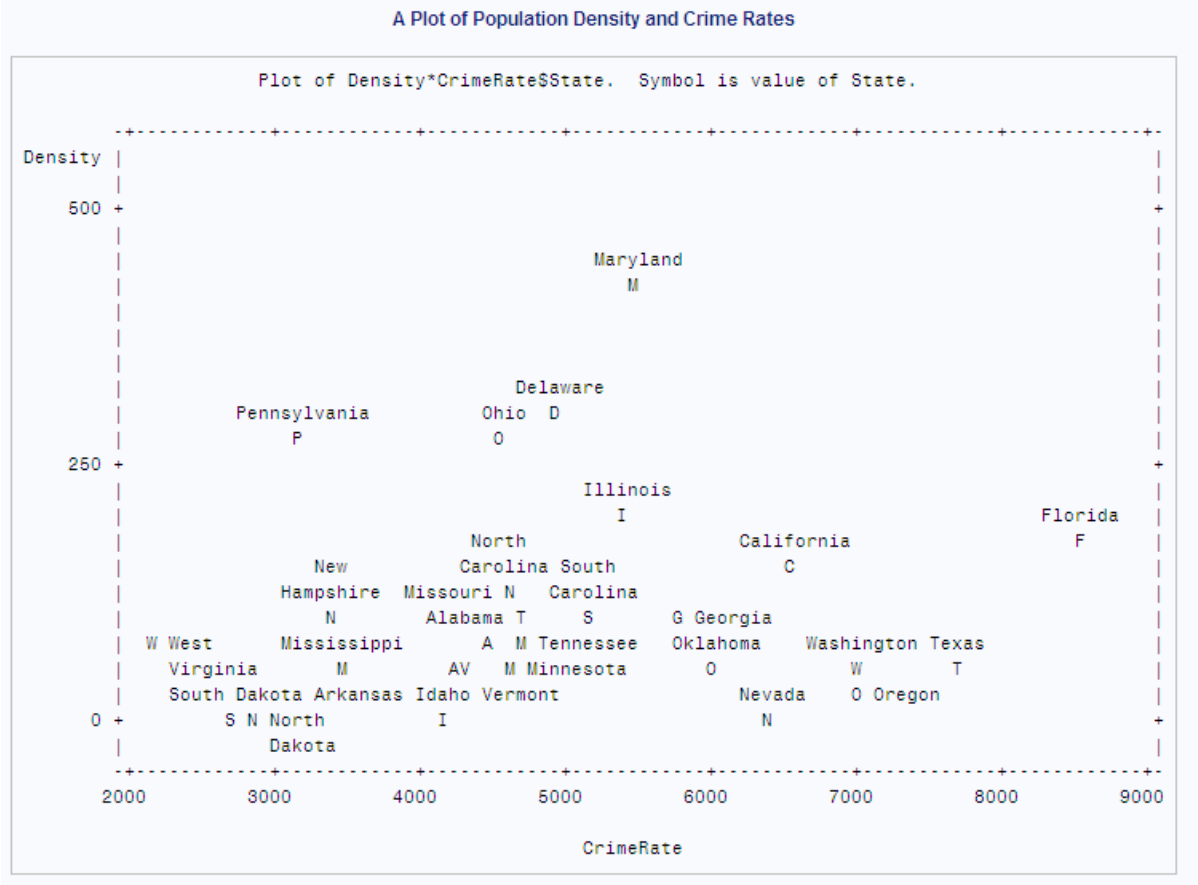
You can also overlay two plots, as shown in the following output. One plot shows the high values of the DJIA data set; the other plot shows the low values. The plot also shows that you can specify plotting symbols and put a box around a plot. The statements that produce the following output are shown in "Example 3: Overlaying Two Plots" on page 1655.

Output 45.2 *Plotting Two Sets of Values at Once*



PROC PLOT can also label points on a plot with the values of a variable, as shown in the following output. The plotted data represents population density and crime rates for selected U.S. states.The SAS code that produces the following output is shown in "Example 11: Adjusting Labels on a Plot with the PLACEMENT= Option" on page 1679.

Output 45.3 *Labeling Points on a Plot*



Concepts: PLOT Procedure

RUN Groups

PROC PLOT is an interactive procedure. It remains active after a RUN statement is executed. Usually, SAS terminates a procedure after executing a RUN statement. When you start the PLOT procedure, you can continue to submit any valid statements without resubmitting the PROC PLOT statement. Thus, you can easily experiment with changing labels, values of tick marks, and so on. Any options submitted in the PROC PLOT statement remain in effect until you submit another PROC PLOT statement.

When you submit a RUN statement, PROC PLOT executes all the statements submitted since the last PROC PLOT or RUN statement. Each group of statements

is called a *RUN group*. With each RUN group, PROC PLOT begins a new page and begins with the first item in the VPERCENT= and HPERCENT= lists, if any.

To terminate the procedure, submit a QUIT statement, a DATA statement, or a PROC statement. Like the RUN statement, each of these statements completes a RUN group. If you do not want to execute the statements in the RUN group, then use the RUN CANCEL statement, which terminates the procedure immediately.

You can use the BY statement interactively. The BY statement remains in effect until you submit another BY statement or terminate the procedure.

See "Example 11: Adjusting Labels on a Plot with the PLACEMENT= Option" on page 1679 for an example of using RUN-group processing with PROC PLOT.

Labels and Plot Points

Pointer Symbols

Pointer symbols associate a point with its label by pointing in the general direction of the label placement. When you use a label variable and do not specify a plotting symbol or if the variable value is null ('00'x), PROC PLOT uses pointer symbols as plotting symbols. PROC PLOT uses four different pointer symbols based on the value of the S= and V= suboptions in the PLACEMENT= option. The table below shows the pointer symbols:

Table 45.1 *Pointer Symbols*

S=	V=	Symbol
LEFT	any	<
RIGHT	any	>
CENTER	>0	∘
CENTER	<=0	v

If you are using pointer symbols and multiple points coincide, then PROC PLOT uses the number of points, 2-9, as the plotting symbol. If the number of points is more than 9, then the procedure uses an asterisk (*).

Note: Because of character set differences among operating environments, the pointer symbol for S=CENTER and V>0 might differ from the one shown here.

Understanding Penalties

PROC PLOT assesses the quality of placements with penalties. If all labels are plotted with zero penalty, then no labels collide and all labels are near their symbols. When it is not possible to place all labels with zero penalty, PROC PLOT tries to minimize the total penalty.

The following table lists the penalty, its default value, the index used to reference the penalty, and the range of values that can be assigned to the penalty. Each penalty is described in more detail in Table 45.85 on page 1624.

Table 45.2 *Penalties Table*

Penalty	Default Penalty	Index	Range
Not placing a blank	1	1	0-500
Bad split, no split character specified	1	2	0-500
Bad split with split character	50	3	0-500
Free horizontal shift, *fhs*	2	4	0-500
Free vertical shift, *fvs*	1	5	0-500
Vertical shift weight, *vsw*	2	6	0-500
Vertical or horizontal shift denominator, *vhsd*	5	7	1-500
Collision state	500	8	0-10,000
(Reserved for future use)		9-14	
Not placing the first character	11	15	0-500
Not placing the second character	10	16	0-500
Not placing the third character	8	17	0-500
Not placing the fourth character	5	18	0-500
Not placing the fifth through 200th character	2	19-214	0-500

The following table contains the index values from the previous table with a description of the corresponding penalty.

Table 45.3 *Index Values for Penalties*

1	A nonblank character in the plot collides with an embedded blank in a label, or there is not a blank or a plot boundary before or after each label fragment.
2	A split occurs on a nonblank or nonpunctuation character when you do not specify a split character.
3	A label is placed with a different number of lines than the L= suboption specifies, when you specify a split character.
4-7	A label is placed far away from the corresponding point. PROC PLOT calculates the penalty according to this (integer arithmetic) formula: $[\mathrm{MAX}(\lvert H\rvert - fhs, 0) + vsw \times \mathrm{MAX}(\lvert V\rvert - (L+fvs+(V > 0))/2, 0)]/vhsd$ Notice that penalties 4 through 7 are actually just components of the formula used to determine the penalty. Changing the penalty for a free horizontal or free vertical shift to a large value such as 500 removes any penalty for a large horizontal or vertical shift. "Example 6: Plotting Date Values on an Axis" on page 1662 illustrates a case in which removing the horizontal shift penalty is useful.
8	A label might collide with its own plotting symbol. If the plotting symbol is blank, then a collision state cannot occur. See "Collision States" on page 1625 for more information.
15-214	A label character does not appear in the plot. By default, the penalty for not printing the first character is greater than the penalty for not printing the second character, and so on. By default, the penalty for not printing the fifth and subsequent characters is the same.

Note: Labels can share characters without penalty.

Changing Penalties

You can change the default penalties with the PENALTIES= option in the PLOT statement. Because PROC PLOT considers penalties when it places labels, changing the default penalties can change the placement of the labels.

For example, if you have labels that all begin with the same two-letters, then you can increase the default penalty for not printing the third, fourth, and fifth characters and decrease the penalty for not printing the first and second characters. See "Using the PENALTIES= Option" on page 1648 for an example of how to use the PENALTIES= option.

Collision States

Collision states are placement states that can cause a label to collide with its own plotting symbol. PROC PLOT usually avoids using collision states because of the large default penalty of 500 that is associated with them. PROC PLOT does not consider the actual length or splitting of any particular label when determining if a placement state is a collision state.

Here are the rules that PROC PLOT uses to determine collision states:

- When S=CENTER, placement states that do not shift the label up or down sufficiently so that all of the label is shifted onto completely different lines from the symbol are collision states.
- When S=RIGHT, placement states that shift the label zero or more positions to the left without first shifting the label up or down onto completely different lines from the symbol are collision states.
- When S=LEFT, placement states that shift the label zero or more positions to the right without first shifting the label up or down onto completely different lines from the symbol are collision states.

Note: A collision state cannot occur if you do not use a plotting symbol.

Reference Lines

PROC PLOT places labels and computes penalties before placing reference lines on a plot. The procedure does not attempt to avoid rows and columns that contain reference lines.

Hidden Label Characters

In addition to the number of hidden observations and hidden plotting symbols, PROC PLOT prints the number of hidden label characters. Label characters can be hidden by plotting symbols or other label characters.

Overlaid Label Plots

When you overlay a label plot and a nonlabel plot, PROC PLOT tries to avoid collisions between the labels and the characters of the nonlabel plot. When a label character collides with a character in a nonlabel plot, PROC PLOT adds the usual penalty to the penalty sum.

When you overlay two or more label plots, all label plots are treated as a single plot in avoiding collisions and computing hidden character counts. Labels of different plots never overprint, even with the OVP system option in effect.

Computational Resources Used for Label Plots

This section uses the following variables to discuss how much time and memory PROC PLOT uses to construct label plots:

n
number of points with labels.

len
constant length of labels.

s
number of label pieces, or fragments.

p
number of placement states specified in the PLACE= option.

Time

For a given plot size, the time that is required to construct the plot is approximately proportional to $n \times len$. The amount of time required to split the labels is approximately proportional to ns^2 . Generally, the more placement states that you specify, the more time that PROC PLOT needs to place the labels. However, increasing the number of horizontal and vertical shifts gives PROC PLOT more flexibility to avoid collisions, often resulting in less time used to place labels.

Memory

PROC PLOT uses 24*p* bytes of memory for the internal placement state list. PROC PLOT uses $n(84 + 5len + 4s(1 + 1.5(s + 1)))$ bytes for the internal list of labels. PROC PLOT builds all plots in memory; each printing position uses one byte of memory.

If you run out of memory, then request fewer plots in each PLOT statement and put a RUN statement after each PLOT statement.

Syntax: PLOT Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Requirement: At least one PLOT statement is required.

Tips: PROC PLOT supports RUN-group processing.

You can use the ATTRIB, FORMAT, LABEL, and WHERE statements with PROC PLOT.

PROC PLOT<*options*>;

BY<DESCENDING>*variable-1*<<DESCENDING>*variable-2*...><NOTSORTED>;

PLOT*plot-request(s)*</ *options*>;

Statement	Task	Example
PROC PLOT	Request the plots be produced	Ex. 10
BY	Produce a separate plot for each BY group	Ex. 8
PLOT	Describe the plots that you want	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 8, Ex. 9, Ex. 11, Ex. 12, Ex. 13

PROC PLOT Statement

Requests that the plots be produced.

Tip: You can use data set options with the DATA= option. *SAS Data Set Options: Reference*

Example: "Example 10: Excluding Observations That Have Missing Values" on page 1676

Syntax

PROC PLOT<*options*>;

Summary of Optional Arguments

DATA=<*SAS-data-set*>
specifies the input data set.

ENCRYPTKEY=<*key-value*>
specifies the key value needed for plotting an AES-encrypted data set.

Control the appearance of the plot

FORMCHAR <*(position(s))*>'*formatting-character(s)*'

specifies the characters that construct the borders of the plot.

NOLEGEND
suppresses the legend at the top of the plot.

VTOH=*aspect-ratio*
specifies the aspect ratio of the characters on the output device.

Control the axes

MISSING
includes missing character variable values.

NOMISS
excludes observations with missing values.

UNIFORM
uniformly scales axes across BY groups.

Control the size of the plot

HPERCENT=*percent(s)*
specifies the percentage of the available horizontal space for each plot.

VPERCENT=*percent(s)*
specifies the percentage of the available vertical space for each plot.

Optional Arguments

DATA=<*SAS-data-set*>
specifies the input data set. specifies the input SAS data set.

ENCRYPTKEY=<*key-value*>
specifies the key value needed for plotting an AES-encrypted data set. specifies the key value needed for plotting an AES-encrypted data set. If the input data set was created with ENCRYPT=AES, then you must specify the ENCRYPTKEY= value to plot its data. For example, if a data set named secretPlot is created using the DATA statement

```
data secretPlot(encrypt=AES encryptkey=Ib007)
```

then you must specify the following PROC statement to plot the data in secretPlot:

```
proc plot data=secretPlot(encryptkey=Ib007);
```

See "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference* for more information about the ENCRYPTKEY= data set option.

FORMCHAR <*(position(s))*>'*formatting-character(s)*'
specifies the characters that construct the borders of the plot. defines the characters to use for constructing the borders of the plot.

position(s)
identifies the position of one or more characters in the SAS formatting-character string. A space or a comma separates the positions.

Default Omitting (*position(s)*) is the same as specifying all twenty possible SAS formatting characters, in order.

Range PROC PLOT uses formatting characters 1, 2, 3, 5, 7, 9, and 11. The following table shows the formatting characters that PROC PLOT uses.

Table 45.4 *Character Positions*

Position	Default	Used to Draw
1	|	Vertical separators
2	-	Horizontal separators
3 5 9 11	-	Corners
7	+	Intersection of vertical and horizontal separators

formatting-character(s)
lists the characters to use for the specified positions. PROC PLOT assigns characters in *formatting-character(s)* to *position(s)*, in the order in which they are listed. For example, the following option assigns the asterisk (*) to the third formatting character, the number sign (#) to the seventh character, and does not alter the remaining characters: `formchar(3,7)='*#'`

Interaction The SAS system option FORMCHAR= specifies the default formatting characters. The system option defines the entire string of formatting characters. The FORMCHAR= option in a procedure can redefine selected characters.

Tips You can use any character in *formatting-characters*, including hexadecimal characters. If you use hexadecimal characters, then you must put `x` after the closing quotation mark. For example, the following option assigns the hexadecimal character 2-D to the third formatting character, the hexadecimal character 7C to the seventh character, and does not alter the remaining characters: `formchar(3,7)='2D7C'x`

Specifying all blanks for *formatting-character(s)* produces plots with no borders. For example, the following code specifies all blanks: `formchar (1,2,7)=''`.

HPERCENT=*percent(s)*
specifies the percentage of the available horizontal space for each plot. specifies one or more percentages of the available horizontal space to use for each plot. HPERCENT= enables you to put multiple plots on one page. PROC PLOT tries to fit as many plots as possible on a page. After using each of the *percent(s)*, PROC PLOT cycles back to the beginning of the list. A zero in the list forces PROC PLOT to go to a new page even if it could fit the next plot on the same page.

HPERCENT=33
prints three plots per page horizontally; each plot is one-third of a page wide.

HPERCENT=50 25 25
prints three plots per page; the first is twice as wide as the other two.

HPERCENT=33 0
produces plots that are one-third of a page wide; each plot is on a separate page.

HPERCENT=300
produces plots three pages wide.

At the beginning of every BY group and after each RUN statement, PROC PLOT returns to the beginning of the *percent(s)* and starts printing a new page.

Alias HPCT=

Default 100

Example "Example 4: Producing Multiple Plots per Page" on page 1658

MISSING
includes missing character variable values in the construction of the axes. It has no effect on numeric variables.

Interaction overrides the NOMISS option for character variables.

NOLEGEND
suppresses the legend at the top of each plot. The legend lists the names of the variables being plotted and the plotting symbols used in the plot.

NOMISS
excludes observations for which either variable is missing from the calculation of the axes. Normally, PROC PLOT draws an axis based on all the values of the variable being plotted, including points for which the other variable is missing.

Interactions The HAXIS= option overrides the effect of NOMISS on the horizontal axis. The VAXIS= option overrides the effect on the vertical axis.

NOMISS is overridden by MISSING for character variables.

Example "Example 10: Excluding Observations That Have Missing Values" on page 1676

UNIFORM
uniformly scales axes across BY groups. Uniform scaling enables you to directly compare the plots for different values of the BY variables.

Restriction You cannot use PROC PLOT with the UNIFORM option with an engine that supports concurrent access if another user is updating the data set at the same time.

VPERCENT=*percent(s)*
specifies one or more percentages of the available vertical space to use for each plot. If you use a percentage greater than 100, then PROC PLOT prints sections of the plot on successive pages.

Alias VPCT=

Default 100

See "HPERCENT=*percent(s)*" on page 1629

Example "Example 4: Producing Multiple Plots per Page" on page 1658

VTOH=*aspect-ratio*
specifies the aspect ratio (vertical to horizontal) of the characters on the output device. *aspect-ratio* is a positive real number. If you use the VTOH= option, then PROC PLOT spaces tick marks so that the distance between horizontal tick marks is nearly equal to the distance between vertical tick marks. For example, if characters are twice as high as they are wide, then specify VTOH=2.

Interaction VTOH= has no effect if you use the HSPACE= and VSPACE= options in the PLOT statement.

Note The minimum value allowed is 0.

See "HAXIS=*axis-specification*" on page 1636 for a way to equate axes so that the given distance represents the same data range on both axes.

BY Statement

Produces a separate plot and starts a new page for each BY group.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

See: "BY" on page 74

Example: "Example 8: Plotting BY Groups" on page 1668

Syntax

BY<DESCENDING>*variable-1*<<DESCENDING>*variable-2*...><NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the

BY statement, then you must sort or index the data set by the values of the variables specified in the BY statement. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the observations are sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The data is grouped in another way, such as chronological order.

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

PLOT Statement

Requests the plots to be produced by PROC PLOT.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Tip: You can use multiple PLOT statements.

Examples:
"Example 1: Specifying a Plotting Symbol" on page 1650
"Example 2: Controlling the Horizontal Axis and Adding a Reference Line" on page 1653
"Example 3: Overlaying Two Plots" on page 1655
"Example 4: Producing Multiple Plots per Page" on page 1658
"Example 5: Plotting Data on a Logarithmic Scale" on page 1660
"Example 6: Plotting Date Values on an Axis" on page 1662
"Example 7: Producing a Contour Plot" on page 1665
"Example 8: Plotting BY Groups" on page 1668
"Example 9: Adding Labels to a Plot" on page 1672
"Example 11: Adjusting Labels on a Plot with the PLACEMENT= Option" on page 1679
"Example 12: Adjusting Labeling on a Plot with a Macro" on page 1684
"Example 13: Changing a Default Penalty" on page 1687

Syntax

PLOT*plot-request(s)*</ *options*>;

Summary of Optional Arguments

BOX
: puts a box around the plot.

OVERLAY
: overlays plots.

Control the axes

HAXIS=*axis-specification*
: specifies the tick-mark values for the horizontal axis.

HEXPAND
: expands the horizontal axis.

HPOS=*axis-length*
: specifies the number of print positions on the horizontal axis.

HREVERSE
: reverses the order of the values on the horizontal axis.

HSPACE=*n*
: specifies the distance between tick marks on the horizontal axis.

HZERO
: assigns a value of zero to the first tick mark on the horizontal axis.

VAXIS=*axis-specification*
: specifies the tick-mark values for the vertical axis.

VEXPAND
: expands the vertical axis.

VPOS=*axis-length*
: specifies the number of print positions on the vertical axis.

VREVERSE
: reverses the order of the values on the vertical axis.

VSPACE=*n*
: specifies the distance between tick marks on the vertical axis.

VZERO
: assigns a value of zero to the first tick mark on the vertical axis.

Label points on a plot

LIST<=*penalty-value*>
: lists the penalty and the placement state of the points.

OUTWARD='*character*'
: forces the labels away from the origin.

PENALTIES<(*index-list*)>=*penalty-list*
: changes default penalties.

PLACEMENT=(*expression(s)*)
: specifies locations for the placement of the labels.

SPLIT='*split-character*'
: specifies a split character for the label.

STATES
: lists all placement states in effect.

Produce a contour plot

CONTOUR<=*number-of-levels*>
: draws a contour plot.

Scontour-level='*character-list*'
: specifies the plotting symbol for one contour level.

Produce a countour plot

SLIST='*character-list-1*' <'*character-list-2 ...*'>
: specifies the plotting symbol for multiple contour levels.

Specify reference lines

HREF=*value-specification*
: draws a line perpendicular to the specified values on the horizontal axis.

HREFCHAR='*character*'
: specifies a character to use to draw the horizontal reference line.

VREF=*value-specification*
: draws a line perpendicular to the specified values on the vertical axis.

VREFCHAR='*character*'
: specifies a character to use to draw the vertical reference line.

Required Argument

plot-request(s)
specifies the variables (vertical and horizontal) to plot and the plotting symbol to use to mark the points on the plot.

Each form of *plot-request(s)* supports a label variable. A label variable is preceded by a dollar sign ($) and specifies a variable whose values label the points on the plot.

```
plot y*x $ label-variable
```

```
plot y*x='*' $ label-variable
```

For more information, see "Labels and Plot Points" on page 1622. In addition, see "Example 9: Adding Labels to a Plot" on page 1672 and all the examples that follow it.

The *plot-request(s)* can be one or more of the following:

vertical*horizontal <$ label-variable>
specifies the variable to plot on the vertical axis and the variable to plot on the horizontal axis.

For example, the following statement requests a plot of Y by X:

```
plot y*x;
```

Y appears on the vertical axis, X on the horizontal axis.

This form of the plot request uses the default method of choosing a plotting symbol to mark plot points. When a point on the plot represents the values of one observation in the data set, PROC PLOT puts the character A at that point. When a point represents the values of two observations, the character B appears. When a point represents values of three observations, the character C appears, and so on, through the alphabet. The character Z is used for the occurrence of 26 or more observations at the same printing position.

vertical*horizontal='character' **<$** ***label-variable>***
specifies the variables to plot on the vertical and horizontal axes and specifies a plotting symbol to mark each point on the plot. A single character is used to represent values from one or more observations.

For example, the following statement requests a plot of Y by X, with each point on the plot represented by a plus sign (+):

```
plot y*x='+';
```

vertical*horizontal=variable **<$** ***label-variable>***
specifies the variables to plot on the vertical and horizontal axes and specifies a variable whose values are to mark each point on the plot. The variable can be either numeric or character. The first (left-most) nonblank character in the formatted value of the variable is used as the plotting symbol (even if more than one value starts with the same letter). When more than one observation maps to the same plotting position, the value from the first observation marks the point. For example, in the following statement GENDER is a character variable with values of `FEMALE` and `MALE`; the values `F` and `M` mark each observation on the plot.

```
plot height*weight=gender;
```

See "Specifying Variable Lists in Plot Requests" on page 1647 and "Specifying Combinations of Variables" on page 1647

Optional Arguments

BOX
draws a border around the entire plot, rather than just on the left side and bottom.

Example "Example 3: Overlaying Two Plots" on page 1655

CONTOUR<=*number-of-levels*>
draws a contour plot using plotting symbols with varying degrees of shading where *number-of-levels* is the number of levels for dividing the range of *variable*. The plot request must be of the form *vertical*horizontal=variable* where *variable* is a numeric variable in the data set. The intensity of shading is determined by the values of this variable.

When you use CONTOUR, PROC PLOT does not plot observations with missing values for *variable*.

Overprinting, if it is enabled by the OVP system option, is used to produce the shading. Otherwise, single characters varying in darkness are used. The CONTOUR option is most effective when the plot is dense.

Default 10

Range 1-10

Example "Example 7: Producing a Contour Plot" on page 1665

HAXIS=*axis-specification*

specifies the tick-mark values for the horizontal axis.

n< ... *n*>

BY *increment*

n TO *n* BY *increment*

- For numeric values, *axis-specification* is either an explicit list of values, a BY increment, or a combination of both:

  The values must be in either ascending or descending order. Use a negative value for *increment* to specify descending order. The specified values are spaced evenly along the horizontal axis even if the values are not uniformly distributed. Numeric values can be specified in the following ways:

Table 45.5 *Specifying Numeric HAXIS= Values*

HAXIS= value	Comments
`10 to 100 by 5`	Values appear in increments of 5, starting at 10 and ending at 100.
`by 5`	Values are incremented by 5. PROC PLOT determines the minimum and maximum values for the tick marks.
`10 100 1000 10000`	Values are not uniformly distributed. This specification produces a logarithmic plot. If PROC PLOT cannot determine the function implied by the axis specification, it uses simple linear interpolation between the points. To determine whether PROC PLOT correctly interpolates a function, you can use the DATA step to generate data that determines the function and see whether it appears linear when plotted. See "Example 5: Plotting Data on a Logarithmic Scale" on page 1660 for an example.
`1 2 10 to 100 by 5`	A combination of the previous specifications.

- *For character variables*, *axis-specification* is a list of unique values that are enclosed in quotation marks:

'value-1' <...*'value-n'*>

For example, the following statement assigns three cities to represent the tick-mark values for the horizontal axis:

```
haxis='Paris' 'London' 'Tokyo'
```

The character strings are case sensitive. If a character variable has an associated format, then *axis-specification* must specify the formatted value. The values can appear in any order.

- *For axis variables that contain date-time values*, *axis-specification* is either an explicit list of values or a starting value and an ending value with an increment specified:

'date-time-value'i<...*'date-time-value'i*>

'date-time-value'i TO <...*'date-time-value'i*><BY *increment*>

'date-time-value'i
any SAS date, time, or datetime value described for the SAS functions INTCK and INTNX. The suffix *i* is one of the following:

D
date

T
time

DT
datetime

increment
one of the valid arguments for the INTCK or INTNX functions. *increment* can be one of the following:

Table 45.6 *INTCK and INTNX Values*

For dates	For datetimes	For times
DAY	DTDAY	HOUR
WEEK	DTWEEK	MINUTE
MONTH	DTMONTH	SECOND
QTR	DTQTR	
YEAR	DTYEAR	

The following example includes the date increment:

```
   haxis='01JAN95'd to '01JAN96'd
   by month

haxis='01JAN95'd to '01JAN96'd
   by qtr
```

Note: You must use a FORMAT statement to print the tick-mark values in an understandable form.

Interaction You can use the HAXIS= and VAXIS= options with the VTOH= option to equate axes. If your data is suitable, then use HAXIS=BY *n* and VAXIS=BY *n* with the same value for *n* and specify a value for the VTOH= option. The number of columns that separate the horizontal tick marks is nearly equal to the number of lines that separate the vertical tick marks times the value of the VTOH= option. In some cases, PROC PLOT cannot simultaneously use all three values and changes one or more of the values.

Examples "Example 2: Controlling the Horizontal Axis and Adding a Reference Line" on page 1653

"Example 5: Plotting Data on a Logarithmic Scale" on page 1660

"Example 6: Plotting Date Values on an Axis" on page 1662

HEXPAND
expands the horizontal axis to minimize the margins at the sides of the plot and to maximize the distance between tick marks, if possible.

HEXPAND causes PROC PLOT to ignore information about the spacing of the data. Plots produced with this option waste less space but can obscure the nature of the relationship between the variables.

HPOS=*axis-length*
specifies the number of print positions on the horizontal axis. The maximum value of *axis-length* that allows a plot to fit on one page is three positions less than the value of the LINESIZE= system option. This maximum ensures that there is enough space for the procedure to print information next to the vertical axis. The exact maximum depends on the number of characters that are in the vertical variable's values. If *axis-length* is too large to fit on a line, then PROC PLOT ignores the option.

HREF=*value-specification*
draws lines on the plot perpendicular to the specified values on the horizontal axis. PROC PLOT includes the values that you specify with the HREF= option on the horizontal axis unless you specify otherwise with the HAXIS= option.

For the syntax for *value-specification*, see "HAXIS=*axis-specification*" on page 1636.

Example "Example 8: Plotting BY Groups" on page 1668

HREFCHAR='*character*'
specifies the character to use to draw the horizontal reference line.

Default vertical bar (|)

See "FORMCHAR <*(position(s))*>'*formatting-character(s)*'" on page 1628 and "HREF=*value-specification*" on page 1638

HREVERSE
reverses the order of the values on the horizontal axis.

HSPACE=*n*
specifies that a tick mark will occur on the horizontal axis at every *n*th print position, where *n* is the value of HSPACE=.

HZERO
assigns a value of zero to the first tick mark on the horizontal axis.

Interaction PROC PLOT ignores HZERO if the horizontal variable has negative values or if the HAXIS= option specifies a range that does not begin with zero.

LIST<=*penalty-value*>
lists the horizontal and vertical axis values, the penalty, and the placement state of all points plotted with a penalty greater than or equal to *penalty-value*. If no plotted points have a penalty greater than or equal to *penalty-value*, then no list is printed.

Tip LIST is equivalent to LIST=0.

See "Understanding Penalties" on page 1623

Example "Example 11: Adjusting Labels on a Plot with the PLACEMENT= Option" on page 1679

OUTWARD='*character*'
tries to force the point labels outward, away from the origin of the plot, by protecting positions next to symbols that match *character* that are in the direction of the origin (0,0). The algorithm tries to avoid putting the labels in the protected positions, so they usually move outward.

Tip This option is useful only when you are labeling points with the values of a variable.

OVERLAY
overlays all plots that are specified in the PLOT statement on one set of axes. The variable names, or variable labels if they exist, from the first plot are used to label the axes. Unless you use the HAXIS= option or the VAXIS= option, PROC PLOT automatically scales the axes in the way that best fits all the variables.

When the SAS system option OVP is in effect and overprinting is allowed, the plots are superimposed. Otherwise, when NOOVP is in effect, PROC PLOT uses the plotting symbol from the first plot to represent points that appear in more than one plot. In such a case, the output includes a message telling you how many observations are hidden.

Example "Example 3: Overlaying Two Plots" on page 1655

PENALTIES<(*index-list*)>=*penalty-list*
changes the default penalties. The *index-list* provides the positions of the penalties in the list of penalties. The *penalty-list* contains the values that you are specifying for the penalties that are indicated in the *index-list*. The *index-list*

and the *penalty-list* can contain one or more integers. In addition, both *index-list* and *penalty-list* accept the form: `value TO value`

See "Understanding Penalties" on page 1623

Example "Example 13: Changing a Default Penalty" on page 1687

PLACEMENT=(*expression(s)*)

controls the placement of labels by specifying possible locations of the labels relative to their coordinates. Each *expression* consists of a list of one or more suboptions (H=, L=, S=, or V=) that are joined by an asterisk (*) or a colon (:). PROC PLOT uses the asterisk and colon to expand each expression into combinations of values for the four possible suboptions. The asterisk creates every possible combination of values in the expression list. A colon creates only pairwise combinations. The colon takes precedence over the asterisk. With the colon, if one list is shorter than the other, then the values in the shorter list are reused as necessary.

Use the following suboptions to control the placement:

H=*integer(s)*

specifies the number of horizontal spaces (columns) to shift the label relative to the starting position. Both positive and negative integers are valid. Positive integers shift the label to the right; negative integers shift it to the left. For example, you can use the H= suboption in the following way:

```
place=(h=0 1 -1 2 -2)
```

You can use the keywords BY ALT in this list. BY ALT produces a series of numbers whose signs alternate between positive and negative and whose absolute values change by one after each pair. For example, the following PLACE= specifications are equivalent:

```
place=(h=0 -1 to -3 by alt)
place=(h=0 -1 1 -2 2 -3 3)
```

If the series includes zero, then the zero appears twice. For example, the following PLACE= options are equivalent:

```
place=(h= 0 to 2 by alt)
place=(h=0 0 1 -1 2 -2)
```

Default H=0

Range −500 to 500

L=*integer(s)*

specifies the number of lines onto which the label can be split.

Default L=1

Range 1-200

S=*start-position(s)*

specifies where to start printing the label. The value for *start-position* can be one or more of the following:

CENTER
the procedure centers the label around the plotting symbol.

RIGHT
the label starts at the plotting symbol location and continues to the right.

LEFT
the label starts to the left of the plotting symbol and ends at the plotting symbol location.

Default CENTER

V=*integer(s)*
specifies the number of vertical spaces (lines) to shift the label relative to the starting position. V= behaves the same as the H= suboption, described earlier.

A new expression begins when a suboption is not preceded by an operator. Parentheses around each expression are optional. They make it easier to recognize individual expressions in the list. However, the entire expression list must be in parentheses, as shown in the following example. The following table shows how this expression is expanded and describes each placement state.

```
place=((v=1)
    (s=right left : h=2 -2)
    (v=-1)
    (h=0 1 to 2 by alt * v=1 -1)
    (l=1 to 3 * v=1 to 2 by alt *
     h=0 1 to 2 by alt))
```

Each combination of values is a *placement state*. The procedure uses the placement states in the order in which they appear in the placement states list, so specify your most preferred placements first. For each label, the procedure tries all states, then it uses the first state that places the label with minimum penalty. When all labels are initially placed, the procedure cycles through the plot multiple times, systematically refining the placements. The refinement step tries to both minimize the penalties and to use placements nearer to the beginning of the states list. However, PROC PLOT uses a heuristic approach for placements, so the procedure does not always find the best set of placements.

Table 45.7 *Expanding an Expression List into Placement States*

Expression	Placement State	Meaning
(V=1)	S=CENTER L=1 H=0 V=1	Center the label, relative to the point, on the line above the point. Use one line for the label.
(S=RIGHT LEFT : H=2 −2)	S=RIGHT L=1 H=2 V=0	Begin the label in the second column to the right of the point. Use one line for the label.

Expression	Placement State	Meaning
	S=LEFT L=1 H=−2 V=0	End the label in the second column to the left of the point. Use one line for the label.
(V=−1)	S=CENTER L=1 H=0 V=− 1	Center the label, relative to the point, on the line below the point. Use one line for the label.
(H=0 1 to 2 BY ALT * V=1 −1)	S=CENTER L=1 H=0 V=1	Center the label, relative to the point, on the line above the point.
	S=CENTER L=1 H=0 V=−1	Center the label, relative to the point, on the line below the point.
	S=CENTER L=1 H=1 V=1	From center, shift the label one column to the right on the line above the point.
	S=CENTER L=1 H=1 V=−1	From center, shift the label one column to the right on the line below the point.
	S=CENTER L=1 H=−1 V=1	From center, shift the label one column to the left on the line above the point.
	S=CENTER L=1 H=− 1 V=−1	From center, shift the label one column to the left on the line below the point.
	S=CENTER L=1 H=2 V=1 S=CENTER L=1 H=2 V=−1	From center, shift the labels two columns to the right, first on the line above the point, then on the line below.
	S=CENTER L=1 H=−2 V=1 S=CENTER L=1 H=−2 V=−1	From center, shift the labels two columns to the left, first on the line above the point, then on the line below.
(L=1 to 3 * V=1 to 2 BY ALT * H=0 1 to 2 BY ALT)	S=CENTER L=1 H=0 V=1	Center the label, relative to the point, on the line above

Expression	Placement State	Meaning
		the point. Use one line for the label.
	S=CENTER L=1 H=1 V=1 S=CENTER L=1 H=−1 V=1 S=CENTER L=1 H=2 V=1 S=CENTER L=1 H=−2 V=1	From center, shift the label one or two columns to the right or left on the line above the point. Use one line for the label.
	S=CENTER L=1 H=0 V=−1	Center the label, relative to the point, on the line below the point. Use one line for the label.
	S=CENTER L=1 H=1 V=−1 S=CENTER L=1 H=−1 V=−1 S=CENTER L=1 H=2 V=−1 S=CENTER L=1 H=−2 V=−1	From center, shift the label one or two columns to the right and the left on the line below the point.
	.	Use the same horizontal shifts on the line two lines above the point and on the line two lines below the point.
	S=CENTER L=1 H=− 2 V=−2	
	S=CENTER L=2 H=0 V=1	Repeat the whole process splitting the label across two lines. Then repeat it splitting the label across three lines.
	S=CENTER L=3 H=− 2 V=−2	

Alias PLACE=

Default There are two defaults for the PLACE= option. If you are using a blank as the plotting symbol, then the default placement state is PLACE=(S=CENTER : V=0 : H=0 : L=1), which centers the label. If you are using anything other than a blank, then the default is PLACE=((S=RIGHT LEFT : H=2 −2) (V=1 −1 * H=0 1 -1 2 -2)). The default for labels placed with symbols includes multiple positions around the plotting symbol so the procedure has flexibility when placing labels on a crowded plot.

Tip Use the STATES option to print a list of placement states.

See "Labels and Plot Points" on page 1622

Examples "Example 11: Adjusting Labels on a Plot with the PLACEMENT= Option" on page 1679

"Example 12: Adjusting Labeling on a Plot with a Macro" on page 1684

Scontour-level='character-list'
specifies the plotting symbol to use for a single contour level. When PROC PLOT produces contour plots, it automatically chooses the symbols to use for each level of intensity. You can use the S= option to override these symbols and specify your own. You can include up to three characters in *character-list*. If overprinting is not allowed, then PROC PLOT uses only the first character.

For example, to specify three levels of shading for the Z variable, use the following statement:

```
plot y*x=z /
    contour=3 s1='A' s2='+' s3='X0A';
```

You can also specify the plotting symbols as hexadecimal constants:

```
plot y*x=z /
    contour=3 s1='7A'x  s2='7F'x s3='A6'x;
```

This feature was designed especially for printers where the hexadecimal constants can represent gray scale fill characters.

Range 1 to the highest contour level (determined by the CONTOUR option).

See "SLIST='*character-list-1*' <'*character-list-2* ...'>" on page 1644 and "CONTOUR<=*number-of-levels*>" on page 1635

SLIST='*character-list-1*' <'*character-list-2* ...'>
specifies plotting symbols for multiple contour levels. Each *character-list* specifies the plotting symbol for one contour level: the first *character-list* for the first level, the second *character-list* for the second level, and so on. The following example shows how to assign 5 different plotting symbols to 5 contour levels:

```
plot y*x=z /
     contour=5  slist='.' ':' '!' '=' '+O';
```

If you omit a plotting symbol for each contour level, then PROC PLOT uses the default symbols:

```
slist='.' ',' '-' '=' '+' 'O' 'X'       'W' '*' '#'
```

Restriction If you use the SLIST= option, then it must be listed last in the PLOT statement.

See "*Scontour-level='character-list'*" on page 1644 and "CONTOUR<=*number-of-levels*>" on page 1635

SPLIT='*split-character*'
when labeling plot points, specifies where to split the label when the label spans two or more lines. The label is split onto the number of lines that is specified in the L= suboption to the PLACEMENT= option. If you specify a split

character, then the procedure always splits the label on each occurrence of that character, even if it cannot find a suitable placement. If you specify L=2 or more but do not specify a split character, then the procedure tries to split the label on blanks or punctuation but will split words if necessary.

PROC PLOT shifts split labels as a block, not as individual fragments (a *fragment* is the part of the split label that is contained on one line). For example, to force `This is a label` to split after the `a`, change it to `This is a*label` and specify `SPLIT='*'`.

See "Labels and Plot Points" on page 1622

STATES
lists all the placement states in effect. STATES prints the placement states in the order in which you specify them in the PLACE= option.

VAXIS=*axis-specification*
specifies tick mark values for the vertical axis. VAXIS= follows the same rules as the HAXIS= option.

Examples "Example 7: Producing a Contour Plot" on page 1665

"Example 12: Adjusting Labeling on a Plot with a Macro" on page 1684

VEXPAND
expands the vertical axis to minimize the margins above and below the plot and to maximize the space between vertical tick marks, if possible.

See "HEXPAND" on page 1638

VPOS=*axis-length*
specifies the number of print positions on the vertical axis. The maximum value for *axis-length* that allows a plot to fit on one page is eight lines less than the value of the SAS system option PAGESIZE= because you must allow room for the procedure to print information under the horizontal axis. The exact maximum depends on the titles that are used, whether plots are overlaid, and whether CONTOUR is specified. If the value of *axis-length* specifies a plot that cannot fit on one page, then the plot spans multiple pages.

See "HPOS=*axis-length*" on page 1638

VREF=*value-specification*
draws lines on the plot perpendicular to the specified values on the vertical axis. PROC PLOT includes the values that you specify with the VREF= option on the vertical axis unless you specify otherwise with the VAXIS= option. For the syntax for *value-specification*, see "HAXIS=*axis-specification*" on page 1636.

Example "Example 2: Controlling the Horizontal Axis and Adding a Reference Line" on page 1653

VREFCHAR='*character*'
specifies the character to use to draw the vertical reference lines.

Default horizontal bar (-)

See "FORMCHAR <*(position(s))*>*'formatting-character(s)'*" on page 1628, "HREFCHAR=*'character'*" on page 1638, and "VREF=*value-specification*" on page 1645

VREVERSE
reverses the order of the values on the vertical axis.

VSPACE=*n*
specifies that a tick mark will occur on the vertical axis at every *n*th print position, where *n* is the value of VSPACE=.

VZERO
assigns a value of zero to the first tick mark on the vertical axis.

Interaction PROC PLOT ignores the VZERO option if the vertical variable has negative values or if the VAXIS= option specifies a range that does not begin with zero.

Usage: PLOT Procedure

Generating Data with Program Statements

When you generate data to be plotted, a good rule is to generate fewer observations than the number of positions on the horizontal axis. PROC PLOT then uses the increment of the horizontal variable as the interval between tick marks.

Because PROC PLOT prints one character for each observation, using SAS program statements to generate the data set for PROC PLOT can enhance the effectiveness of continuous plots. For example, suppose that you want to generate data in order to plot the following equation, for *x* ranging from 0 to 100:

$$y = 2.54 + 3.83x$$

You can submit these statements:

```
options linesize=80;
 data generate;
    do x=0 to 100 by 2;
       y=2.54+3.83*x;
       output;
    end;
 run;
 proc plot data=generate;
    plot y*x;
 run;
```

If the plot is printed with a LINESIZE= value of 80, then about 75 positions are available on the horizontal axis for the X values. Thus, 2 is a good increment: 51 observations are generated, which is fewer than the 75 available positions on the horizontal axis.

However, if the plot is printed with a LINESIZE= value of 132, then an increment of 2 produces a plot in which the plotting symbols have space between them. For a smoother line, a better increment is 1, because 101 observations are generated.

Specifying Variable Lists in Plot Requests

You can use SAS variable lists in plot requests. For example, the following are valid plot requests:

Table 45.8 *Plot Requests*

Plot Request	What is Plotted
`(a - - d)`	`a*b a*c a*d b*c b*d c*d`
`(x1 - x4)`	`x1*x2 x1*x3 x1*x4 x2*x3 x2*x4 x3*x4`
`(_numeric_)`	All combinations of numeric variables
`y*(x1 - x4)`	`y*x1 y*x2 y*x4 y*x4`

If both the vertical and horizontal specifications request more than one variable and if a variable appears in both lists, then it will not be plotted against itself. For example, the following statement does not plot B*B and C*C:

```
plot (a b c)*(b c d);
```

Specifying Combinations of Variables

The operator in request is either an asterisk (*) or a colon (:). An asterisk combines the variables in the lists to produce all possible combinations of *x* and *y* variables. For example, the following plot requests are equivalent:

```
plot (y1-y2) * (x1-x2);

plot y1*x1 y1*x2 y2*x1 y2*x2;
```

A colon combines the variables pairwise. Thus, the first variables of each list combine to request a plot, as do the second, third, and so on. For example, the following plot requests are equivalent:

```
plot (y1-y2) : (x1-x2);

plot y1*x1 y2*x2;
```

Using the PENALTIES= Option

In the following example, the PENALTIES= option increases the default penalty for not printing the third, fourth, and fifth label characters to 11, 10, and 8, and it decreases the penalties for not printing the first and second characters to 2:

```
penalties(15 to 20)=2 2 11 10 8 2
```

This example extends the penalty list. The 20th penalty of 2 is the penalty for not printing the sixth through 200th character. When the last index *i* is greater than 18, the last penalty is used for the (*i* − 14th character and beyond.

You can also extend the penalty list by just specifying the starting index. For example, the following PENALTIES= option is equivalent to the one above:

```
penalties(15)=2 2 11 10 8 2
```

Results: PLOT Procedure

Scale of the Axes

Normally, PROC PLOT looks at the minimum difference between each pair of the five lowest ordered values of each variable (the *delta*) and ensures that there is no more than one of these intervals per print position on the final scaled axis, if possible. If there is not enough room for this interval arrangement, and if PROC PLOT guesses that the data was artificially generated, then it puts a fixed number of deltas in each print position. Otherwise, PROC PLOT ignores the value.

Printed Output

Each plot uses one full page unless the plot's size is changed by the VPOS= and HPOS= options in the PLOT statement, the VPERCENT= or HPERCENT= options in the PROC PLOT statement, or the PAGESIZE= and LINESIZE= system options.

Titles, legends, and variable labels are printed at the top of each page. Each axis is labeled with the variable's name or, if it exists, the variable's label.

Normally, PROC PLOT begins a new plot on a new page. However, the VPERCENT= and HPERCENT= options enable you to print more than one plot on a page. VPERCENT= and HPERCENT= are described earlier in "PROC PLOT Statement" on page 1627 .

PROC PLOT always begins a new page after a RUN statement and at the beginning of a BY group.

ODS Table Names

The PLOT procedure assigns a name to each table that it creates. You can use these names to reference the table when using the Output Delivery System (ODS) to select tables and create output data sets. For more information, see "ODS Table Names Produced by Base SAS Procedures" in *SAS Output Delivery System: Procedures Guide*.

Table 45.9 *ODS Tables Produced by the PLOT Procedure*

Table Name	Description	Conditions When Table Is Generated
Plot	A single plot	When you do not specify the OVERLAY option.
Overlaid	Two or more plots on a single set of axes	When you specify the OVERLAY option.

Portability of ODS Output with PROC PLOT

Under certain circumstances, using PROC PLOT with the Output Delivery System produces files that are not portable. If the SAS system option FORMCHAR= in your SAS session uses nonstandard line-drawing characters, then the output might include strange characters instead of lines in operating environments in which the SAS Monospace font is not installed. To avoid this problem, specify the following OPTIONS statement before executing PROC PLOT:

```
options formchar="|----|+|---+=|-/\<>*";
```

Missing Values

If values of either of the plotting variables are missing, then PROC PLOT does not include the observation in the plot. However, in a plot of Y*X, values of X with corresponding missing values of Y are included in scaling the X axis, unless the NOMISS option is specified in the PROC PLOT statement.

Hidden Observations

By default, PROC PLOT uses different plotting symbols (A, B, C, and so on) to represent observations whose values coincide on a plot. However, if you specify your own plotting symbol or if you use the OVERLAY option, then you might not be able to recognize coinciding values.

If you specify a plotting symbol, then PROC PLOT uses the same symbol regardless of the number of observations whose values coincide. If you use the OVERLAY option and overprinting is not in effect, then PROC PLOT uses the symbol from the first plot request. In both cases, the output includes a message telling you how many observations are hidden.

Examples: PLOT Procedure

Example 1: Specifying a Plotting Symbol

Features: PROC PLOT statement option
FORMCHAR
PLOT statement

Data set: DJIA

Details

This example expands on Output 45.237 on page 1619 by specifying a different plotting symbol.

Program

```
options formchar="|----|+|---+=|-/\<>*";

data djia;
      input Year HighDate date7. High LowDate date7. Low;
      format highdate lowdate date7.;
      datalines;
1968 03DEC68   985.21 21MAR68   825.13
1969 14MAY69   968.85 17DEC69   769.93
...more data lines...
2006 27DEC06 12510.57 20JAN06 10667.39
2007 09OCT07 14164.53 05MAR07 12050.41
2008 02MAY08 13058.20 10OCT08  8451.19
;

proc plot data=djia;
      plot high*year='*'
      / vspace=5 vaxis=by 1000;

   title 'High Values of the Dow Jones Industrial Average';
   title2 'from 1968 to 2008';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the DJIA data set. DJIA contains the high and low closing marks for the Dow Jones Industrial Average from 1968 to 2008 . The DATA step creates this data set.

```
data djia;
      input Year HighDate date7. High LowDate date7. Low;
      format highdate lowdate date7.;
      datalines;
1968 03DEC68   985.21 21MAR68   825.13
1969 14MAY69   968.85 17DEC69   769.93
...more data lines...
2006 27DEC06 12510.57 20JAN06 10667.39
2007 09OCT07 14164.53 05MAR07 12050.41
2008 02MAY08 13058.20 10OCT08  8451.19
;
```

Create the plot. The plot request plots the values of High on the vertical axis and the values of Year on the horizontal axis. It also specifies an asterisk as the plotting symbol. The VAXIS= option and the VSPACE= option. The VAXIS=by 1000 option specifies tick mark values for the vertical axis in increments of 1,000. The VSPACE= option specifies the amount of print space between tick marks on the vertical axis.

```
proc plot data=djia;
      plot high*year='*'
      / vspace=5 vaxis=by 1000;
```

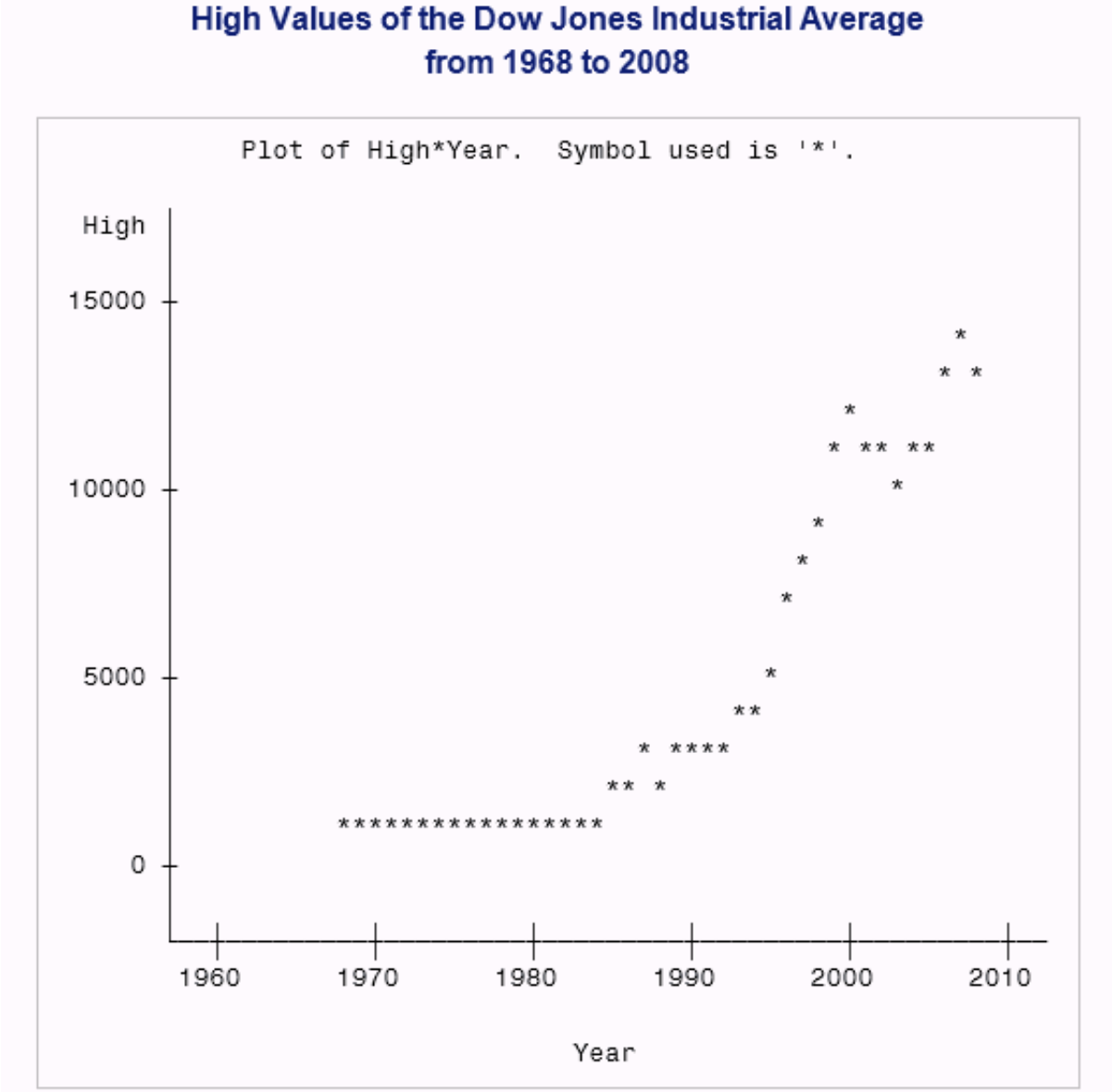
Specify the titles.

```
   title 'High Values of the Dow Jones Industrial Average';
   title2 'from 1968 to 2008';
run;
```

Output

PROC PLOT determines the tick marks and the scale of both axes.

Output 45.4 *Plot with Asterisk as the Plotting Symbol*



Example 2: Controlling the Horizontal Axis and Adding a Reference Line

Features:
PROC PLOT statement option
FORMCHAR
PLOT statement
PLOT statement options
HAXIS=
VREF=

Data set: DJIA

Details

This example specifies values for the horizontal axis and draws a reference line from the vertical axis.

Program

```
options formchar="|----|+|---+=|-/\<>*";

data djia;
      input Year HighDate date7. High LowDate date7. Low;
      format highdate lowdate date7.;
      datalines;
1968 03DEC68   985.21 21MAR68   825.13
1969 14MAY69   968.85 17DEC69   769.93
...more data lines...
2006 27DEC06 12510.57 20JAN06 10667.39
2007 09OCT07 14164.53 05MAR07 12050.41
2008 02MAY08 13058.20 10OCT08  8451.19
;

proc plot data=djia;
   plot high*year='*'

     / haxis=1965 to 2020 by 10 vref=3000;

title 'High Values of Dow Jones Industrial Average';
title2 'from 1968 to 2008';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the DJIA data set. DJIA contains the high and low closing marks for the Dow Jones Industrial Average from 1968 to 2008. The DATA step creates this data set.

```
data djia;
      input Year HighDate date7. High LowDate date7. Low;
      format highdate lowdate date7.;
      datalines;
1968 03DEC68   985.21 21MAR68   825.13
1969 14MAY69   968.85 17DEC69   769.93
...more data lines...
2006 27DEC06 12510.57 20JAN06 10667.39
2007 09OCT07 14164.53 05MAR07 12050.41
2008 02MAY08 13058.20 10OCT08  8451.19
;
```

Create the plot. The plot request plots the values of High on the vertical axis and the values of Year on the horizontal axis. It also specifies an asterisk as the plotting symbol.

```
proc plot data=djia;
   plot high*year='*'
```

Customize the horizontal axis and draw a reference line. HAXIS= specifies that the horizontal axis will show the values 1968 to 2008 in ten-year increments. VREF= draws a reference line that extends from the value 3000 on the vertical axis.

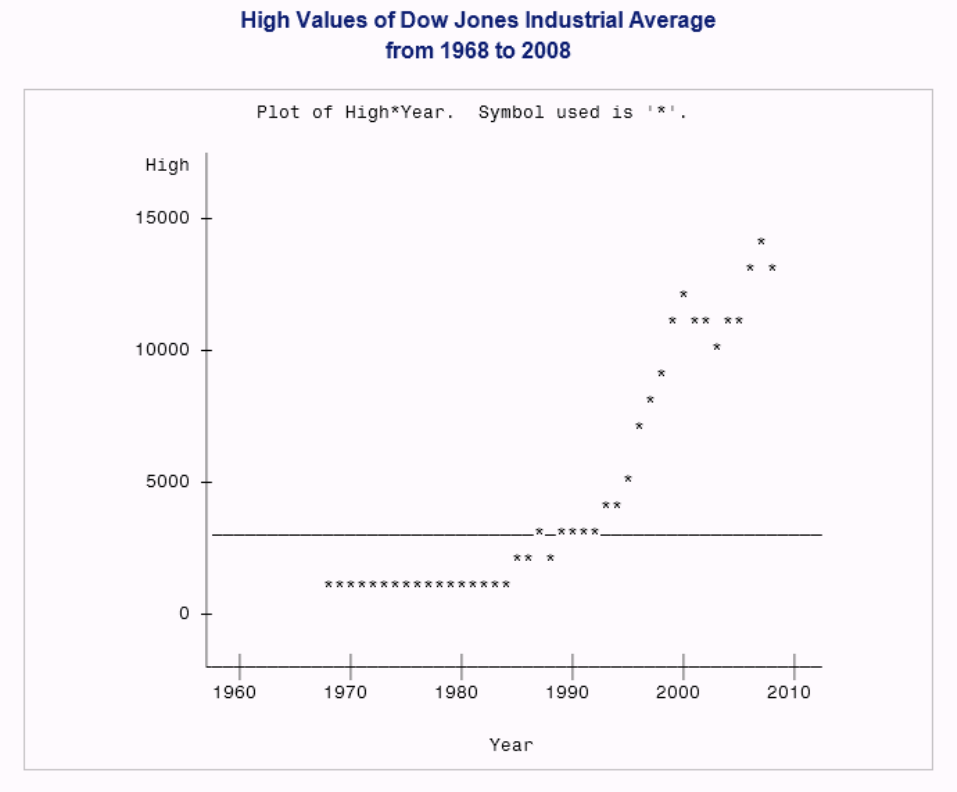
```
      / haxis=1965 to 2020 by 10 vref=3000;
```

Specify the titles.

```
title 'High Values of Dow Jones Industrial Average';
title2 'from 1968 to 2008';
run;
```

Output

Output 45.5 *Plot with Reference Line*



Example 3: Overlaying Two Plots

Features:

PROC PLOT statement option
- FORMCHAR

PLOT statement

PLOT statement options
- BOX
- HAXIS
- OVERLAY
- VAXIS

Data set: DJIA

Details

This example overlays two plots and puts a box around the plot.

Program

```
options formchar="|";

data djia;
      input Year HighDate date7. High LowDate date7. Low;
      format highdate lowdate date7.;
      datalines;
1968 03DEC68   985.21 21MAR68   825.13
1969 14MAY69   968.85 17DEC69   769.93
...more data lines...
2006 27DEC06 12510.57 20JAN06 10667.39
2007 09OCT07 14164.53 05MAR07 12050.41
2008 02MAY08 13058.20 10OCT08  8451.19
;

proc plot data=djia formchar="|----|+|---+=|-/\<>*";
   plot high*year='*'
        low*year='o' / overlay box
        haxis=by 10
        vaxis=by 5000;

   title 'Plot of Highs and Lows';
   title2 'for the Dow Jones Industrial Average';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|";
```

Create the DJIA data set. DJIA contains the high and low closing marks for the Dow Jones Industrial Average from 1968 to 2008. The DATA step creates this data set.

```
data djia;
      input Year HighDate date7. High LowDate date7. Low;
      format highdate lowdate date7.;
      datalines;
1968 03DEC68   985.21 21MAR68   825.13
1969 14MAY69   968.85 17DEC69   769.93
...more data lines...
2006 27DEC06 12510.57 20JAN06 10667.39
2007 09OCT07 14164.53 05MAR07 12050.41
2008 02MAY08 13058.20 10OCT08  8451.19
;
```

Create the plot. Create the plot using the PROC statement. Set the FORMCHAR option. Setting the FORMCHAR option to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available. The first plot request plots High on the vertical axis, plots Year on the horizontal axis, and specifies an asterisk as a plotting symbol. The second plot request plots Low on the vertical axis, plots Year on the horizontal axis,

and specifies an 'o' as a plotting symbol. OVERLAY superimposes the second plot onto the first. BOX draws a box around the plot. OVERLAY and BOX apply to both plot requests. HAXIS= specifies that the horizontal axis will show the values 1968 to 2008 in ten-year increments. VAXIS= specifies that the vertical axis will show the values in increments of 5,000.

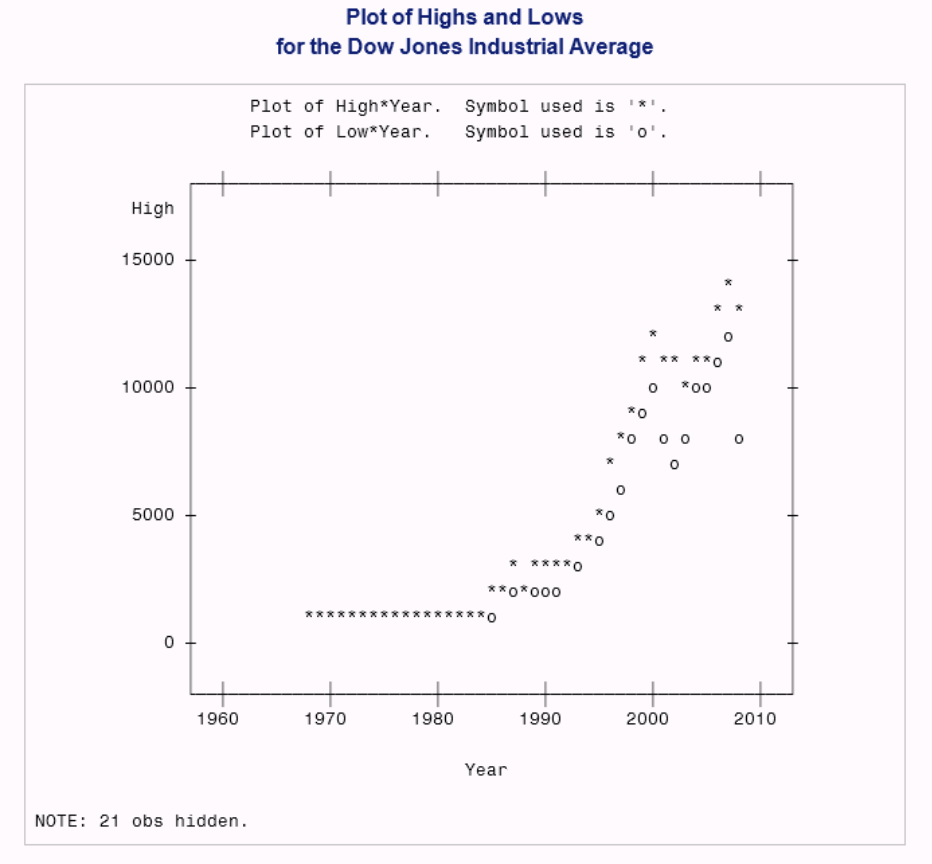
```
proc plot data=djia formchar="|----|+|---+=|-/\<>*";
   plot high*year='*'
        low*year='o' / overlay box
        haxis=by 10
        vaxis=by 5000;
```

Specify the titles.

```
   title 'Plot of Highs and Lows';
   title2 'for the Dow Jones Industrial Average';
run;
```

Output

Output 45.6 *Two Plots Overlaid Using Different Plotting Symbols*



Example 4: Producing Multiple Plots per Page

Features: PROC PLOT statement options
- FORMCHAR
- HPERCENT=
- VPERCENT=

PLOT statement

Data set: DJIA

Details

This example places three plots on one page of output.

Program

```
options formchar="|----|+|---+=|-/\<>*" pagesize=40 linesize=120;

data djia;
      input Year HighDate date7. High LowDate date7. Low;
      format highdate lowdate date7.;
      datalines;
1968 03DEC68   985.21 21MAR68   825.13
1969 14MAY69   968.85 17DEC69   769.93
...more data lines...
2006 27DEC06 12510.57 20JAN06 10667.39
2007 09OCT07 14164.53 05MAR07 12050.41
2008 02MAY08 13058.20 10OCT08  8451.19
;

proc plot data=djia vpercent=50 hpercent=50;

   plot high*year='*';

   plot low*year='o';

   plot high*year='*' low*year='o' / overlay box;

   title 'Plots of the Dow Jones Industrial Average';
   title2 'from 1968 to 2008';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available. The PAGESIZE= option sets the number of lines of output to 40, and the LINESIZE= option sets the line size in the output window to 120 characters.

```
options formchar="|----|+|---+=|-/\<>*" pagesize=40 linesize=120;
```

Create the DJIA data set. DJIA contains the high and low closing marks for the Dow Jones Industrial Average from 1968 to 2008. The DATA step creates this data set.

```
data djia;
      input Year HighDate date7. High LowDate date7. Low;
      format highdate lowdate date7.;
      datalines;
1968 03DEC68   985.21 21MAR68   825.13
1969 14MAY69   968.85 17DEC69   769.93
...more data lines...
2006 27DEC06 12510.57 20JAN06 10667.39
2007 09OCT07 14164.53 05MAR07 12050.41
2008 02MAY08 13058.20 10OCT08  8451.19
;
```

Specify the plot sizes. VPERCENT= specifies that 50% of the vertical space on the page of output is used for each plot. HPERCENT= specifies that 50% of the horizontal space is used for each plot.

```
proc plot data=djia vpercent=50 hpercent=50;
```

Create the first plot. This plot request plots the values of High on the vertical axis and the values of Year on the horizontal axis. It also specifies an asterisk as the plotting symbol.

```
   plot high*year='*';
```

Create the second plot. This plot request plots the values of Low on the vertical axis and the values of Year on the horizontal axis. It also specifies an asterisk as the plotting symbol.

```
   plot low*year='o';
```

Create the third plot. The first plot request plots High on the vertical axis, plots Year on the horizontal axis, and specifies an asterisk as a plotting symbol. The second plot request plots Low on the vertical axis, plots Year on the horizontal axis, and specifies an 'o' as a plotting symbol. OVERLAY superimposes the second plot onto the first. BOX draws a box around the plot. OVERLAY and BOX apply to both plot requests.

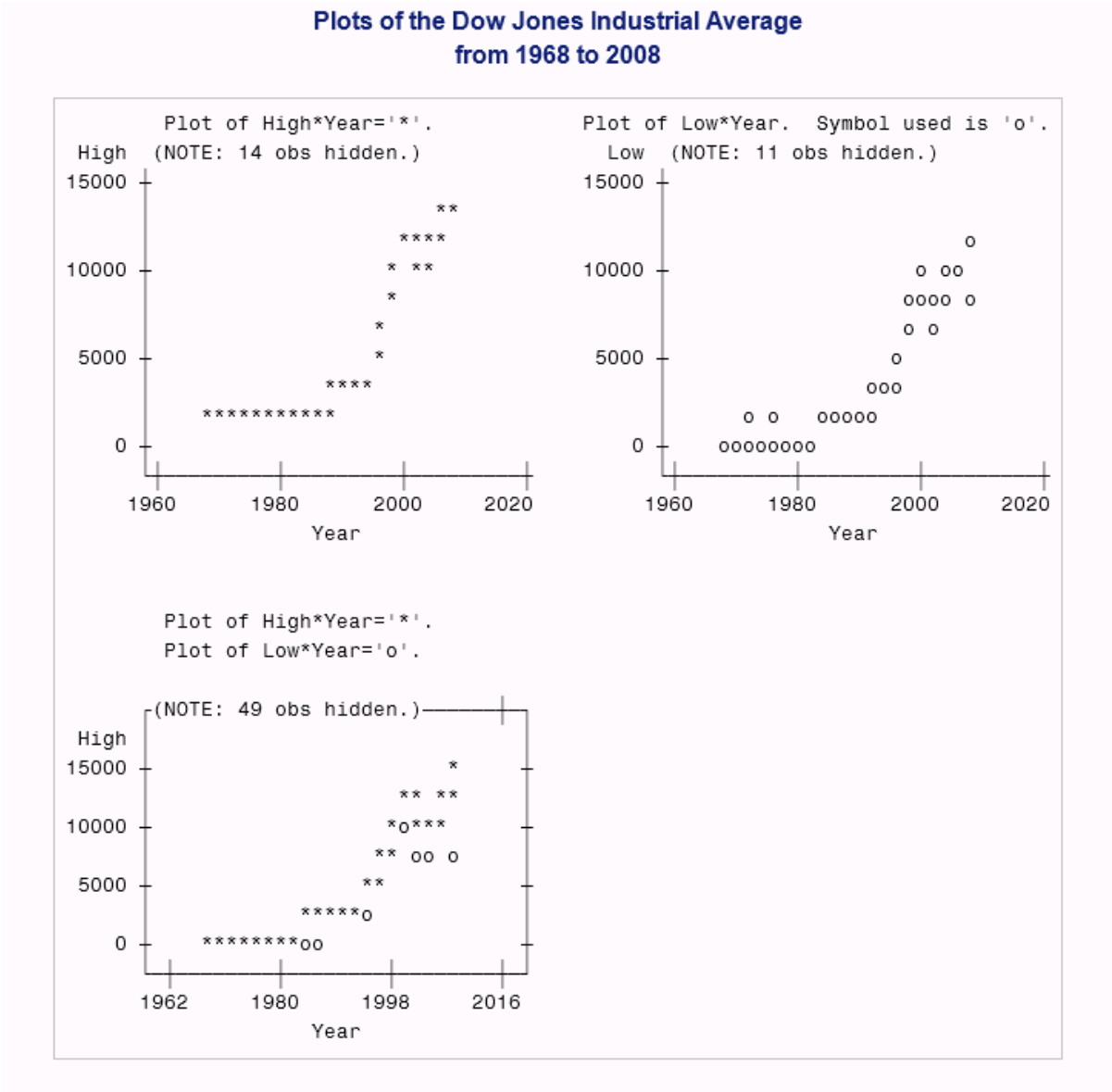
```
   plot high*year='*' low*year='o' / overlay box;
```

Specify the titles.

```
   title 'Plots of the Dow Jones Industrial Average';
   title2 'from 1968 to 2008';
run;
```

Output

Output 45.7 *Three Plots on One Page*



Example 5: Plotting Data on a Logarithmic Scale

Features:
- PROC PLOT statement option
  - PLOT statement
- PLOT statement options
  - HAXIS=
  - VSPACE=
- DATA step

Data set: EQUA

Details

This example uses a DATA step to generate the data set EQUA. The DATA step creates the data by using an iterative DO statement. The PROC PLOT step shows two plots of the same data: one plot without a horizontal axis specification and one plot with a logarithmic scale specified for the horizontal axis.

Program

```
data equa;
   do Y=1 to 3 by .1;
      X=10**y;
      output;
   end;
run;

proc plot data=equa hpercent=50;

    plot y*x / vspace=1;
    plot y*x / haxis=10 100 1000 vspace=1;

    title 'Two Plots with Different';
    title2 'Horizontal Axis Specifications';
run;
```

Program Description

Create the EQUA data set. EQUA creates values of X and Y by incrementing the variable Y from 1 to 3 by increments of .1. Each value of X is calculated as 10^{Y}.

```
data equa;
   do Y=1 to 3 by .1;
      X=10**y;
      output;
   end;
run;
```

Specify the plot sizes. HPERCENT= makes room for two plots side-by-side by specifying that 50% of the horizontal space is used for each plot.

```
proc plot data=equa hpercent=50;
```

Create the plots. The PLOT statement requests plot Y on the vertical axis and X on the horizontal axis. HAXIS= specifies a logarithmic scale for the horizontal axis for the second plot. The VSPACE= option specifies the amount of print space between the tick marks.

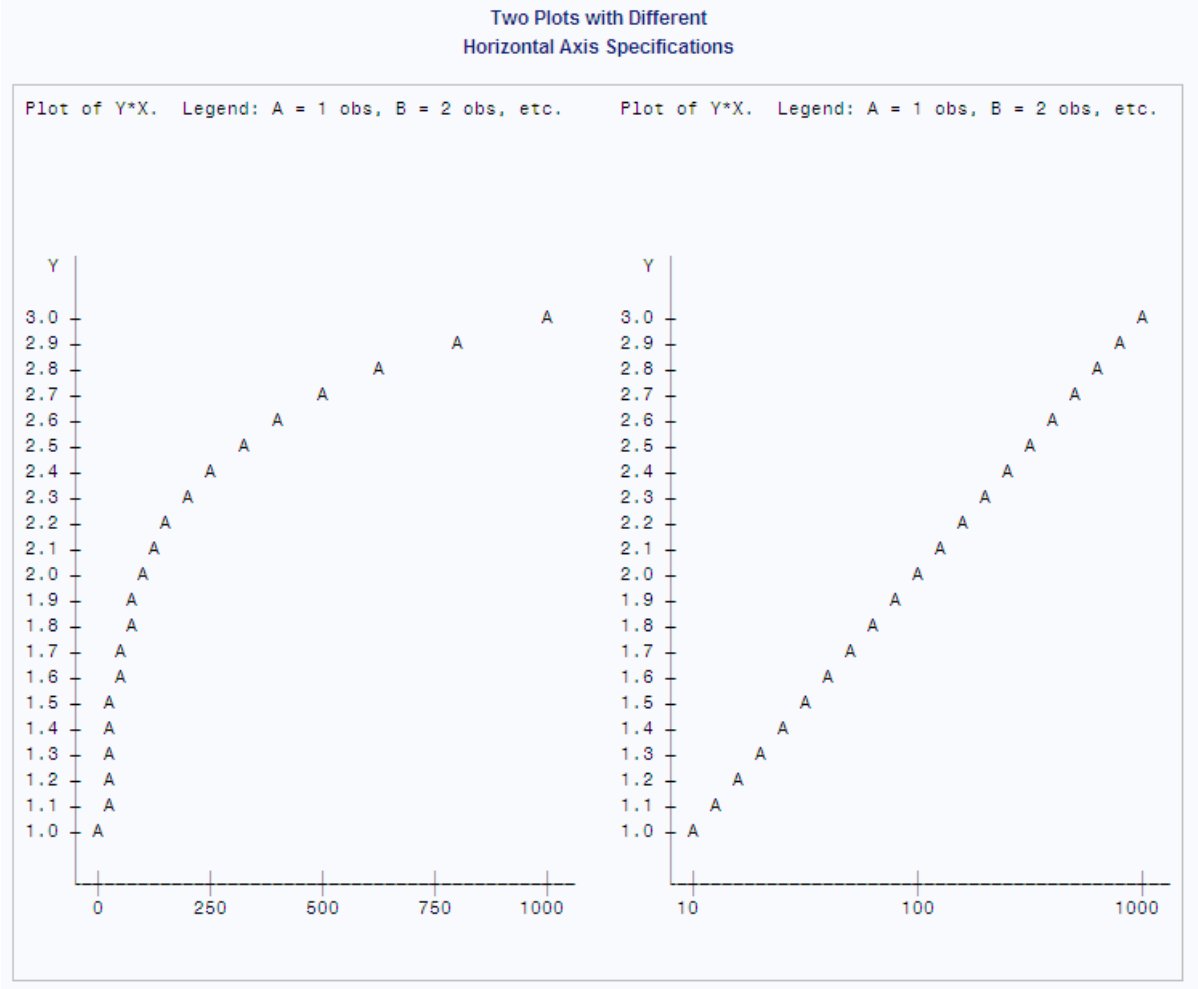
```
    plot y*x / vspace=1;
    plot y*x / haxis=10 100 1000 vspace=1;
```

Specify the titles.

```
    title 'Two Plots with Different';
    title2 'Horizontal Axis Specifications';
run;
```

Output

Output 45.8 *Two Plots with Different Horizontal Axis Specifications*



Example 6: Plotting Date Values on an Axis

Features:

PROC PLOT statement options
FORMCHAR

PLOT statement

PLOT statement options
HAXIS=

DATA step

Data set: EMERGENCY_CALLS

Details

This example uses a DATA step to create the data set EMERGENCY_CALLS and shows how you can specify date values on an axis.

Program

```
options formchar="|----|+|---+=|-/\<>*";

data emergency_calls;
   input Date : date7. Calls @@;
   label calls='Number of Calls';
   datalines;
1APR94 134   11APR94 384  13FEB94 488
2MAR94 289   21MAR94 201  14MAR94 460
3JUN94 184   13JUN94 152  30APR94 356
4JAN94 179   14JAN94 128  16JUN94 480
5APR94 360   15APR94 350  24JUL94 388
6MAY94 245   15DEC94 150  17NOV94 328
7JUL94 280   16MAY94 240  25AUG94 280
8AUG94 494   17JUL94 499  26SEP94 394
9SEP94 309   18AUG94 248  23NOV94 590
19SEP94 356  24FEB94 201  29JUL94 330
10OCT94 222  25MAR94 183  30AUG94 321
11NOV94 294  26APR94 412   2DEC94 511
27MAY94 294  22DEC94 413  28JUN94 309
;

proc plot data=emergency_calls;
   plot calls*date / haxis='1JAN94'd to '1JAN95'd by month vaxis=by
100 vspace=5;

   format date mmyyd5.;

   title 'Calls to City Emergency Services Number';
   title2 'Sample of Days for 1994';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the EMERGENCY_CALLS data set. EMERGENCY_CALLS contains the number of telephone calls to an emergency help line for each date.

```
data emergency_calls;
   input Date : date7. Calls @@;
   label calls='Number of Calls';
   datalines;
1APR94 134   11APR94 384  13FEB94 488
2MAR94 289   21MAR94 201  14MAR94 460
3JUN94 184   13JUN94 152  30APR94 356
4JAN94 179   14JAN94 128  16JUN94 480
5APR94 360   15APR94 350  24JUL94 388
6MAY94 245   15DEC94 150  17NOV94 328
7JUL94 280   16MAY94 240  25AUG94 280
8AUG94 494   17JUL94 499  26SEP94 394
9SEP94 309   18AUG94 248  23NOV94 590
19SEP94 356  24FEB94 201  29JUL94 330
10OCT94 222  25MAR94 183  30AUG94 321
11NOV94 294  26APR94 412   2DEC94 511
27MAY94 294  22DEC94 413  28JUN94 309
;
```

Create the plot. The plot request plots Calls on the vertical axis and Date on the horizontal axis. HAXIS= uses a monthly time for the horizontal axis. The notation **'1JAN94'd** is a date constant. The value **'1JAN95'd** ensures that the axis will have enough room for observations from December.

```
proc plot data=emergency_calls;
   plot calls*date / haxis='1JAN94'd to '1JAN95'd by month vaxis=by
100 vspace=5;
```

Format the DATE values. The FORMAT statement assigns the MMYYD5. format to Date, which uses 2-digit month and 2-digit year values separated by a hyphen.

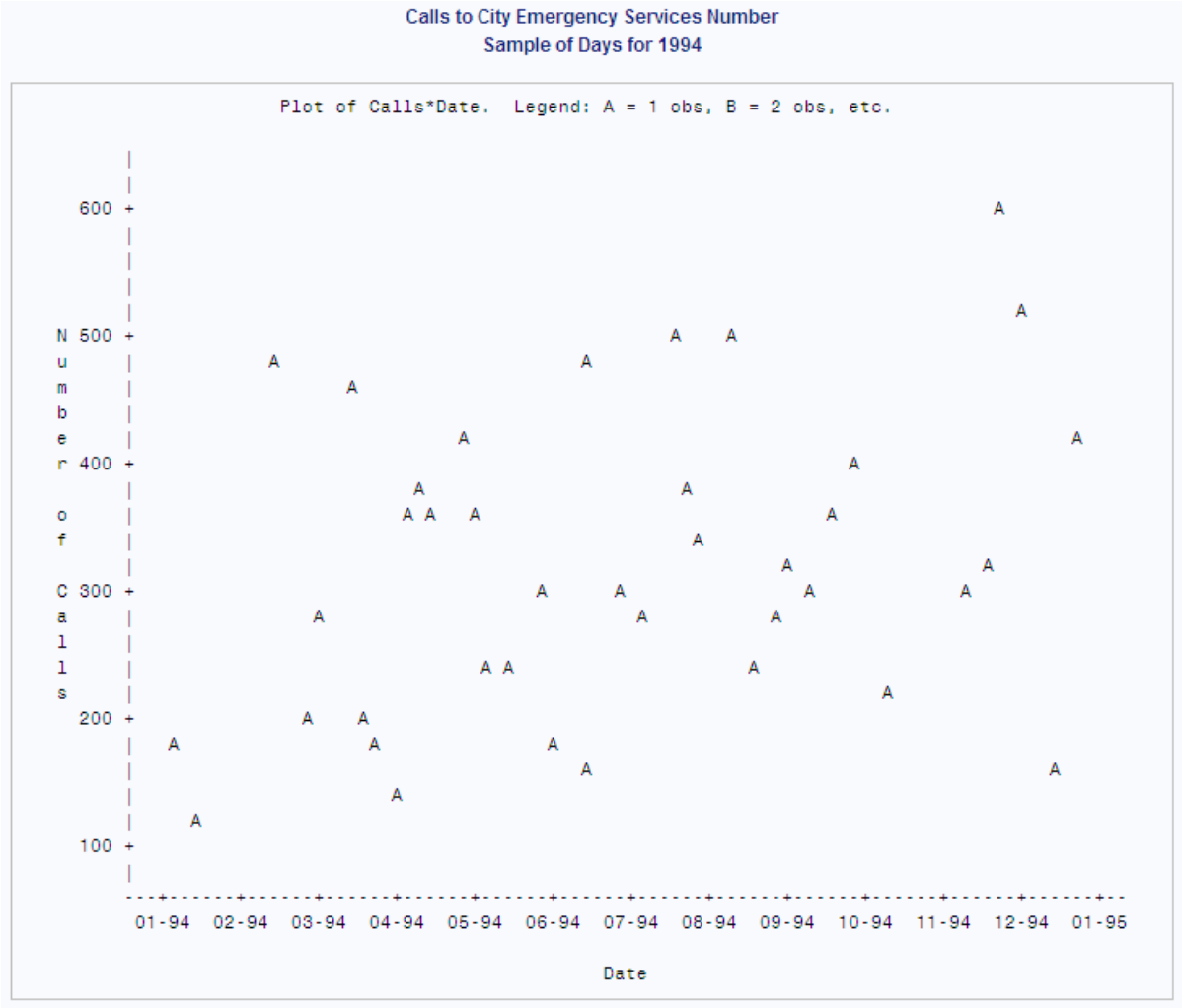
```
   format date mmyyd5.;
```

Specify the titles.

```
   title 'Calls to City Emergency Services Number';
   title2 'Sample of Days for 1994';
run;
```

Output

Output 45.9 *Plot with Date Values along the Horizontal Axis*



Example 7: Producing a Contour Plot

Features:
- PROC PLOT statement option FORMCHAR
- PLOT statement
- PLOT statement option CONTOUR=
- DATA step
- PROC PRINT
- OBS= data set option
- NOOBS system option

Data set: CONTOURS

Details

This example uses a DATA step to create the data set CONTOURS. It shows how to represent the values of three variables with a two-dimensional plot by setting one of the variables as the CONTOUR variable. The variables X and Y appear on the axes, and Z is the contour variable. Program statements are used to generate the observations for the plot, and the following equation describes the contour surface:

$$z = 46.2 + .09x - .0005x^2 + .1y - .0005y^2 + .0004xy$$

Program

```
options formchar="|----|+|---+=|-/\<>*";

data contours;
   format Z 5.1;
   do X=0 to 400 by 5;
      do Y=0 to 350 by 10;
         z=46.2+.09*x-.0005*x**2+.1*y-.0005*y**2+.0004*x*y;
         output;
      end;
   end;
run;

proc print data=contours(obs=5) noobs;
   title 'CONTOURS Data Set';
   title2 'First 5 Observations Only';
run;

proc plot data=contours;
plot y*x=z / contour=10;

    title 'A Contour Plot';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the CONTOURS data set. The CONTOURS data set contains observations with values of X that range from 0 to 400 by 5 and with values of Y that range from 0 to 350 by 10.

```
data contours;
   format Z 5.1;
```

```
   do X=0 to 400 by 5;
      do Y=0 to 350 by 10;
         z=46.2+.09*x-.0005*x**2+.1*y-.0005*y**2+.0004*x*y;
         output;
      end;
   end;
run;
```

Print the CONTOURS data set. The OBS= data set option limits the printing to only the first 5 observations. NOOBS suppresses printing of the observation numbers.

```
proc print data=contours(obs=5) noobs;
   title 'CONTOURS Data Set';
   title2 'First 5 Observations Only';
run;
```

Create the plot. The PLOT statement plots Y on the vertical axis, plots X on the horizontal axis, and specifies Z as the contour variable. CONTOUR=10 specifies that the plot will divide the values of Z into ten increments, and each increment will have a different plotting symbol.

```
proc plot data=contours;
plot y*x=z / contour=10;
```

Specify the title.

```
    title 'A Contour Plot';
run;
```

Output

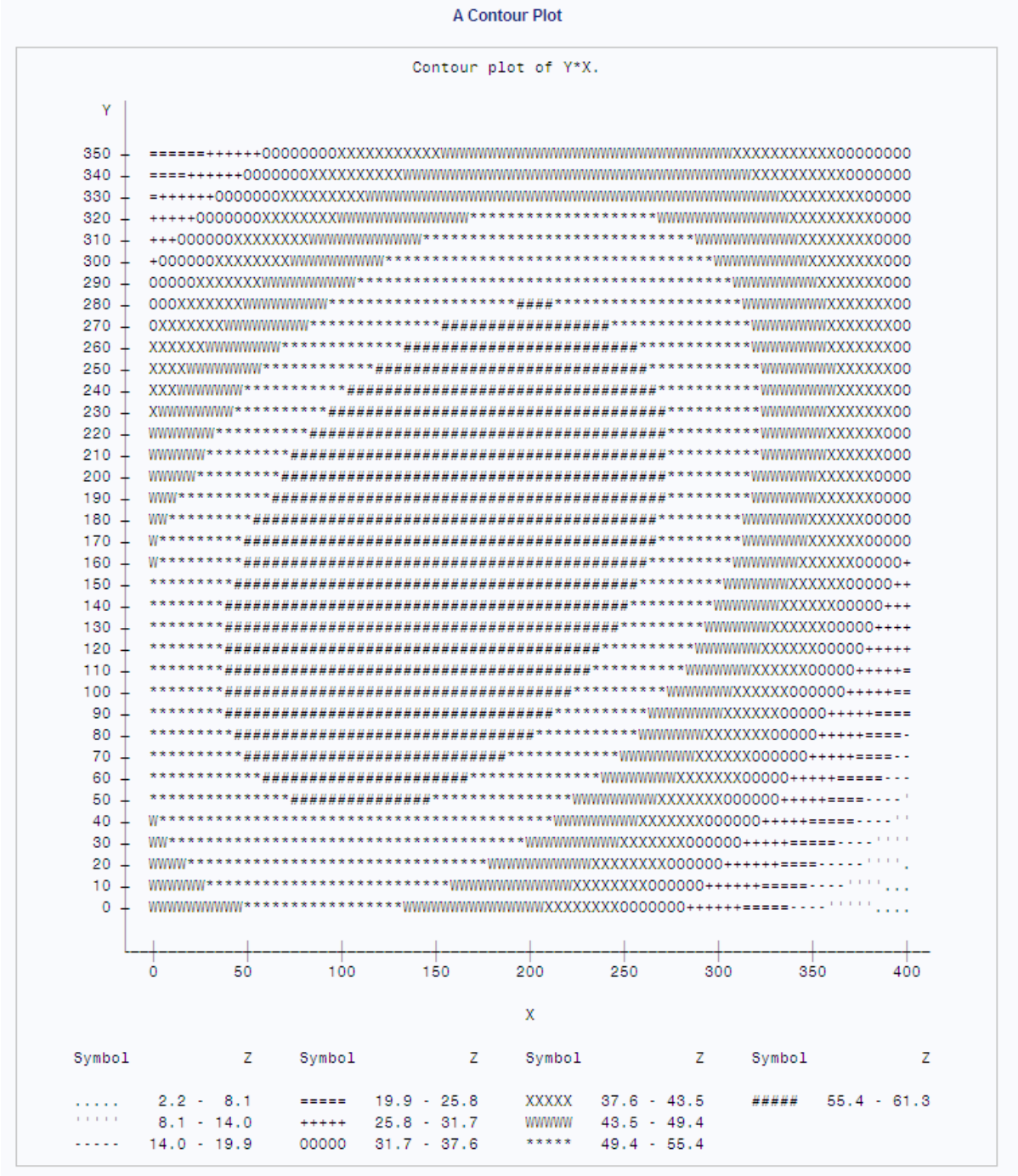
The shadings associated with the values of Z appear at the bottom of the plot. The plotting symbol # shows where high values of Z occur.

Output 45.10 *CONTOURS Data Set, First Five Observations*

CONTOURS Data Set
First 5 Observations Only

Z	X	Y
46.2	0	0
47.2	0	10
48.0	0	20
48.8	0	30
49.4	0	40

Output 45.11 *Contour Plot of Y*X*



Example 8: Plotting BY Groups

Features: PROC PLOT statement option
FORMCHAR

BY statement

PLOT statement

PLOT statement options
- HAXIS=
- HREF=
- HSPACE=
- VAXIS=
- VSPACE=

PROC SORT

DATA step

Data set: EDUCATION

Details

This example uses the data set "EDUCATION" on page 2785 to show BY-group processing in PROC PLOT.

Program

```
options formchar=|----|+|---+=|-/\<>*";

data education;
   input State $14. +1 Code $ DropoutRate Expenditures MathScore
         Region $;
   label dropout='Dropout Percentage - 1989'
          expend='Expenditure Per Pupil - 1989'
            math='8th Grade Math Exam - 1990';
   datalines;
Alabama        AL 22.3 3197 252 SE
Alaska         AK 35.8 7716 .   W
...more data lines...
New York       NY 35.0 .    261 NE
North Carolina NC 31.2 3874 250 SE
North Dakota   ND 12.1 3952 281 MW
Ohio           OH 24.4 4649 264 MW
;

proc sort data=education;
   by region;
run;

proc plot data=education;
   by region;

    plot expenditures*dropoutrate='*' / href=28.6
         vaxis=by 500 vspace=5
         haxis=by 5 hspace=12;

    title 'Plot of Dropout Rate and Expenditure Per Pupil';
 run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar=|----|+|---+=|-/\<>*";
```

Create the EDUCATION data set. "EDUCATION" on page 2785 contains educational data (Source: U.S. Department of Education) about some U.S. states. DropoutRate is the percentage of high school dropouts. Expenditures is the dollar amount the state spends on each pupil. MathScore is the score of eighth-grade students on a standardized math test. Not all states participated in the math test.

```
data education;
   input State $14. +1 Code $ DropoutRate Expenditures MathScore
         Region $;
   label dropout='Dropout Percentage - 1989'
          expend='Expenditure Per Pupil - 1989'
            math='8th Grade Math Exam - 1990';
   datalines;
Alabama        AL 22.3 3197 252 SE
Alaska         AK 35.8 7716 .   W
...more data lines...
New York       NY 35.0 .    261 NE
North Carolina NC 31.2 3874 250 SE
North Dakota   ND 12.1 3952 281 MW
Ohio           OH 24.4 4649 264 MW
;
```

Sort the EDUCATION data set. PROC SORT sorts EDUCATION by Region so that Region can be used as the BY variable in PROC PLOT.

```
proc sort data=education;
   by region;
run;
```

Create a separate plot for each BY group. The BY statement creates a separate plot for each value of Region.

```
proc plot data=education;
   by region;
```

Create the plot with a reference line. The PLOT statement plots Expenditures on the vertical axis, plots DropoutRate on the horizontal axis, and specifies an asterisk as the plotting symbol. HREF= draws a reference line that extends from 28.6 on the horizontal axis. The reference line represents the national average. VAXIS and HAXIS are used to set the tick marks along the vertical and horizontal axes. The VSPACE= option specifies the amount of print space between the vertical tick marks.

```
   plot expenditures*dropoutrate='*' / href=28.6
        vaxis=by 500 vspace=5
        haxis=by 5 hspace=12;
```

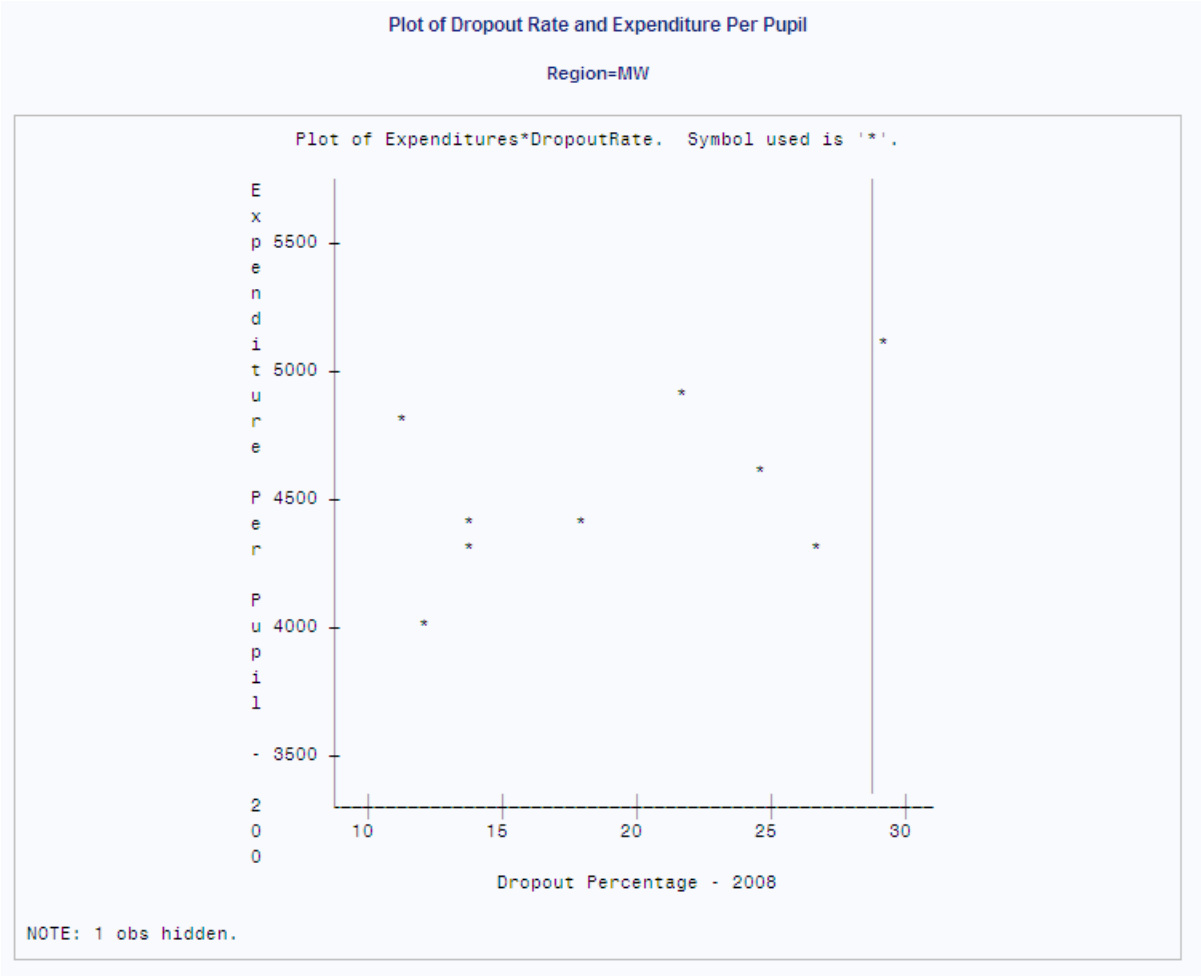
Specify the title.

```
   title 'Plot of Dropout Rate and Expenditure Per Pupil';
run;
```

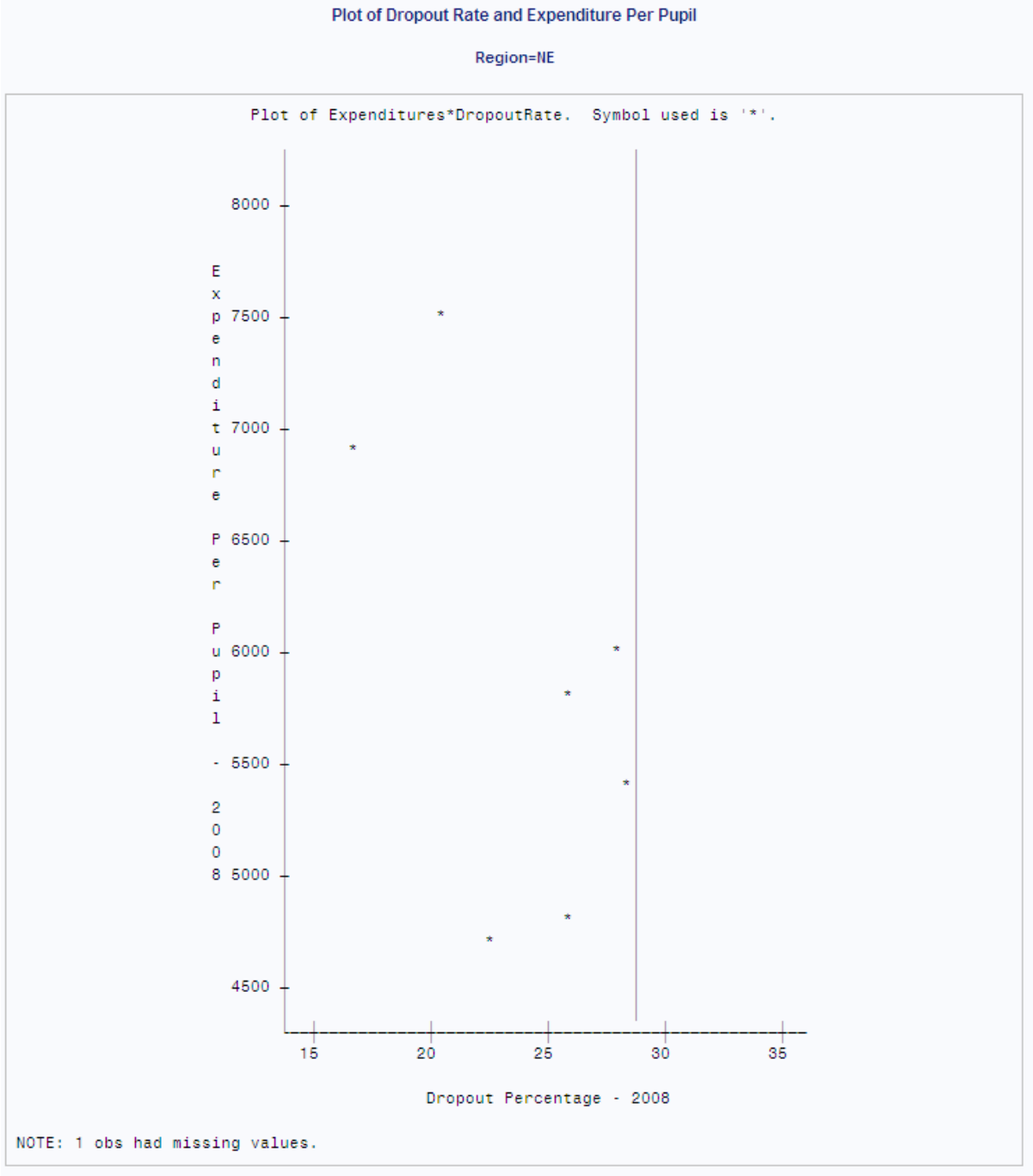
Output

PROC PLOT produces a plot for each BY group. Only the plots for Midwest and Northeast are shown.

Output 45.12 *Plot for Each BY Group, Midwest Region*



Output 45.13 *Plot for Each BY Group, Northeast Region*



Example 9: Adding Labels to a Plot

Features: PROC PLOT statement option
FORMCHAR

BY statement

PLOT statement

PROC SORT

Data set: EDUCATION

Details

This example shows how to use variables in a data set to label the points on a plot. The example adds labels to the output from the example "Example 8: Plotting BY Groups" on page 1668 . PROC SORT is used first to sort the data set by Region so that Region can be used as the BY variable in the first PLOT statement.

Program

```
options formchar="|----|+|---+=|-/\<>*";

proc sort data=education;
   by region;
run;

proc plot data=education;
   by region;

   plot expenditures*dropoutrate='*' $ state / href=28.6
        vaxis=by 500 vspace=5
        haxis=by 5 hspace=12;

   title 'Plot of Dropout Rate and Expenditure Per Pupil';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Sort the EDUCATION data set. PROC SORT sorts EDUCATION by Region so that Region can be used as the BY variable in PROC PLOT.

```
proc sort data=education;
   by region;
run;
```

Create a separate plot for each BY group. The BY statement creates a separate plot for each value of Region.

```
proc plot data=education;
   by region;
```

Create the plot with a reference line and a label for each data point. The plot request plots Expenditures on the vertical axis, plots DropoutRate on the horizontal axis, and specifies an asterisk as the plotting symbol. The label variable specification (**$ state**) in the PLOT statement labels each point on the plot with the name of the corresponding state. HREF= draws a reference line that extends from 28.6 on the horizontal axis. The reference line represents the national average. VAXIS and HAXIS are used to set the tick marks along the vertical and horizontal axes. The HSPACE=12 option specifies that there are 12 print spaces between the horizontal tick marks.

```
plot expenditures*dropoutrate='*' $ state / href=28.6
     vaxis=by 500 vspace=5
     haxis=by 5 hspace=12;
```

Specify the title.

```
   title 'Plot of Dropout Rate and Expenditure Per Pupil';
run;
```

Output

PROC PLOT produces a plot for each BY group. Only the plots for `Midwest` and `Northeast` are shown.

Output 45.14 Plot with Labels, Midwest Region

Plot of Dropout Rate and Expenditure Per Pupil

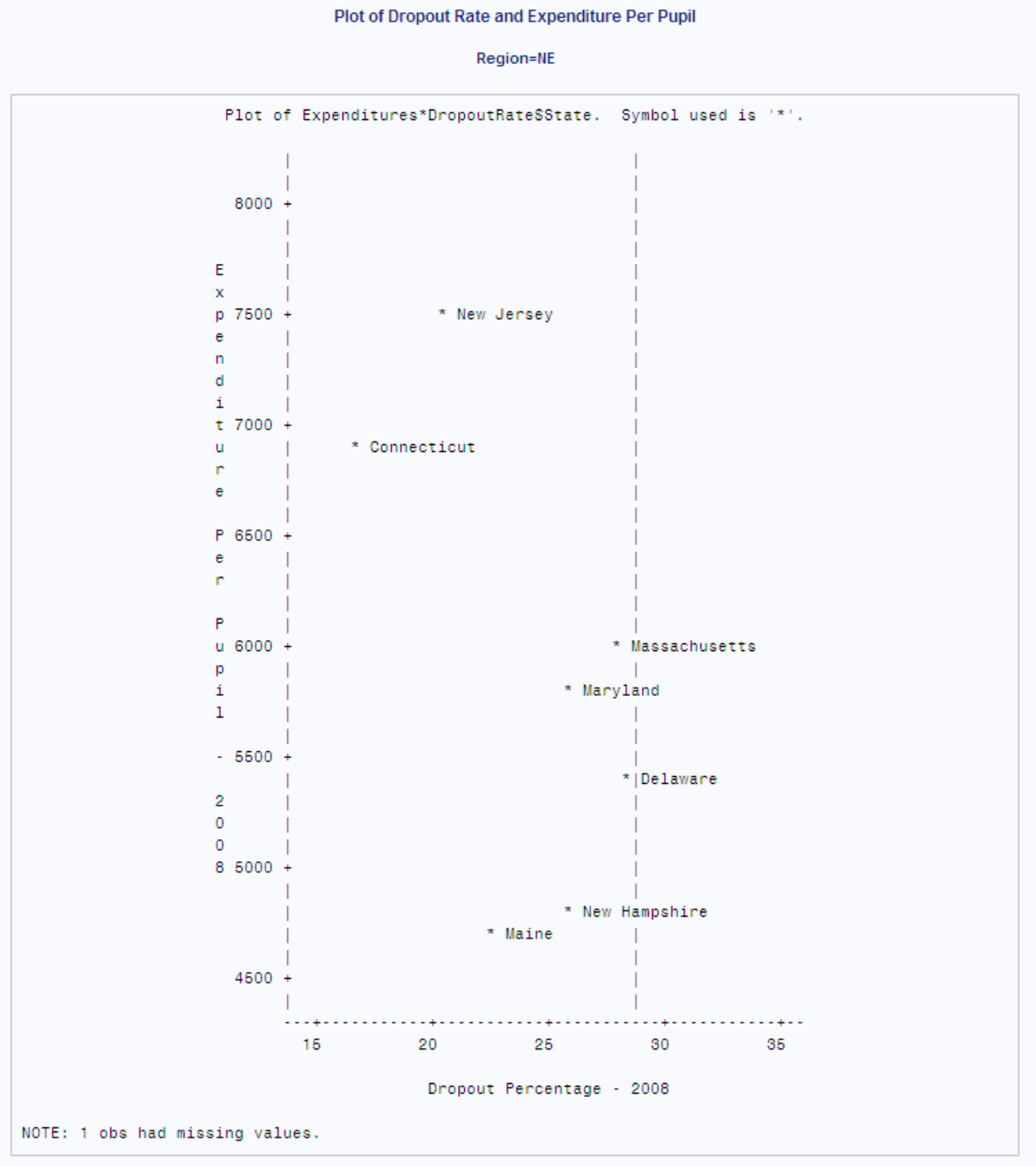
Region=MW

```
                     Plot of Expenditures*DropoutRate$State.  Symbol used is '*'.

                    E      |                                               |
                    x      |                                               |
                    p 5500 +                                               |
                    e      |                                               |
                    n      |                                               |
                    d      |                                               |
                    i      |                                       Michigan|*
                    t 5000 +                                               |
                    u      |                              * Illinois       |
                    r      |     * Minnesota                               |
                    e      |                                               |
                           |                                     * Ohio    |
                    P 4500 +                                               |
                    e      |  Nebraska *         * Kansas                  |
                    r      |      Iowa * Indiana                      * Missouri
                           |                                               |
                    P      |                                               |
                    u 4000 +       * North Dakota                          |
                    p      |                                               |
                    i      |                                               |
                    l      |                                               |
                           |                                               |
                    - 3500 +                                               |
                           |                                               |
                    2      ---+-----------+-----------+-----------+-----------+--
                    0        10          15          20          25          30
                    0
                                          Dropout Percentage - 2008

NOTE: 1 obs hidden.
```

Output 45.15 *Plot with Labels, Northeast Region*



Example 10: Excluding Observations That Have Missing Values

Features: PROC PLOT statement options
FORMCHAR
NOMISS

BY statement

PLOT statement

PLOT statement options

HAXIS=
HREF=
HSPACE=
VAXIS=
VSPACE=

PROC SORT

WHERE statement

Data set: EDUCATION

Details

This example shows how missing values affect the calculation of the axes. The example uses the "EDUCATION" on page 2785 data set.

Program

```
options formchar="|----|+|---+=|-/\<>*";

proc sort data=education;
   by region;
run;

proc plot data=education nomiss;

    by region;

    plot expenditures*dropoutrate='*' $ state / href=28.6
         vaxis=by 500 vspace=5
         haxis=by 5 hspace=12;

    title 'Plot of Dropout Rate and Expenditure Per Pupil';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Sort the EDUCATION data set. PROC SORT sorts EDUCATION by Region so that Region can be used as the BY variable in PROC PLOT.

```
proc sort data=education;
```

```
   by region;
run;
```

Exclude data points with missing values. NOMISS excludes observations that have a missing value for either of the axis variables.

```
proc plot data=education nomiss;
```

Create a separate plot for each BY group. The BY statement creates a separate plot for each value of Region.

```
     by region;
```

Create the plot with a reference line and a label for each data point. The plot request plots Expenditures on the vertical axis, plots DropoutRate on the horizontal axis, and specifies an asterisk as the plotting symbol. The label variable specification (**$ state**) in the PLOT statement labels each point on the plot with the name of the corresponding state. HREF= draws a reference line extending from 28.6 on the horizontal axis. The reference line represents the national average. VAXIS and HAXIS are used to set the tick marks along the vertical and horizontal axes. The VSPACE=5 option specifies that there are 5 spaces between tick marks on the vertical axis and HSPACE=12 specifies that there are 12 spaces between the horizontal tick marks.

```
     plot expenditures*dropoutrate='*' $ state / href=28.6
          vaxis=by 500 vspace=5
          haxis=by 5 hspace=12;
```

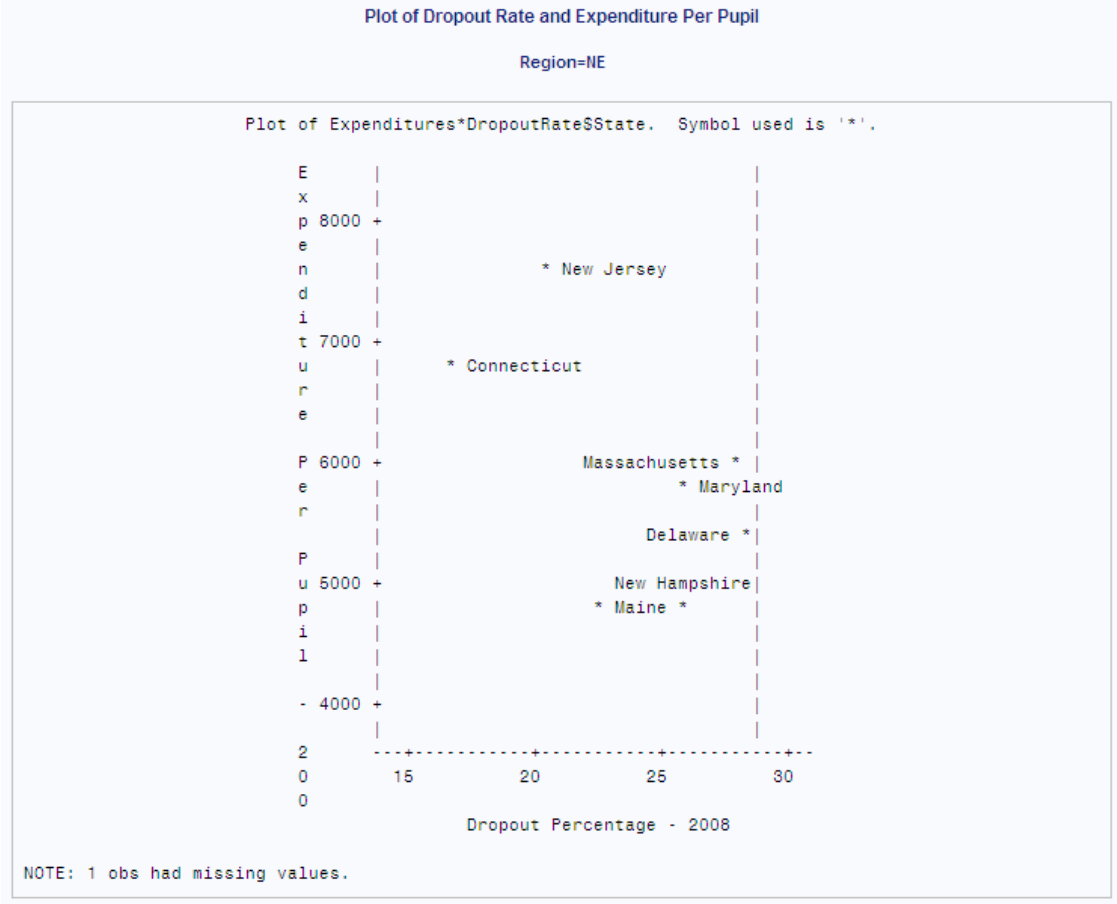
Specify the title.

```
     title 'Plot of Dropout Rate and Expenditure Per Pupil';
run;
```

Output

PROC PLOT produces a plot for each BY group. Only the plot for the **Northeast** is shown. Because **New York** has a missing value for Expenditures, the observation is excluded and PROC PLOT does not use the value 35 for DropoutRate to calculate the horizontal axis. Compare the horizontal axis in this output with the horizontal axis in the plot for **Northeast** in “Example 9: Adding Labels to a Plot” on page 1672.

Output 45.16 *Plot with Missing Values Excluded*



Example 11: Adjusting Labels on a Plot with the PLACEMENT= Option

Features:

PROC PLOT statement option
- FORMCHAR

PLOT statement

PLOT statement options
- BOX=
- LIST=
- PLACEMENT=
- HAXIS=
- HSPACE=
- VAXIS=
- VSPACE=

DATA step

RUN-group processing

Data set: CENSUS

Details

This example illustrates the default placement of labels and how to adjust the placement of labels on a crowded plot. The labels are values of variables in the data set "CENSUS" on page 2748.[1]

This example also shows RUN group processing in PROC PLOT.

Program

```
options formchar="|----|+|---+=|-/\<>*";

data census;
   input Density CrimeRate State $ 14-27 PostalCode $ 29-30;
   datalines;
263.3 4575.3 Ohio           OH
62.1 7017.1  Washington     WA

...more data lines...

111.6 4665.6 Tennessee      TN
120.4 4649.9 North Carolina NC
;


proc plot data=census;
   plot density*crimerate=state $ state /

   box
   list=1
   haxis=by 1000
   vaxis=by 250
   vspace=10
   hspace=10;

    plot density*crimerate=state $ state /
              box
              list=1
              haxis=by 1000
              vaxis=by 250
              vspace=10

           placement=((v=2 1 : l=2 1)
                 ((l=2 2 1 : v=0 1 0) * (s=right left : h=2 -2))
                 (s=center right left * l=2 1 * v=0 1 -1 2 *
                  h=0 1 to 5 by alt));

   title 'A Plot of Population Density and Crime Rates';
run;
```

1. Source: U.S. Bureau of the Census and the 1987 Uniform Crime Reports, FBI.

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the CENSUS data set. CENSUS contains the variables CrimeRate and Density for selected states. CrimeRate is the number of crimes per 100,000 people. Density is the population density per square mile in the 1980 census. A DATA step, "CENSUS" on page 2748 creates this data set.

```
data census;
   input Density CrimeRate State $ 14-27 PostalCode $ 29-30;
   datalines;
263.3 4575.3 Ohio           OH
62.1 7017.1  Washington     WA

...more data lines...

111.6 4665.6 Tennessee      TN
120.4 4649.9 North Carolina NC
;
```

Create the plot with a label for each data point. The plot request plots Density on the vertical axis, CrimeRate on the horizontal axis, and uses the first letter of the value of State as the plotting symbol. This makes it easier to match the symbol with its label. The label variable specification (`$ state`) in the PLOT statement labels each point with the corresponding state name.

```
proc plot data=census;
   plot density*crimerate=state $ state /
```

Specify plot options. BOX draws a box around the plot. LIST= lists the labels that have penalties greater than or equal to 1. HAXIS= and VAXIS= specify increments only. PROC PLOT uses the data to determine the range for the axes. The VSPACE=10 option specifies that there are 10 spaces between tick marks on the vertical axis and HSPACE=10 specifies that there are 10 spaces between the horizontal tick marks.

```
      box
      list=1
      haxis=by 1000
      vaxis=by 250
      vspace=10
      hspace=10;
```

Request a second plot. Because PROC PLOT is interactive, the procedure is still running at this point in the program. It is not necessary to restart the procedure to submit another plot request. LIST=1 produces no output because there are no penalties of 1 or greater.

```
      plot density*crimerate=state $ state /
                box
                list=1
                haxis=by 1000
```

```
      vaxis=by 250
      vspace=10
```

Specify placement options. PLACEMENT= gives PROC PLOT more placement states to use to place the labels. PLACEMENT= contains three expressions. The first expression specifies the preferred positions for the label. The first expression resolves to placement states centered above the plotting symbol, with the label on one or two lines. The second and third expressions resolve to placement states that enable PROC PLOT to place the label in multiple positions around the plotting symbol.

```
      placement=((v=2 1 : l=2 1)
            ((l=2 2 1 : v=0 1 0) * (s=right left : h=2 -2))
            (s=center right left * l=2 1 * v=0 1 -1 2 *
             h=0 1 to 5 by alt));
```

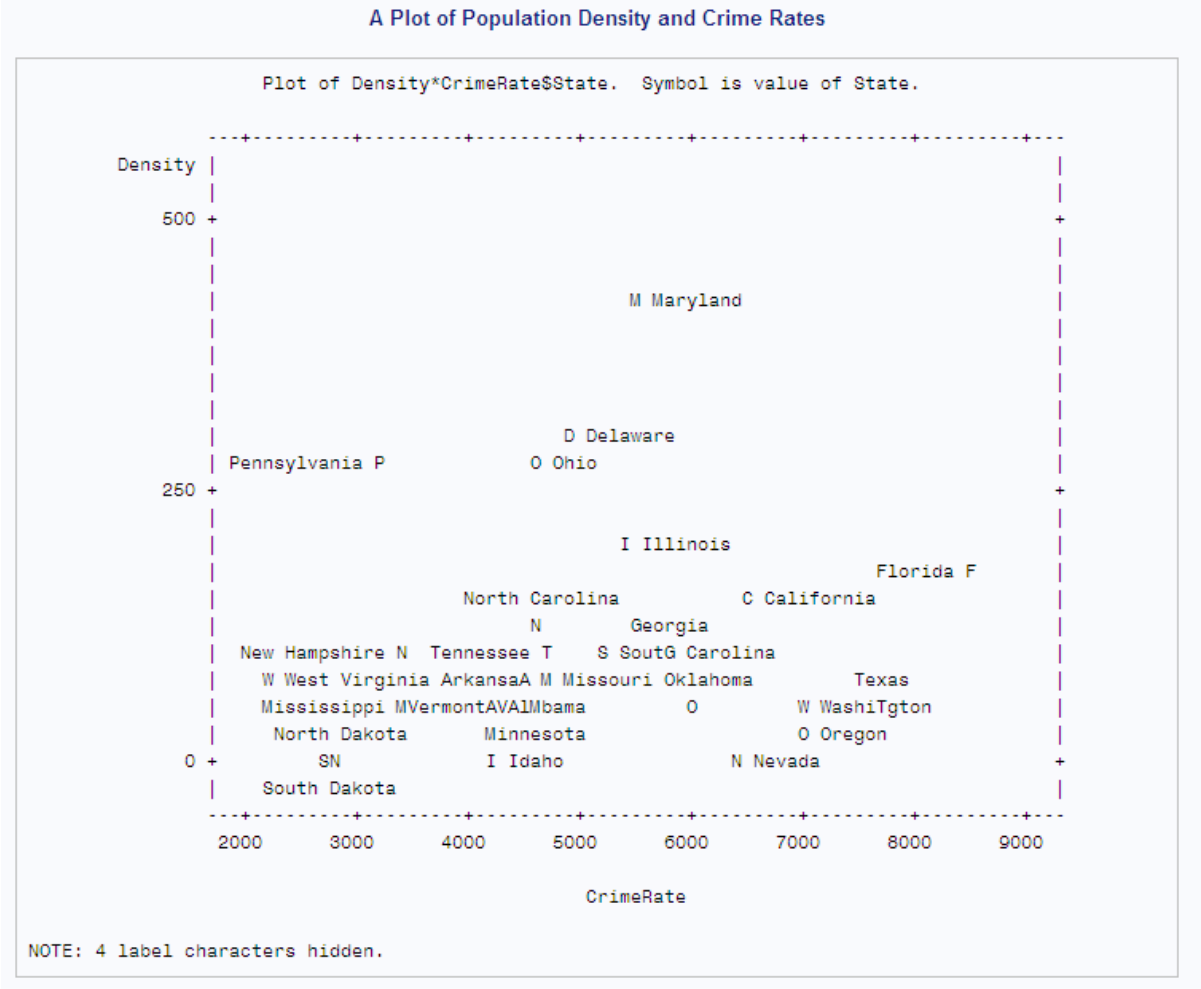
Specify the title.

```
   title 'A Plot of Population Density and Crime Rates';
run;
```

Output

The labels **Tennessee**, **South Carolina**, **Arkansas**, **Minnesota**, and **South Dakota** have penalties. The default placement states do not provide enough possibilities for PROC PLOT to avoid penalties given the proximity of the points. Four label characters are hidden.

Output 45.17 *Plot with Penalties*

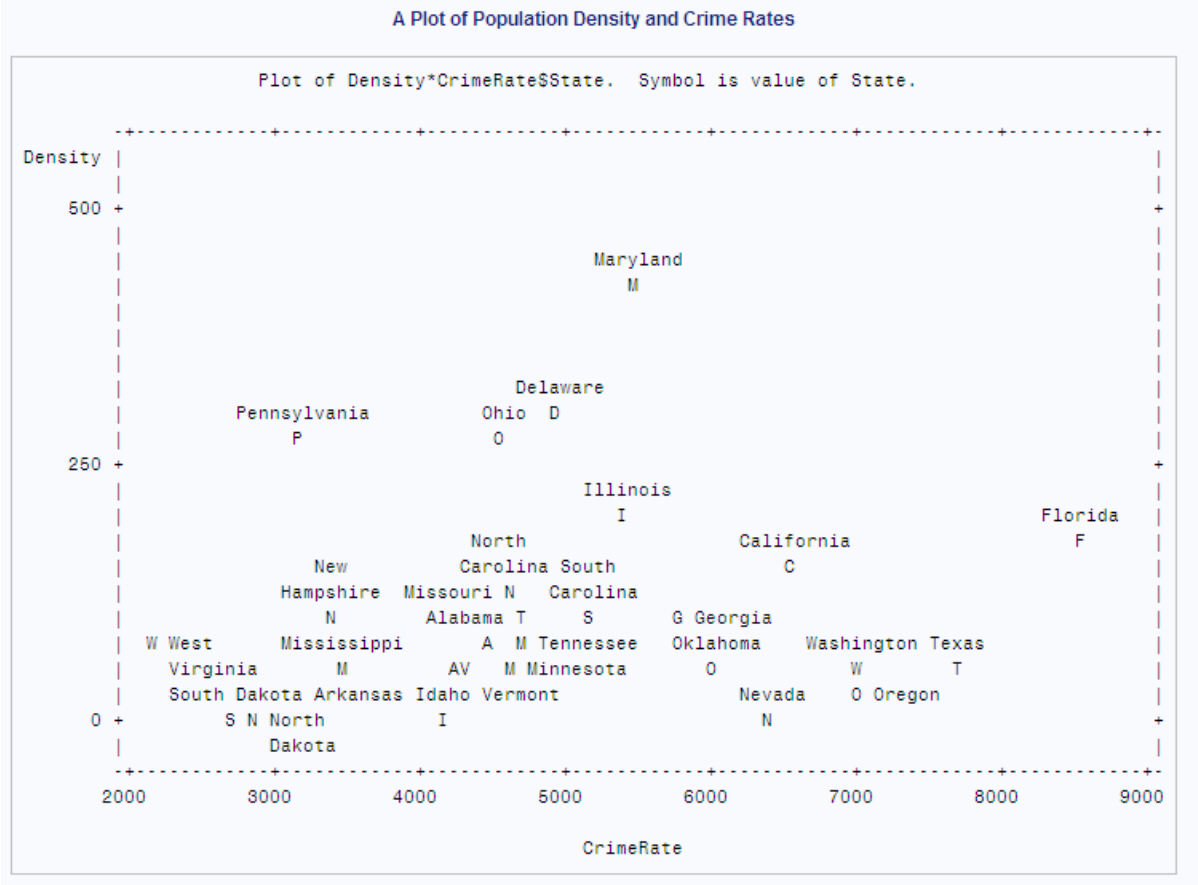


List of Point Locations, Penalties, and Placement States

Label	Vertical Axis	Horizontal Axis	Penalty	Starting Position	Lines	Vertical Shift	Horizontal Shift
South Carolina	103.40	5161.9	2	Right	1	0	2
Alabama	76.60	4451.4	9	Center	1	-1	2
Arkansas	43.90	4245.2	2	Center	1	1	-1
Vermont	55.20	4271.2	2	Left	1	0	-2
Washington	62.10	7017.1	2	Right	1	0	2

No collisions occur in the plot.

Output 45.18 *Plot with Labels Placed to Avoid Collisions*



Example 12: Adjusting Labeling on a Plot with a Macro

Features:

PROC PLOT statement option
- FORMCHAR

PLOT statement

PLOT statement option
- BOX=
- LIST=
- HAXIS=
- VAXIS=
- VSPACE=

%IF statement

%MACRO statement

Data set: CENSUS

Details

This example illustrates the default placement of labels and uses a macro to adjust the placement of labels. The labels are values of a variable in the data set "CENSUS" on page 2748.

Program

```
options formchar="|----|+|---+=|-/\<>*";

%macro place(n);
   %if &n > 13 %then %let n = 13;
       placement=(
   %if &n <= 0 %then (s=center); %else (h=2 -2 : s=right left);
   %if &n = 1 %then (v=1 * h=0 -1 to -2 by alt);
   %else %if &n = 2 %then (v=1 -1 * h=0 -1 to -5 by alt);
   %else %if &n > 2 %then (v=1 to 2 by alt * h=0 -1 to -10 by alt);
   %if &n > 3 %then
       (s=center right left * v=0 1 to %eval(&n - 2) by alt *
       h=0 -1 to %eval(-3 * (&n - 2)) by alt *
       l=1 to %eval(2 + (10 * &n - 35) / 30)); )
   %if &n > 4 %then penalty(7)=%eval((3 * &n) / 2);
%mend;

proc plot data=census;
   plot density*crimerate=state $ state /

           box
           list=1
           haxis=by 1000
           vaxis=by 250
           vspace=12
           %place(4);

   title 'A Plot of Population Density and Crime Rates';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Use conditional logic to determine placement. The %PLACE macro provides an alternative to using the PLACEMENT= option. The higher the value of n , the more freedom PROC PLOT has to place labels.

```
%macro place(n);
```

```
   %if &n > 13 %then %let n = 13;
       placement=(
   %if &n <= 0 %then (s=center); %else (h=2 -2 : s=right left);
   %if &n = 1 %then (v=1 * h=0 -1 to -2 by alt);
   %else %if &n = 2 %then (v=1 -1 * h=0 -1 to -5 by alt);
   %else %if &n > 2 %then (v=1 to 2 by alt * h=0 -1 to -10 by alt);
   %if &n > 3 %then
       (s=center right left * v=0 1 to %eval(&n - 2) by alt *
       h=0 -1 to %eval(-3 * (&n - 2)) by alt *
       l=1 to %eval(2 + (10 * &n - 35) / 30)); )
   %if &n > 4 %then penalty(7)=%eval((3 * &n) / 2);
%mend;
```

Create the plot. The plot request plots Density on the vertical axis, CrimeRate on the horizontal axis, and uses the first letter of the value of State as the plotting symbol. The label variable specification ($ state) in the PLOT statement t labels each point with the corresponding state name.

```
proc plot data=census;
   plot density*crimerate=state $ state /
```

Specify plot options. BOX draws a box around the plot. LIST= lists the labels that have penalties greater than or equal to 1. HAXIS= and VAXIS= specify increments only. PROC PLOT uses the data to determine the range for the axes. The VSPACE=12 option specifies that there are 12 spaces between tick marks on the vertical axis. The PLACE macro determines the placement of the labels.

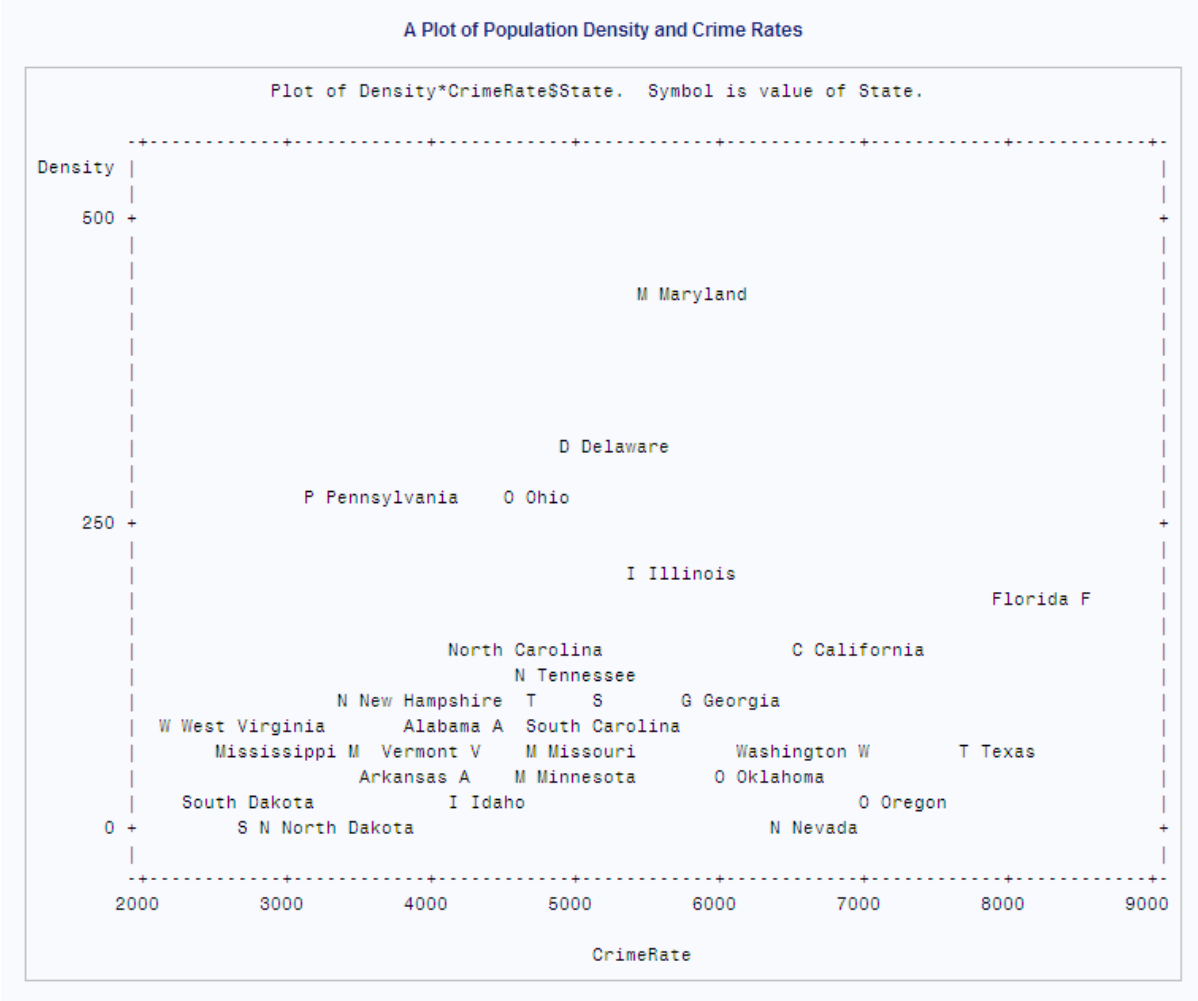
```
            box
            list=1
            haxis=by 1000
            vaxis=by 250
            vspace=12
            %place(4);
```

Specify the title.

```
   title 'A Plot of Population Density and Crime Rates';
run;
```

Output

Output 45.19 *Plot with Labels Placed Using a Macro*



Example 13: Changing a Default Penalty

Features:
- PROC PLOT statement option
  - FORMCHAR
- PLOT statement
- PLOT statement option
  - HAXIS=
  - LIST=
  - PENALTIES=
  - PLACEMENT=
  - VAXIS=
  - VSPACE=

Data set: CENSUS

Details

This example demonstrates how changing a default penalty affects the placement of labels. The goal is to produce a plot that has labels that do not detract from how the points are scattered.

Program

```
options formchar="|----|+|---+=|-/\<>*";

   proc plot data=census;
      plot density*crimerate=state $ state /

           placement=(h=100 to 10 by alt * s=left right)

           penalties(4)=500  list=0

           haxis=0 to 13000 by 1000
           vaxis=by 100
           vspace=5;

   title 'A Plot of Population Density and Crime Rates';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";

   proc plot data=census;
      plot density*crimerate=state $ state /
```

Specify the placement. PLACEMENT= specifies that the preferred placement states are 100 columns to the left and the right of the point, on the same line with the point.

```
           placement=(h=100 to 10 by alt * s=left right)
```

Change the default penalty. PENALTIES(4)= changes the default penalty for a free horizontal shift to 500, which removes all penalties for a horizontal shift. LIST= shows how far PROC PLOT shifted the labels away from their respective points.

```
           penalties(4)=500  list=0
```

Customize the axes. HAXIS= creates a horizontal axis long enough to leave space for the labels on the sides of the plot. VAXIS= specifies that the values on the vertical axis be in increments of 100. The VSPACE=5 option specifies that there are 5 spaces between tick marks on the vertical axis.

```
         haxis=0 to 13000 by 1000
         vaxis=by 100
         vspace=5;
```

Specify the title.

```
   title 'A Plot of Population Density and Crime Rates';
run;
```

Output

Output 45.20 *Plot with Default Penalties Adjusted*

A Plot of Population Density and Crime Rates

```
                              Plot of Density*CrimeRate$State.  Symbol is value of State.

 Density |
     500 +
         |
         |
         |
         |                                              M                                                      Maryland
     400 +
         |
         |
         |
         |
     300 +                                          D                                                          Delaware
         |
         |                           P           O                                                    Pennsylvania Ohio
         |
         |
     200 +                                             I                                                       Illinois
         |Florida                                                               F
         |                                                      C                                            California
         |
         |                                       T                                             North Carolina Tennessee
     100 +Georgia                      N             S    G                                New Hampshire South Carolina
         |                    W                 A M                                      Alabama Missouri West Virginia
         |Washington Texas              M     V  M                  W     T               Vermont Minnesota Mississippi
         |Oklahoma                            A             O                                                  Arkansas
         |Oregon                             I                      O                                             Idaho
       0 +                       S N                           N                       North Dakota South Dakota Nevada
         ---+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+-------+--
            0     1000    2000    3000    4000    5000    6000    7000    8000    9000    10000   11000   12000   13000

                                                            CrimeRate

NOTE: 1 obs hidden.
```

Output 45.21 *List of Point Locations, Penalties, and Placement States*

List of Point Locations, Penalties, and Placement States							
Label	Vertical Axis	Horizontal Axis	Penalty	Starting Position	Lines	Vertical Shift	Horizontal Shift
Maryland	428.70	5477.6	0	Right	1	0	55
Delaware	307.60	4938.8	0	Right	1	0	59
Pennsylvania	264.30	3163.2	0	Right	1	0	65
Ohio	263.30	4575.3	0	Right	1	0	66
Illinois	205.30	5416.5	0	Right	1	0	56
Florida	180.00	8503.2	0	Left	1	0	-64
California	151.40	6506.4	0	Right	1	0	45
Tennessee	111.60	4665.6	0	Right	1	0	61
North Carolina	120.40	4649.9	0	Right	1	0	46
New Hampshire	102.40	3371.7	0	Right	1	0	52
South Carolina	103.40	5161.9	0	Right	1	0	52
Georgia	94.10	5792.0	0	Left	1	0	-42
West Virginia	80.80	2190.7	0	Right	1	0	76
Alabama	76.60	4451.4	0	Right	1	0	41
Missouri	71.20	4707.5	0	Right	1	0	47
Mississippi	53.40	3438.6	0	Right	1	0	68
Vermont	55.20	4271.2	0	Right	1	0	44
Minnesota	51.20	4615.8	0	Right	1	0	49
Washington	62.10	7017.1	0	Left	1	0	-49
Texas	54.30	7722.4	0	Left	1	0	-49
Arkansas	43.90	4245.2	0	Right	1	0	65
Oklahoma	44.10	6025.6	0	Left	1	0	-43
Idaho	11.50	4156.3	0	Right	1	0	69
Oregon	27.40	6969.9	0	Left	1	0	-53
South Dakota	9.10	2678.0	0	Right	1	0	67
North Dakota	9.40	2833.0	0	Right	1	0	52
Nevada	7.30	6371.4	0	Right	1	0	50

46

PMENU Procedure

Overview: PMENU Procedure

What Does the PMENU Procedure Do?

The PMENU procedure defines menus that can be used in DATA step windows, macro windows, both SAS/AF and SAS/FSP windows, or in any SAS application that enables you to specify customized menus.

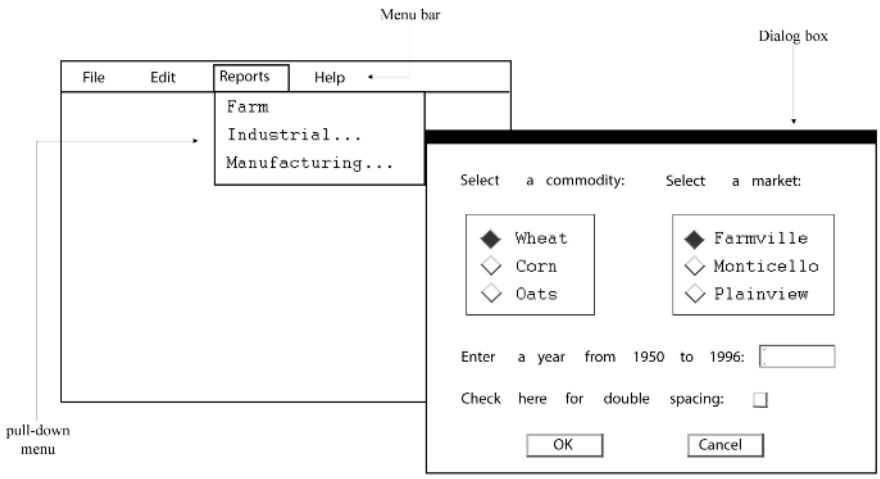
Menus can replace the command line as a way to execute commands. To activate menus, issue the PMENU command from any command line. Menus must be activated in order for them to appear.

The PMENU procedure produces no immediately visible output. It simply builds a catalog entry of type PMENU that can be used later in an application.

SAS Menus

When menus are activated, each active window has a menu bar, which lists items that you can select. Depending on which item you select, SAS either processes a command, displays a menu or a submenu, or requests that you complete information in a dialog box. The dialog box is simply a box of questions or choices that require answers before an action can be performed. The following figure illustrates features that you can create with PROC PMENU.

Figure 46.1 *Menu Bar, Menu, and Dialog Box*



Note: A menu bar in some operating environments might appear as a pop-up menu or might appear at the bottom of the window.

Concepts: PMENU Procedure

Procedure Execution

Initiating the Procedure

You can define multiple menus by separating their definitions with RUN statements. A group of statements that ends with a RUN statement is called a RUN group. You must completely define a PMENU catalog entry before submitting a RUN statement. You do not have to restart the procedure after a RUN statement.

You must include an initial MENU statement that defines the menu bar, and you must include all ITEM statements and any SELECTION, MENU, SUBMENU, and DIALOG statements as well as statements that are associated with the DIALOG statement within the same RUN group. For example, the following statements define two separate PMENU catalog entries. Both are stored in the same catalog, but each PMENU catalog entry is independent of the other. In the example, both PMENU catalog entries create menu bars that simply list windowing environment commands the user can select and execute:

```
libname proclib 'SAS-data-library';

proc pmenu catalog=proclib.mycat;
   menu menu1;
   item end;
   item bye;
run;

   menu menu2;
   item end;
   item pgm;
   item log;
   item output;
run;
```

When you submit these statements, you receive a message that says that the PMENU entries have been created. To display one of these menu bars, you must associate the PMENU catalog entry with a window and then activate the window

with the menus turned on, as described in "Steps for Building and Using PMENU Catalog Entries" on page 1694.

Ending the Procedure

Submit a QUIT, DATA, or new PROC statement to execute any statements that have not executed and end the PMENU procedure. Submit a RUN CANCEL statement to cancel any statements that have not executed and end the PMENU procedure.

Steps for Building and Using PMENU Catalog Entries

In most cases, building and using PMENU entries requires the following steps:

1. Use PROC PMENU to define the menu bars, menus, and other features that you want. Store the output of PROC PMENU in a SAS catalog. For more information, see "Associating a Menu with a Window" on page 1732.
2. Define a window using SAS/AF and SAS/FSP software, or the WINDOW or %WINDOW statement in Base SAS software.
3. Associate the PMENU catalog entry created in step 1 with a window by using one of the following:
   - the MENU= option in the WINDOW statement in Base SAS software. For more information, see "Associating a Menu with a Window" on page 1732.
   - the MENU= option in the %WINDOW statement in the macro facility.
   - the **Command Menu** field in the GATTR window in PROGRAM entries in SAS/AF software.
   - the Keys, Pmenu, and **Commands** window in a FRAME entry in SAS/AF software. See "Example 5: Associating Menus with a FRAME Application" on page 1735.
   - the PMENU function in SAS/AF and SAS/FSP software.
   - the SETPMENU command in SAS/FSP software. See "Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713.
4. Activate the window that you created. Make sure that the menus are turned on.

Templates for Coding PROC PMENU Steps

The following coding templates summarize how to use the statements in the PMENU procedure. Refer to descriptions of the statements for more information:

- Build a simple menu bar. All items on the menu bar are windowing environment commands:

```
proc pmenu;
   menu menu-bar;
   item command;
   ...more-ITEM-statements...
run;
```

- Create a menu bar with an item that produces a menu:

```
proc pmenu;
    menu menu-bar;
    item 'menu-item' menu=pull-down-menu;
    ...more-ITEM-statements...
    menu pull-down-menu;
    ...ITEM-statements-for-pull-down-menu...
run;
```

- Create a menu bar with an item that submits a command other than the one that appears on the menu bar:

```
proc pmenu;
   menu menu-bar;
   item 'menu-item' selection=selection;
   ...more-ITEM-statements...
   selection selection 'command-string';
run;
```

- Create a menu bar with an item that opens a dialog box, which displays information and requests text input:

```
proc pmenu;
   menu menu-bar;
   item 'menu-item' menu=pull-down-menu;
   ...more-ITEM-statements...
   menu pull-down-menu;
      item 'menu-item' dialog=dialog-box;
      dialog dialog-box 'command @1';
         text #line @column 'text';
         text #line @column LEN=field-length;
run;
```

- Create a menu bar with an item that opens a dialog box, which permits one choice from a list of possible values:

```
proc pmenu;
   menu menu-bar;
   item 'menu-item' menu=pull-down-menu;
   ...more-ITEM-statements...
   menu pull-down-menu;
```

```
      item 'menu-item' dialog=dialog-box;
      dialog dialog-box 'command %1';
         text #line @column 'text';
         radiobox default=button-number;
         rbutton #line @column
                 'text-for-selection';
         ...more-RBUTTON-statements...
run;
```

- Create a menu bar with an item that opens a dialog box, which permits several independent choices:

```
proc pmenu;
   menu menu-bar;
   item 'menu-item' menu=pull-down-menu;
   ...more-ITEM-statements...
   menu pull-down-menu;
      item 'menu-item' dialog=dialog-box;
      dialog dialog-box 'command &1';
         text #line @column 'text';
         checkbox #line @column 'text';
         ...more-CHECKBOX-statements...
run;
```

Syntax: PMENU Procedure

Restriction: You must use at least one MENU statement followed by at least one ITEM statement.

Tips: Supports RUN group processing

You can also use any global statement. For a list, see "Global Statements" on page 25 and "Dictionary of SAS Global Statements" in *SAS Global Statements: Reference*.

See: "PMENU Procedure: Windows" in *SAS Companion for Windows*

"PMENU Procedure: UNIX" in *SAS Companion for UNIX Environments*

"PMENU Procedure Statement: z/OS" in *SAS Companion for z/OS*

PROC PMENU <CATALOG=<*libref.*>*catalog*>
<DESC *'entry-description'*>;

MENU *menu-bar*;

ITEM *command* <*options*> <*action-options*>;

ITEM *'menu-item'* <*options*> <*action-options*>;

DIALOG *dialog-box 'command-string field-number-specification'*;

CHECKBOX <ON> #*line* @*column 'text-for-selection'*
<COLOR=*color*> <SUBSTITUTE=*'text-for-substitution'*>;

RADIOBOX DEFAULT=*button-number*;

RBUTTON <NONE> #*line* @*column'text-for-selection'*
<COLOR=*color*> <SUBSTITUTE=*'text-for-substitution'*>;

TEXT #*line* @*column field-description*
<ATTR=*attribute*> <COLOR=*color*>;

MENU *pull-down-menu*;

SELECTION *selection* '*command-string*';

SEPARATOR;

SUBMENU *submenu-name SAS-file*;

Statement	Task	Example
PROC PMENU	Define customized menus	Ex. 1
CHECKBOX	Define choices a user can make in a dialog box	
DIALOG	Describe a dialog box that is associated with an item in a menu	Ex. 2, Ex. 3, Ex. 4
ITEM	Identify an item to be listed in a menu bar or in a menu	Ex. 1, Ex. 3, Ex. 5
MENU	Name the catalog entry or define a menu	Ex. 1, Ex. 5
RADIOBOX	List and define mutually exclusive choices within a dialog box	Ex. 3
RBUTTON	List and define mutually exclusive choices within a dialog box	Ex. 3
SELECTION	Define a command that is submitted when an item is selected	Ex. 1, Ex. 4
SEPARATOR	Draw a line between items in a menu	
SUBMENU	Define a common submenu associated with an item	Ex. 1
TEXT	Specify text and the input fields for a dialog box	Ex. 2

PROC PMENU Statement

Invokes the PMENU procedure and specifies where to store all PMENU catalog entries that are created in the PROC PMENU step.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Example: "Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713

Syntax

PROC PMENU <CATALOG=<*libref*.>*catalog*>
<DESC *'entry-description'*>;

Optional Arguments

CATALOG=<*libref*.>*catalog*
specifies the catalog in which you want to store PMENU entries.

Default If you omit *libref*, then the PMENU entries are stored in a catalog in the SASUSER library. If you omit CATALOG=, then the entries are stored in the SASUSER.PROFILE catalog.

Example "Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713

DESC *'entry-description'*
provides a description for the PMENU catalog entries created in the step.

Default Menu description

Note These descriptions are displayed when you use the CATALOG window in the windowing environment or the CONTENTS statement in the CATALOG procedure.

CHECKBOX Statement

Defines choices that a user can make within a dialog box.

Restriction: Must be used after a DIALOG statement.

Syntax

CHECKBOX <ON> #*line* @*column* '*text-for-selection*'
<COLOR=*color*> <SUBSTITUTE='*text-for-substitution*'>;

Required Arguments

column
specifies the column in the dialog box where the check box and text are placed.

line
specifies the line in the dialog box where the check box and text are placed.

text-for-selection
defines the text that describes this check box. This text appears in the window and, if the SUBSTITUTE= option is not used, is also inserted into the command in the preceding DIALOG statement when the user selects the check box.

Optional Arguments

COLOR=*color*
defines the color of the check box and the text that describes it.

ON
indicates that by default this check box is active. If you use this option, then you must specify it immediately after the CHECKBOX keyword.

SUBSTITUTE='*text-for-substitution*'
specifies the text that is to be inserted into the command in the DIALOG statement.

Details

Check Boxes in a Dialog Box

Each CHECKBOX statement defines a single item that the user can select independent of other selections. That is, if you define five choices with five CHECKBOX statements, then the user can select any combination of these choices. When the user selects choices, the text-for-selection values that are associated with the selections are inserted into the command string of the previous DIALOG statement at field locations prefixed by an ampersand (&).

DIALOG Statement

Describes a dialog box that is associated with an item on a menu.

Restriction: Must be followed by at least one TEXT statement.

Examples:
"Example 2: Collecting User Input in a Dialog Box" on page 1716
"Example 3: Creating a Dialog Box to Search Multiple Variables" on page 1719
"Example 4: Creating Menus for a DATA Step Window Application" on page 1727

Syntax

DIALOG *dialog-box* '*command-string field-number-specification*';

Required Arguments

command-string

is the command or partial command that is executed when the item is selected. The limit of the *command-string* that results after the substitutions are made is the command-line limit for your operating environment. Typically, the command-line limit is approximately 80 characters.

The limit for '*command-string field-number-specification*' is 200 characters.

Note: If you are using PROC PMENU to submit any command that is valid only in the PROGRAM EDITOR window (such as the INCLUDE command), then you must have the windowing environment running, and you must return control to the PROGRAM EDITOR window.

dialog-box

is the same name specified for the DIALOG= option in a previous ITEM statement.

field-number-specification

can be one or more of the following:

@1...@*n* %1...%*n* &1...&*n*

You can embed the field numbers, for example, @1, %1, or &1, in the command string and mix different types of field numbers within a command string. The numeric portion of the field number corresponds to the relative position of TEXT, RADIOBOX, and CHECKBOX statements, not to any actual number in these statements.

@1...@*n*

are optional TEXT statement numbers that can add information to the command before it is submitted. Numbers preceded by an at sign (@) correspond to TEXT statements that use the LEN= option to define input fields.

%1...%*n*

are optional RADIOBOX statement numbers that can add information to the command before it is submitted. Numbers preceded by a percent sign (%) correspond to RADIOBOX statements following the DIALOG statement.

Note Keep in mind that the numbers correspond to RADIOBOX statements, not to RBUTTON statements.

&1...&*n*

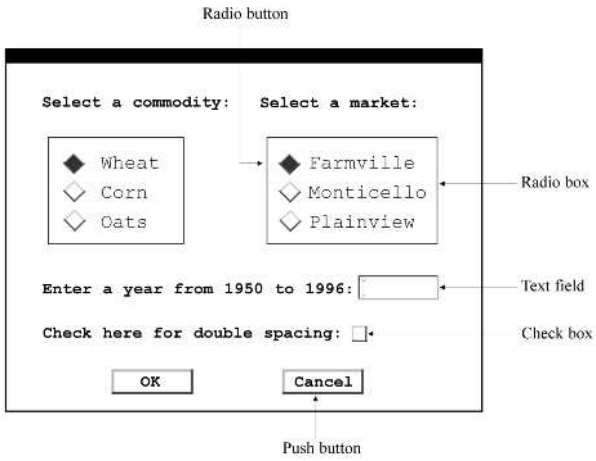
are optional CHECKBOX statement numbers that can add information to the command before it is submitted. Numbers preceded by an ampersand (&) correspond to CHECKBOX statements following the DIALOG statement.

Note To specify a literal @ (at sign), % (percent sign), or & (ampersand) in the *command-string*, use a double character: @@ (at signs), %% (percent signs), or && (ampersands).

Details

- You cannot control the placement of the dialog box. The dialog box is not scrollable. The size and placement of the dialog box are determined by your windowing environment.
- To use the DIALOG statement, specify an ITEM statement with the DIALOG= option in the ITEM statement.
- The ITEM statement creates an entry in a menu bar or in a menu, and the DIALOG= option specifies which DIALOG statement describes the dialog box.
- You can use CHECKBOX, RADIOBOX, and RBUTTON statements to define the contents of the dialog box.
- The following figure shows a typical dialog box. A dialog box can request information in three ways:
  - Fill in a field. Fields that accept text from a user are called text fields.
  - Choose from a list of mutually exclusive choices. A group of selections of this type is called a radio button, and each individual selection is called a radio button.
  - Indicate whether you want to select other independent choices. For example, you could choose to use various options by selecting any or all of the listed selections. A selection of this type is called a check box.

Figure 46.2 *A Typical Dialog Box*



Dialog boxes have two or more buttons, such as OK and Cancel, automatically built into the box. A button causes an action to occur.

Note: The actual names of the buttons vary in different windowing environments.

ITEM Statement

Identifies an item to be listed in a menu bar or in a menu.

Examples:
"Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713
"Example 3: Creating a Dialog Box to Search Multiple Variables" on page 1719
"Example 5: Associating Menus with a FRAME Application" on page 1735

Syntax

ITEM *command* <*options*> <*action-options*>;
ITEM '*menu-item*' <*options*> <*action-options*>;

Summary of Optional Arguments

ACCELERATE=*name-of-key*
: defines a key sequence that can be used instead of selecting an item.

action-option
: specifies the action for the item.

GRAY
: indicates that the item is not an active choice in this window.

HELP='*help-text*'
: specifies text that is displayed when the user displays the menu item.

ID=*integer*
: specifies a value that is used as an identifier for an item in a menu.

MNEMONIC=*character*
: defines a single character that can select the item.

STATE=CHECK | RADIO
: places a check box or a radio button next to an item.

Required Arguments

command
: a single word that is a valid SAS command for the window in which the menu appears. Commands that are more than one word, such as WHERE CLEAR, must be enclosed in single quotation marks. The *command* appears in uppercase letters on the menu bar.

  If you want to control the case of a SAS command on the menu, then enclose the command in single quotation marks. The case that you use then appears on the menu.

'menu-item'
a word or text string, enclosed in quotation marks, that describes the action that occurs when the user selects this item. A menu item should not begin with a percent sign (%).

Optional Arguments

ACCELERATE=*name-of-key*
defines a key sequence that can be used instead of selecting an item. When the user presses the key sequence, it has the same effect as selecting the item from the menu bar or menu.

Restrictions The functionality of this option is limited to only a few characters. For details, see the SAS documentation for your operating environment.

This option is not available in all operating environments. If you include this option and it is not available in your operating environment, then the option is ignored.

action-option
is one of the following:

DIALOG=*dialog-box*
specifies the name of an associated DIALOG statement, which displays a dialog box when the user selects this item.

Example "Example 3: Creating a Dialog Box to Search Multiple Variables" on page 1719

MENU=*pull-down-menu*
specifies the name of an associated MENU statement, which displays a menu when the user selects this item.

See "Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713

SELECTION=*selection*
specifies the name of an associated SELECTION statement, which submits a command when the user selects this item.

See "Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713

SUBMENU=*submenu*
associates the item with a common submenu.

specifies the name of an associated SUBMENU statement, which displays a pmenu entry when the user selects this item.

See "Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713

If no DIALOG=, MENU=, SELECTION=, or SUBMENU= option is specified, then the *command* or *menu-item* text string is submitted as a command-line command when the user selects the item.

GRAY
indicates that the item is not an active choice in this window. This option is useful when you want to define standard lists of items for many windows, but not all items are valid in all windows. When this option is set and the user selects the item, no action occurs.

HELP='*help-text*'
specifies text that is displayed when the user displays the menu item. For example, if you use a mouse to pull down a menu, then position the mouse pointer over the item and the text is displayed.

Restriction This option is not available in all operating environments. If you include this option and it is not available in your operating environment, then the option is ignored.

Tip The place where the text is displayed is operating environment-specific.

ID=*integer*
specifies a value that is used as an identifier for an item in a menu. This identifier is used within a SAS/AF application to selectively activate or deactivate items in a menu or to set the state of an item as a check box or a radio button.

Restrictions Integers from 0 to 3000 are reserved for operating environment and SAS use.

This option is not available in all operating environments. If you include this option and it is not available in your operating environment, then the option is ignored.

Note The minimum value allowed is 3001.

Tips ID= is useful with the WINFO function in SAS Component Language.

You can use the same ID for more than one item.

See "STATE=CHECK | RADIO" on page 1705

MNEMONIC=*character*
underlines the first occurrence of *character* in the text string that appears on the menu. The *character* must be in the text string.

The *character* is typically used in combination with another key, such as Alt. When you use the key sequence, it has the same effect as putting your cursor on the item. But it *does not* invoke the action that the item controls.

Restriction This option is not available in all operating environments. If you include this option and it is not available in your operating environment, then the option is ignored.

STATE=CHECK | RADIO
provides the ability to place a check box or a radio button next to an item that has been selected.

Restriction This option is not available in all operating environments. If you include this option and it is not available in your operating environment, then the option is ignored.

Tip STATE= is used with the ID= option and the WINFO function in SAS Component Language.

Details

Defining Items on the Menu Bar

You must use ITEM statements to name all the items that appear in a menu bar. You also use the ITEM statement to name the items that appear in any menus. The items that you specify in the ITEM statement can be commands that are issued when the user selects the item, or they can be descriptions of other actions that are performed by associated DIALOG, MENU, SELECTION, or SUBMENU statements.

All ITEM statements for a menu must be placed immediately after the MENU statement and before any DIALOG, SELECTION, SUBMENU, or other MENU statements. In some operating environments, you can insert SEPARATOR statements between ITEM statements to produce lines separating groups of items in a menu. For more information, see "SEPARATOR Statement" on page 1710.

Note: If you specify a menu bar that is too long for the window, then it might be truncated or wrapped to multiple lines.

MENU Statement

Names the catalog entry that stores the menus or defines a menu.

Examples: "Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713
"Example 5: Associating Menus with a FRAME Application" on page 1735

Syntax

MENU *menu-bar*;

MENU *pull-down-menu*;

Required Arguments

One of the following arguments is required:

menu-bar
names the catalog entry that stores the menus.

pull-down-menu
names the menu that appears when the user selects an item in the menu bar. The value of *pull-down-menu* must match the *pull-down-menu* name that is specified in the MENU= option in a previous ITEM statement.

Details

Defining Menus

When used to define a menu, the MENU statement must follow an ITEM statement that specifies the MENU= option. Both the ITEM statement and the MENU statement for the menu must be in the same RUN group as the MENU statement that defines the menu bar for the PMENU catalog entry.

For both menu bars and menus, follow the MENU statement with ITEM statements that define each of the items that appear on the menu. Group all ITEM statements for a menu together. For example, the following PROC PMENU step creates one catalog entry, WINDOWS, which produces a menu bar with two items, **Primary windows** and **Other windows**. When you select one of these items, a menu is displayed.

```
libname proclib 'SAS-data-library';

proc pmenu cat=proclib.mycat;

      /* create catalog entry */
   menu windows;
   item 'Primary windows' menu=prime;
   item 'Other windows' menu=other;

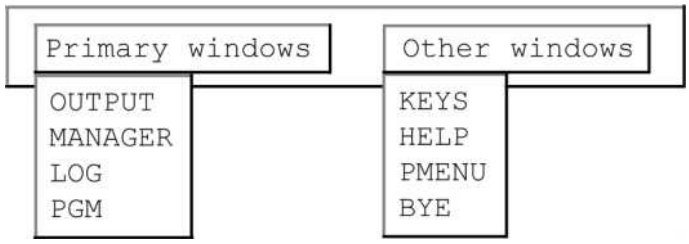
      /* create first menu */
   menu prime;
   item output;
   item manager;
   item log;
   item pgm;

      /* create second menu */
   menu other;
   item keys;
   item help;
   item pmenu;
   item bye;

   /* end of run group */
run;
```

The following figure shows the resulting menu selections.

Figure 46.3 *Menu*



RADIOBOX Statement

Defines a box that contains mutually exclusive choices within a dialog box.

Restrictions: Must be used after a DIALOG statement.

Must be followed by one or more RBUTTON statements.

Example: "Example 3: Creating a Dialog Box to Search Multiple Variables" on page 1719

Syntax

RADIOBOX DEFAULT=*button-number*;

Required Argument

DEFAULT=*button-number*
indicates which radio button is the default.

Default 1

Details

The RADIOBOX statement indicates the beginning of a list of selections. Immediately after the RADIOBOX statement, you must list an RBUTTON statement for each of the selections the user can make. When the user makes a choice, the text value that is associated with the selection is inserted into the command string of the previous DIALOG statement at field locations prefixed by a percent sign (%).

RBUTTON Statement

Lists mutually exclusive choices within a dialog box.

Restriction: Must be used after a RADIOBOX statement.

Example: "Example 3: Creating a Dialog Box to Search Multiple Variables" on page 1719

Syntax

RBUTTON <NONE> #*line* @*column*'*text-for-selection*'
<COLOR=*color*> <SUBSTITUTE='*text-for-substitution*'>;

Required Arguments

column
specifies the column in the dialog box where the radio button and text are placed.

line
specifies the line in the dialog box where the radio button and text are placed.

text-for-selection
defines the text that appears in the dialog box and, if the SUBSTITUTE= option is not used, defines the text that is inserted into the command in the preceding DIALOG statement.

Note: Be careful not to overlap columns and lines when placing text and radio buttons. If you overlap text and buttons, Then you will get an error message. Also, specify space between other text and a radio button.

Optional Arguments

COLOR=*color*
defines the color of the radio button and the text that describes the button.

Restriction This option is not available in all operating environments. If you include this option and it is not available in your operating environment, then the option is ignored.

NONE
defines a button that indicates none of the other choices. Defining this button enables the user to ignore any of the other choices. No characters, including blanks, are inserted into the DIALOG statement.

Restriction If you use this option, then it must appear immediately after the RBUTTON keyword.

SUBSTITUTE='*text-for-substitution*'
specifies the text that is to be inserted into the command in the DIALOG statement.

See "Example 3: Creating a Dialog Box to Search Multiple Variables" on page 1719

SELECTION Statement

Defines a command that is submitted when an item is selected.

Restriction: Must be used after an ITEM statement

Examples: "Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713
"Example 4: Creating Menus for a DATA Step Window Application" on page 1727

Syntax

SELECTION *selection* '*command-string*';

Required Arguments

selection
is the same name specified for the SELECTION= option in a previous ITEM statement.

command-string
is a text string, enclosed in quotation marks, that is submitted as a command-line command when the user selects this item. There is a limit of 200 characters for *command-string*. However, the command-line limit of approximately 80 characters cannot be exceeded. The command-line limit differs slightly for various operating environments.

Note: SAS uses only the first eight characters of an item that is specified with a SELECTION statement. When a user selects an item from a menu list, the first eight characters of each item name in the list must be unique so that SAS can select the correct item in the list. If the first eight characters are not unique, SAS selects the last item in the list.

Details

You define the name of the item in the ITEM statement and specify the SELECTION= option to associate the item with a subsequent SELECTION

statement. The SELECTION statement then defines the actual command that is submitted when the user chooses the item in the menu bar or menu.

You are likely to use the SELECTION statement to define a command string. You create a simple alias by using the ITEM statement, which invokes a longer command string that is defined in the SELECTION statement. For example, you could include an item in the menu bar that invokes a WINDOW statement to enable data entry. The actual commands that are processed when the user selects this item are the commands to include and submit the application.

Note: If you are using PROC PMENU to issue any command that is valid only in the PROGRAM EDITOR window (such as the INCLUDE command), then you must have the windowing environment running. Also, you must return control to the PROGRAM EDITOR window.

SEPARATOR Statement

Draws a line between items on a menu.

Restrictions: Must be used after an ITEM statement.

Not available in all operating environments.

Syntax

SEPARATOR;

SUBMENU Statement

Specifies the SAS file that contains a common submenu associated with an item.

Example: "Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713

Syntax

SUBMENU *submenu-name SAS-file*;

Required Arguments

submenu-name
specifies a name for the submenu statement. To associate a submenu with a menu item, *submenu-name* must match the submenu name specified in the SUBMENU= action-option in the ITEM statement.

SAS-file
specifies the name of the SAS file that contains the common submenu.

TEXT Statement

Specifies text and the input fields for a dialog box.

Restriction: Can be used only after a DIALOG statement.

Example: "Example 2: Collecting User Input in a Dialog Box" on page 1716

Syntax

TEXT #*line* @*column field-description*
<ATTR=*attribute*> <COLOR=*color*>;

Required Arguments

column
specifies the starting column for the text or input field.

field-description
defines how the TEXT statement is used. The *field-description* can be one of the following:

LEN=***field-length***
is the length of an input field in which the user can enter information. If the LEN= argument is used, then the information entered in the field is inserted into the command string of the previous DIALOG statement at field locations that are prefixed by an at sign (@).

See "Example 2: Collecting User Input in a Dialog Box" on page 1716

'text'
is the text string that appears inside the dialog box at the location defined by *line* and *column*.

line
specifies the line number for the text or input field.

Optional Arguments

ATTR=*attribute*
defines the attribute for the text or input field. These are valid attribute values:

- BLINK
- HIGHLIGH
- REV_VIDE
- UNDERLIN

Restrictions This option is not available in all operating environments. If you include this option and it is not available in your operating environment, then the option is ignored.

Your hardware might not support all of these attributes.

COLOR=*color*
defines the color for the text or input field characters. Here are the color values that you can use:

BLACK	BROWN
GRAY	MAGENTA
PINK	WHITE
BLUE	CYAN
GREEN	ORANGE
RED	YELLOW

Restrictions This option is not available in all operating environments. If you include this option and it is not available in your operating environment, then the option is ignored.

Your hardware might not support all of these colors.

Examples: PMENU Procedure

Example 1: Building a Menu Bar for an FSEDIT Application

Features:

PROC PMENU statement option
CATALOG=

ITEM statement options
MENU=
SELECTION=
SUBMENU=

MENU statement

SELECTION statement

SUBMENU statement

Details

This example creates a menu bar that can be used in an FSEDIT application to replace the default menu bar. The selections available on these menus do not enable end users to delete or duplicate observations.

Note:

- The windows in the PROC PMENU examples were produced in the UNIX environment and might appear slightly different from the same windows in other operating environments.
- You should know the operating environment-specific system options that can affect how menus are displayed and merged with existing SAS menus. For details, see the SAS documentation for your operating environment.

Program

```
libname proclib
```

```
'SAS-data-library';

proc pmenu catalog=proclib.menucat;

   menu project;

      item 'File' menu=f;
      item 'Edit' submenu=editmnu;
      item 'Scroll' menu=s;
      item 'Help' menu=h;

      menu f;
         item 'Goback' selection=g;
         item 'Save';
         selection g 'end';

      submenu editmnu sashelp.core.edit;

      menu s;
         item 'Next Obs' selection=n;
         item 'Prev Obs' selection=p;
         item 'Top';
         item 'Bottom';
         selection n 'forward';
         selection p 'backward';

      menu h;
         item 'Keys';
         item 'About this application' selection=hlp;
         selection hlp 'sethelp user.menucat.staffhlp.help;help';
quit;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store menu definitions.

```
libname proclib
'SAS-data-library';
```

Specify the catalog for storing menu definitions. Menu definitions will be stored in the PROCLIB.MENUCAT catalog.

```
proc pmenu catalog=proclib.menucat;
```

Specify the name of the catalog entry. The MENU statement specifies PROJECT as the name of the catalog entry. The menus are stored in the catalog entry PROCLIB.MENUCAT.PROJECT.PMENU.

```
   menu project;
```

Design the menu bar. The ITEM statements specify the items for the menu bar. The value of the MENU= option is used in a subsequent MENU statement. The Edit item uses a common predefined submenu; the menus for the other items are defined in this PROC step.

```
      item 'File' menu=f;
      item 'Edit' submenu=editmnu;
      item 'Scroll' menu=s;
      item 'Help' menu=h;
```

Design the File menu. This group of statements defines the selections available under File on the menu bar. The first ITEM statement specifies `Goback` as the first selection under File. The value of the SELECTION= option corresponds to the subsequent SELECTION statement, which specifies END as the command that is issued for that selection. The second ITEM statement specifies that the SAVE command is issued for that selection.

```
menu f;
   item 'Goback' selection=g;
   item 'Save';
   selection g 'end';
```

Add the EDITMNU submenu. The SUBMENU statement associates a predefined submenu that is located in the SAS file SASHELP.CORE.EDIT with the Edit item on the menu bar. The name of this SUBMENU statement is EDITMNU, which corresponds with the name in the SUBMENU= action-option in the ITEM statement for the Edit item.

```
submenu editmnu sashelp.core.edit;
```

Design the Scroll menu. This group of statements defines the selections available under Scroll on the menu bar.

```
menu s;
   item 'Next Obs' selection=n;
   item 'Prev Obs' selection=p;
   item 'Top';
   item 'Bottom';
   selection n 'forward';
   selection p 'backward';
```

Design the Help menu. This group of statements defines the selections available under Help on the menu bar. The SETHELP command specifies a HELP entry that contains user-written information for this FSEDIT application. The semicolon that appears after the HELP entry name enables the HELP command to be included in the string. The HELP command invokes the HELP entry.

```
menu h;
   item 'Keys';
   item 'About this application' selection=hlp;
   selection hlp 'sethelp user.menucat.staffhlp.help;help';
quit;
```

Associating a Menu Bar with an FSEDIT Session

The following SETPMENU command associates the customized menu bar with the FSEDIT window.

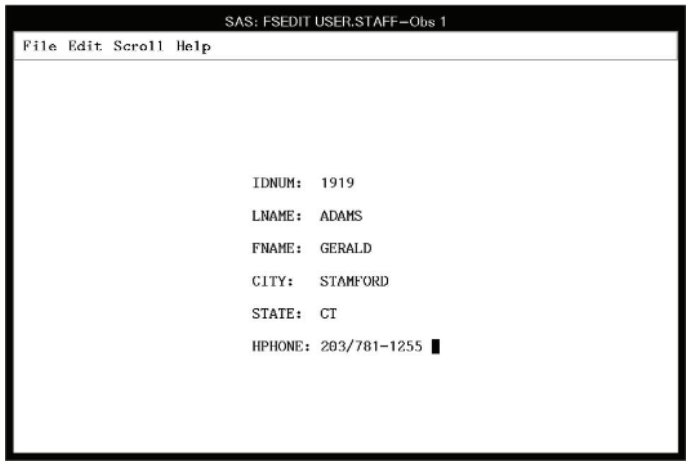
```
setpmenu proclib.menucat.project.pmenu;pmenu on
```

You can also specify the menu bar on the command line in the FSEDIT session or by issuing a CALL EXECCMD command in SAS Component Language (SCL).

For other methods of associating the customized menu bar with the FSEDIT window, see “Associating a Menu Bar with an FSEDIT Session” on page 1724.

The following FSEDIT window shows the menu bar:

Figure 46.4 *Example of a Menu Bar in an FSEDIT Window*



Example 2: Collecting User Input in a Dialog Box

Features: DIALOG statement
TEXT statement option
LEN=

Details

This example adds a dialog box to the menus created in "Example 1: Building a Menu Bar for an FSEDIT Application" on page 1713. The dialog box enables the user to use a WHERE clause to subset the SAS data set.

Tasks include these:

- collecting user input in a dialog box
- creating customized menus for an FSEDIT application

Program

```
libname proclib
'SAS-data-library';

proc pmenu catalog=proclib.menucat;

   menu project;
```

```
      item 'File' menu=f;
      item 'Edit' menu=e;
      item 'Scroll' menu=s;
      item 'Subset' menu=sub;
      item 'Help' menu=h;

      menu f;
         item 'Goback' selection=g;
         item 'Save';
         selection g 'end';

      menu e;
         item 'Cancel';
         item 'Add';

      menu s;
         item 'Next Obs' selection=n;
         item 'Prev Obs' selection=p;
         item 'Top';
         item 'Bottom';
         selection n 'forward';
         selection p 'backward';

      menu sub;
         item 'Where' dialog=d1;
         item 'Where Clear';

      menu h;
         item 'Keys';
         item 'About this application' selection=hlp;
         selection hlp 'sethelp proclib.menucat.staffhlp.help;help';

      dialog d1 'where @1';
         text #2 @3 'Enter a valid WHERE clause or UNDO';
         text #4 @3 'WHERE ';
         text #4 @10 len=40;
quit;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store menu definitions.

```
libname proclib
'SAS-data-library';
```

Specify the catalog for storing menu definitions. Menu definitions will be stored in the PROCLIB.MENUCAT catalog.

```
proc pmenu catalog=proclib.menucat;
```

Specify the name of the catalog entry. The MENU statement specifies PROJECT as the name of the catalog entry. The menus are stored in the catalog entry PROCLIB.MENUCAT.PROJECT.PMENU.

```
   menu project;
```

Design the menu bar. The ITEM statements specify the items for the menu bar. The value of the MENU= option is used in a subsequent MENU statement.

```
item 'File' menu=f;
item 'Edit' menu=e;
item 'Scroll' menu=s;
item 'Subset' menu=sub;
item 'Help' menu=h;
```

Design the File menu. This group of statements defines the selections under File on the menu bar. The first ITEM statement specifies `Goback` as the first selection under File. The value of the SELECTION= option corresponds to the subsequent SELECTION statement, which specifies END as the command that is issued for that selection. The second ITEM statement specifies that the SAVE command is issued for that selection.

```
menu f;
   item 'Goback' selection=g;
   item 'Save';
   selection g 'end';
```

Design the Edit menu. This group of statements defines the selections available under Edit on the menu bar.

```
menu e;
   item 'Cancel';
   item 'Add';
```

Design the Scroll menu. This group of statements defines the selections available under Scroll on the menu bar.

```
menu s;
   item 'Next Obs' selection=n;
   item 'Prev Obs' selection=p;
   item 'Top';
   item 'Bottom';
   selection n 'forward';
   selection p 'backward';
```

Design the Subset menu. This group of statements defines the selections available under Subset on the menu bar. The value d1 in the DIALOG= option is used in the subsequent DIALOG statement.

```
menu sub;
   item 'Where' dialog=d1;
   item 'Where Clear';
```

Design the Help menu. This group of statements defines the selections available under Help on the menu bar. The SETHELP command specifies a HELP entry that contains user-written information for this FSEDIT application. The semicolon enables the HELP command to be included in the string. The HELP command invokes the HELP entry.

```
menu h;
   item 'Keys';
   item 'About this application' selection=hlp;
   selection hlp 'sethelp proclib.menucat.staffhlp.help;help';
```

Design the dialog box. The DIALOG statement builds a WHERE command. The arguments for the WHERE command are provided by user input into the text entry fields described by the three TEXT statements. The @1 notation is a placeholder for user input in the text field. The TEXT statements specify the text in the dialog box and the length of the input field.

```
      dialog d1 'where @1';
         text #2 @3 'Enter a valid WHERE clause or UNDO';
         text #4 @3 'WHERE ';
         text #4 @10 len=40;
quit;
```

Associating a Menu Bar with an FSEDIT Window

The following SETPMENU command associates the customized menu bar with the FSEDIT window.

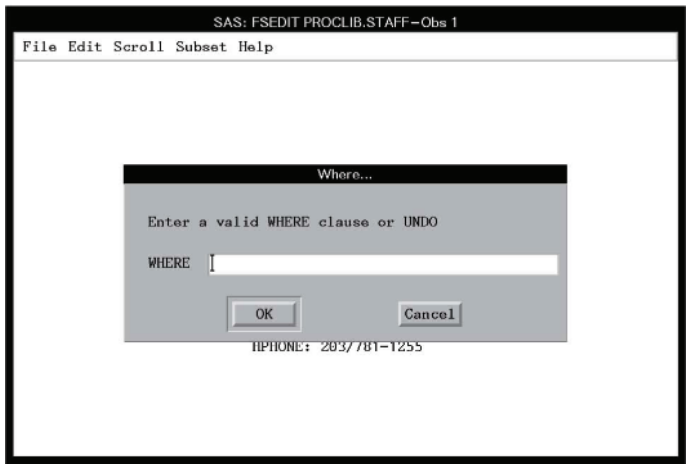
```
setpmenu proclib.menucat.project.pmenu;pmenu on
```

You can also specify the menu bar on the command line in the FSEDIT session or by issuing a CALL EXECCMD command in SAS Component Language (SCL). Refer to *SAS(R) Component Language 9.3: Reference* for complete documentation on SCL.

For other methods of associating the customized menu bar with the FSEDIT window, see "Associating a Menu Bar with an FSEDIT Session" on page 1724.

The following dialog box appears when the user chooses **Subset** and then **Where**.

Figure 46.5 *Example of a Where Dialog Box*



Example 3: Creating a Dialog Box to Search Multiple Variables

Features:

DIALOG statement
    SAS macro invocation

ITEM statement
    DIALOG= option

RADIOBOX statement option

DEFAULT=
RBUTTON statement option
SUBSTITUTE=
SAS macro invocation

Details

This example shows how to modify the menu bar in an FSEDIT session to enable a search for one value across multiple variables. The example creates customized menus to use in an FSEDIT session. The menu structure is the same as in the preceding example, except for the WHERE dialog box.

When selected, the menu item invokes a macro. The user input becomes values for macro parameters. The macro generates a WHERE command that expands to include all the variables needed for the search.

Tasks include these:

- associating customized menus with an FSEDIT session
- searching multiple variables with a WHERE clause
- extending PROC PMENU functionality with a SAS macro

Program

```
libname proclib
'SAS-data-library';

proc pmenu catalog=proclib.menucat;

   menu project;

      item 'File' menu=f;
      item 'Edit' menu=e;
      item 'Scroll' menu=s;
      item 'Subset' menu=sub;
      item 'Help' menu=h;

      menu f;
         item 'Goback' selection=g;
         item 'Save';
         selection g 'end';

      menu e;
         item 'Cancel';
         item 'Add';

      menu s;
         item 'Next Obs' selection=n;
         item 'Prev Obs' selection=p;
         item 'Top';
         item 'Bottom';
```

```
      selection n 'forward';
      selection p 'backward';

   menu sub;
      item 'Where' dialog=d1;
      item 'Where Clear';

   menu h;
      item 'Keys';
      item 'About this application' selection=hlp;
      selection hlp 'sethelp proclib.menucat.staffhlp.help;help';

    dialog d1 '%%wbuild(%1,%2,@1,%3)';

       text #1 @1 'Choose a region:';
       radiobox default=1;
          rbutton #3 @5 'Northeast' substitute='NE';
          rbutton #4 @5 'Northwest' substitute='NW';
          rbutton #5 @5 'Southeast' substitute='SE';
          rbutton #6 @5 'Southwest' substitute='SW';

       text #8 @1 'Choose a contaminant:';
       radiobox default=1;
          rbutton #10 @5  'Pollutant A' substitute='pol_a,2';
          rbutton #11 @5  'Pollutant B' substitute='pol_b,4';

       text #13 @1 'Enter Value for Search:';
       text #13 @25 len=6;

       text #15 @1 'Choose a comparison criterion:';
       radiobox default=1;
          rbutton #16 @5 'Greater Than or Equal To'
                         substitute='GE';
          rbutton #17 @5 'Less Than or Equal To'
                         substitute='LE';
          rbutton #18 @5 'Equal To' substitute='EQ';
quit;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store menu definitions.

```
libname proclib
'SAS-data-library';
```

Specify the catalog for storing menu definitions. Menu definitions will be stored in the PROCLIB.MENUCAT catalog.

```
proc pmenu catalog=proclib.menucat;
```

Specify the name of the catalog entry. The MENU statement specifies STAFF as the name of the catalog entry. The menus are stored in the catalog entry PROCLIB.MENUCAT.PROJECT.PMENU.

```
   menu project;
```

Design the menu bar. The ITEM statements specify the items for the menu bar. The value of the MENU= option is used in a subsequent MENU statement.

```
item 'File' menu=f;
item 'Edit' menu=e;
item 'Scroll' menu=s;
item 'Subset' menu=sub;
item 'Help' menu=h;
```

Design the File menu. This group of statements defines the selections under File on the menu bar. The first ITEM statement specifies `Goback` as the first selection under File. The value of the SELECTION= option corresponds to the subsequent SELECTION statement, which specifies END as the command that is issued for that selection. The second ITEM statement specifies that the SAVE command is issued for that selection.

```
menu f;
   item 'Goback' selection=g;
   item 'Save';
   selection g 'end';
```

Design the Edit menu. The ITEM statements define the selections under Edit on the menu bar.

```
menu e;
   item 'Cancel';
   item 'Add';
```

Design the Scroll menu. This group of statements defines the selections under Scroll on the menu bar. If the quoted string in the ITEM statement is not a valid command, then the SELECTION= option corresponds to a subsequent SELECTION statement, which specifies a valid command.

```
menu s;
   item 'Next Obs' selection=n;
   item 'Prev Obs' selection=p;
   item 'Top';
   item 'Bottom';
   selection n 'forward';
   selection p 'backward';
```

Design the Subset menu. This group of statements defines the selections under Subset on the menu bar. The DIALOG= option names a dialog box that is defined in a subsequent DIALOG statement.

```
menu sub;
   item 'Where' dialog=d1;
   item 'Where Clear';
```

Design the Help menu. This group of statements defines the selections under Help on the menu bar. The SETHELP command specifies a HELP entry that contains user-written information for this FSEDIT application. The semicolon that appears after the HELP entry name enables the HELP command to be included in the string. The HELP command invokes the HELP entry.

```
menu h;
   item 'Keys';
   item 'About this application' selection=hlp;
   selection hlp 'sethelp proclib.menucat.staffhlp.help;help';
```

Design the dialog box. WBUILD is a SAS macro. The double percent sign that precedes WBUILD is necessary to prevent PROC PMENU from expecting a field number to follow. The field numbers %1, %2, and %3 equate to the values that the

user specified with the radio buttons. The field number @1 equates to the search value that the user enters.

```
dialog d1 '%%wbuild(%1,%2,@1,%3)';
```

Add a radio button for region selection. The TEXT statement specifies text for the dialog box that appears on line 1 and begins in column 1. The RADIOBOX statement specifies that a radio button will appear in the dialog box. DEFAULT= specifies that the first radio button (Northeast) will be selected by default. The RBUTTON statements specify the mutually exclusive choices for the radio buttons: Northeast, Northwest, Southeast, or Southwest. SUBSTITUTE= gives the value that is substituted for the %1 in the DIALOG statement above if that radio button is selected.

```
text #1 @1 'Choose a region:';
radiobox default=1;
   rbutton #3 @5 'Northeast' substitute='NE';
   rbutton #4 @5 'Northwest' substitute='NW';
   rbutton #5 @5 'Southeast' substitute='SE';
   rbutton #6 @5 'Southwest' substitute='SW';
```

Add a radio button for pollutant selection. The TEXT statement specifies text for the dialog box that appears on line 8 (#8) and begins in column 1 (@1). The RADIOBOX statement specifies that a radio button will appear in the dialog box. DEFAULT= specifies that the first radio button (Pollutant A) will be selected by default. The RBUTTON statements specify the mutually exclusive choices for the radio buttons: Pollutant A or Pollutant B. SUBSTITUTE= gives the value that is substituted for the %2 in the preceding DIALOG statement if that radio button is selected.

```
text #8 @1 'Choose a contaminant:';
radiobox default=1;
   rbutton #10 @5  'Pollutant A' substitute='pol_a,2';
   rbutton #11 @5  'Pollutant B' substitute='pol_b,4';
```

Add an input field. The first TEXT statement specifies text for the dialog box that appears on line 13 and begins in column 1. The second TEXT statement specifies an input field that is 6 bytes long that appears on line 13 and begins in column 25. The value that the user enters in the field is substituted for the @1 in the preceding DIALOG statement.

```
text #13 @1 'Enter Value for Search:';
text #13 @25 len=6;
```

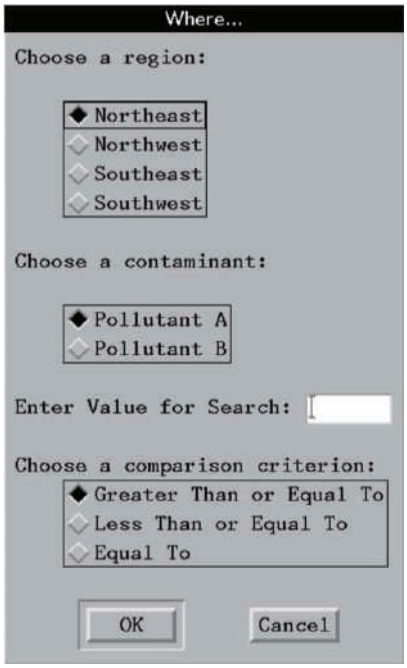
Add a radio button for comparison operator selection. The TEXT statement specifies text for the dialog box that appears on line 15 and begins in column 1. The RADIOBOX statement specifies that a radio button will appear in the dialog box. DEFAULT= specifies that the first radio button (Greater Than or Equal To) will be selected by default. The RBUTTON statements specify the mutually exclusive choices for the radio buttons. SUBSTITUTE= gives the value that is substituted for the %3 in the preceding DIALOG statement if that radio button is selected.

```
text #15 @1 'Choose a comparison criterion:';
radiobox default=1;
   rbutton #16 @5 'Greater Than or Equal To'
                  substitute='GE';
   rbutton #17 @5 'Less Than or Equal To'
                  substitute='LE';
```

```
                rbutton #18 @5 'Equal To' substitute='EQ';
   quit;
```

The following dialog box appears when the user selects Subset and then Where.

Output 46.1 *Example of a Where Dialog Box*



Details

Associating a Menu Bar with an FSEDIT Session

The SAS data set Proclib.Lakes has data about several lakes. Two pollutants, pollutant A and pollutant B, were tested at each lake. Tests were conducted for pollutant A twice at each lake, and the results are recorded in the variables POL_A1 and POL_A2. Tests were conducted for pollutant B four times at each lake, and the results are recorded in the variables POL_B1 - POL_B4. Each lake is located in one of four regions. The following example lists the contents of Proclib.Lakes:

Example Code 46.1 *Contents of the Proclib.Lakes Data Set*

```
                              PROCLIB.LAKES                              1

region    lake         pol_a1    pol_a2    pol_b1    pol_b2    pol_b3    pol_b4

  NE      Carr          0.24      0.99      0.95      0.36      0.44      0.67
  NE      Duraleigh     0.34      0.01      0.48      0.58      0.12      0.56
  NE      Charlie       0.40      0.48      0.29      0.56      0.52      0.95
  NE      Farmer        0.60      0.65      0.25      0.20      0.30      0.64
  NW      Canyon        0.63      0.44      0.20      0.98      0.19      0.01
  NW      Morris        0.85      0.95      0.80      0.67      0.32      0.81
  NW      Golf          0.69      0.37      0.08      0.72      0.71      0.32
  NW      Falls         0.01      0.02      0.59      0.58      0.67      0.02
  SE      Pleasant      0.16      0.96      0.71      0.35      0.35      0.48
  SE      Juliette      0.82      0.35      0.09      0.03      0.59      0.90
  SE      Massey        1.01      0.77      0.45      0.32      0.55      0.66
  SE      Delta         0.84      1.05      0.90      0.09      0.64      0.03
  SW      Alumni        0.45      0.32      0.45      0.44      0.55      0.12
  SW      New Dam       0.80      0.70      0.31      0.98      1.00      0.22
  SW      Border        0.51      0.04      0.55      0.35      0.45      0.78
  SW      Red           0.22      0.09      0.02      0.10      0.32
0.01
```

The "PROCLIB.LAKES" on page 2798 DATA step creates Proclib.Lakes.

The following statements initiate a PROC FSEDIT session for Proclib.Lakes:

```
proc fsedit data=proclib.lakes screen=proclib.lakes;
run;
```

To associate the customized menu bar menu with the FSEDIT session, do any one of the following:

- enter a SETPMENU command on the command line. The command for this example is

  ```
  setpmenu proclib.menucat.project.pmenu
  ```

  Turn on the menus by entering PMENU ON on the command line.
- enter the SETPMENU command in a Command window.
- include an SCL program with the FSEDIT session that uses the customized menus and turns on the menus, for example:

  ```
  fseinit:
    call execcmd('setpmenu proclib.menucat.project.pmenu;
                  pmenu on;');
  return;
  init:
  return;
  main:
  return;
  term:
  return;
  ```

How the WBUILD Macro Works

Consider how you would learn whether any of the lakes in the Southwest region tested for a value of .50 or greater for pollutant A. Without the customized menu item, you would issue the following WHERE command in the FSEDIT window:

```
where region="SW" and (pol_a1 ge .50 or pol_a2 ge .50);
```

Using the custom menu item, you would select **Southwest**, **Pollutant A**, enter .50 as the value, and choose **Greater Than or Equal To** as the comparison criterion. Two lakes, **New Dam** and **Border**, meet the criteria.

The WBUILD macro uses the four pieces of information from the dialog box to generate a WHERE command:

- One of the values for region, either **NE**, **NW**, **SE**, or **SW**, becomes the value of the macro parameter REGION.
- Either **pol_a,2** or **pol_b,4** become the values of the PREFIX and NUMVAR macro parameters. The comma is part of the value that is passed to the WBUILD macro and serves to delimit the two parameters, PREFIX and NUMVAR.
- The value that the user enters for the search becomes the value of the macro parameter VALUE.
- The operator that the user chooses becomes the value of the macro parameter OPERATOR.

To see how the macro works, again consider the following example, in which you want to know whether any of the lakes in the southwest tested for a value of .50 or greater for pollutant A. The following table contains the values of the macro parameters:

Table 46.1 *Values of the Macro Parameters*

REGION	**SW**
PREFIX	**pol_a**
NUMVAR	2
VALUE	.50
OPERATOR	GE

The first %IF statement checks to make sure that the user entered a value. If a value has been entered, then the macro begins to generate the WHERE command. First, the macro creates the beginning of the WHERE command:

```
where region="SW" and (
```

Next, the %DO loop executes. For pollutant A, it executes twice because NUMVAR=2. In the macro definition, the period in **&prefix.&i** concatenates **pol_a** with **1** and with **2**. At each iteration of the loop, the macro resolves PREFIX, OPERATOR, and VALUE, and it generates a part of the WHERE command. On the first iteration, it generates **pol_a1 GE .50**

The %IF statement in the loop checks to determine whether the loop is working on its last iteration. If it is not working, then the macro makes a compound WHERE command by putting an **OR** between the individual clauses. The next part of the WHERE command becomes **OR pol_a2 GE .50**

The loop ends after two executions for pollutant A, and the macro generates the end of the WHERE command:

```
)
```

Results from the macro are placed on the command line. The following code is the definition of the WBUILD macro. The underlined code shows the parts of the WHERE command that are text strings that the macro does not resolve:

```
%macro wbuild(region,prefix,numvar,value,operator);
       /* check to see if value is present */
    %if &value ne %then %do;
       where region="&region" AND (
              /* If the values are character,     */
              /* enclose &value in double quotation marks. */
         %do i=1 %to &numvar;
             &prefix.&i &operator &value
                /* if not on last variable,  */
                /* generate 'OR'             */
           %if &i ne &numvar %then %do;
                OR
           %end;
         %end;
          )
    %end;

%mend wbuild;
```

Example 4: Creating Menus for a DATA Step Window Application

Features: DIALOG statement
SELECTION statement
FILENAME statement

Details

This example defines an application that enables the user to enter human resources data for various departments, and to request reports from the data sets that are created by the data entry.

The first part of the example describes the PROC PMENU step that creates the menus. The subsequent sections describe how to use the menus in a DATA step window application.

Tasks include these:

- associating customized menus with a DATA step window
- creating menus for a DATA step window
- submitting SAS code from a menu selection
- creating a menu selection that calls a dialog box

Program

```
libname proclib
'SAS-data-library';

filename de     'external-file';
filename prt    'external-file';

 proc pmenu catalog=proclib.menus;

    menu select;

   item 'File' menu=f;
   item 'Data_Entry' menu=deptsde;
   item 'Print_Report' menu=deptsprt;

   menu f;
      item 'End this window' selection=endwdw;
      item 'End this SAS session' selection=endsas;
      selection endwdw 'end';
      selection endsas 'bye';

    menu deptsde;
       item 'For Dept01' selection=de1;
       item 'For Dept02' selection=de2;
       item 'Other Departments' dialog=deother;

       selection de1 'end;pgm;include de;change xx 01;submit';
       selection de2 'end;pgm;include de;change xx 02;submit';

       dialog deother 'end;pgm;include de;c deptxx @1;submit';
          text #1 @1 'Enter department name';
          text #2 @3 'in the form DEPT99:';
          text #2 @25 len=7;

     menu deptsprt;
```

```
        item 'For Dept01' selection=prt1;
        item 'For Dept02' selection=prt2;
        item 'Other Departments' dialog=prother;

        selection prt1
              'end;pgm;include prt;change xx 01 all;submit';
        selection prt2
              'end;pgm;include prt;change xx 02 all;submit';

     dialog prother 'end;pgm;include prt;c deptxx @1 all;submit';
        text #1 @1 'Enter department name';
        text #2 @3 'in the form DEPT99:';
        text #2 @25 len=7;

  run;

    menu entrdata;
       item 'File' menu=f;
       menu f;
          item 'End this window' selection=endwdw;
          item 'End this SAS session' selection=endsas;
          selection endwdw 'end';
          selection endsas 'bye';
  run;
quit;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store menu definitions.

```
libname proclib
'SAS-data-library';
```

Declare the DE and PRT filenames. The FILENAME statements define the external files in which the programs to create the windows are stored.

```
filename de     'external-file';
filename prt    'external-file';
```

Specify the catalog for storing menu definitions. Menu definitions will be stored in the PROCLIB.MENUCAT catalog.

```
 proc pmenu catalog=proclib.menus;
```

Specify the name of the catalog entry. The MENU statement specifies SELECT as the name of the catalog entry. The menus are stored in the catalog entry PROCLIB.MENUS.SELECT.PMENU.

```
    menu select;
```

Design the menu bar. The ITEM statements specify the three items on the menu bar. The value of the MENU= option is used in a subsequent MENU statement.

```
    item 'File' menu=f;
    item 'Data_Entry' menu=deptsde;
    item 'Print_Report' menu=deptsprt;
```

Design the File menu. This group of statements defines the selections under File. The value of the SELECTION= option is used in a subsequent SELECTION statement.

```
menu f;
   item 'End this window' selection=endwdw;
   item 'End this SAS session' selection=endsas;
   selection endwdw 'end';
   selection endsas 'bye';
```

Design the Data_Entry menu. This group of statements defines the selections under Data_Entry on the menu bar. The ITEM statements specify that For Dept01 and For Dept02 appear under Data_Entry. The value of the SELECTION= option equates to a subsequent SELECTION statement, which contains the string of commands that are actually submitted. The value of the DIALOG= option equates to a subsequent DIALOG statement, which describes the dialog box that appears when this item is selected.

```
menu deptsde;
   item 'For Dept01' selection=de1;
   item 'For Dept02' selection=de2;
   item 'Other Departments' dialog=deother;
```

Specify commands under the Data_Entry menu. The commands in single quotation marks are submitted when the user selects For Dept01 or For Dept02. The END command ends the current window and returns to the PROGRAM EDITOR window so that further commands can be submitted. The INCLUDE command includes the SAS statements that create the data entry window. The CHANGE command modifies the DATA statement in the included program so that it creates the correct data set. The SUBMIT command submits the DATA step program.

```
selection de1 'end;pgm;include de;change xx 01;submit';
selection de2 'end;pgm;include de;change xx 02;submit';
```

Design the DEOTHER dialog box. The DIALOG statement defines the dialog box that appears when the user selects Other Departments. The DIALOG statement modifies the command string so that the name of the department that is entered by the user is used to change `deptxx` in the SAS program that is included. The first two TEXT statements specify text that appears in the dialog box. The third TEXT statement specifies an input field. The name that is entered in this field is substituted for the @1 in the DIALOG statement.

```
dialog deother 'end;pgm;include de;c deptxx @1;submit';
   text #1 @1 'Enter department name';
   text #2 @3 'in the form DEPT99:';
   text #2 @25 len=7;
```

Design the Print_Report menu. This group of statements defines the choices under the Print_Report item. These ITEM statements specify that For Dept01 and For Dept02 appear in the menu. The value of the SELECTION= option equates to a subsequent SELECTION statement, which contains the string of commands that are actually submitted.

```
menu deptsprt;
   item 'For Dept01' selection=prt1;
   item 'For Dept02' selection=prt2;
   item 'Other Departments' dialog=prother;
```

Specify commands for the Print_Report menu. The commands in single quotation marks are submitted when the user selects For Dept01 or For Dept02. The END command ends the current window and returns to the PROGRAM EDITOR window so that further commands can be submitted. The INCLUDE command includes the SAS statements that print the report. (For more information, see "Printing a Program" on page 1734.) The CHANGE command modifies the PROC PRINT step in the included program so that it prints the correct data set. The SUBMIT command submits the PROC PRINT program.

```
selection prt1
      'end;pgm;include prt;change xx 01 all;submit';
selection prt2
      'end;pgm;include prt;change xx 02 all;submit';
```

Design the PROTHER dialog box. The DIALOG statement defines the dialog box that appears when the user selects Other Departments. The DIALOG statement modifies the command string so that the name of the department that is entered by the user is used to change `deptxx` in the SAS program that is included. The first two TEXT statements specify text that appears in the dialog box. The third TEXT statement specifies an input field. The name entered in this field is substituted for the @1 in the DIALOG statement.

```
dialog prother 'end;pgm;include prt;c deptxx @1 all;submit';
   text #1 @1 'Enter department name';
   text #2 @3 'in the form DEPT99:';
   text #2 @25 len=7;
```

End this RUN group.

```
run;
```

Specify a second catalog entry and menu bar. The MENU statement specifies ENTRDATA as the name of the catalog entry that this RUN group is creating. File is the only item on the menu bar. The selections available are End this window and End this SAS session.

```
menu entrdata;
   item 'File' menu=f;
   menu f;
      item 'End this window' selection=endwdw;
      item 'End this SAS session' selection=endsas;
      selection endwdw 'end';
      selection endsas 'bye';
run;
quit;
```

Other Examples

Associating a Menu with a Window

The first group of statements defines the primary window for the application. These statements are stored in the file that is referenced by the HRWDW fileref:

The WINDOW statement creates the HRSELECT window. MENU= associates the PROCLIB.MENUS.SELECT.PMENU entry with this window.

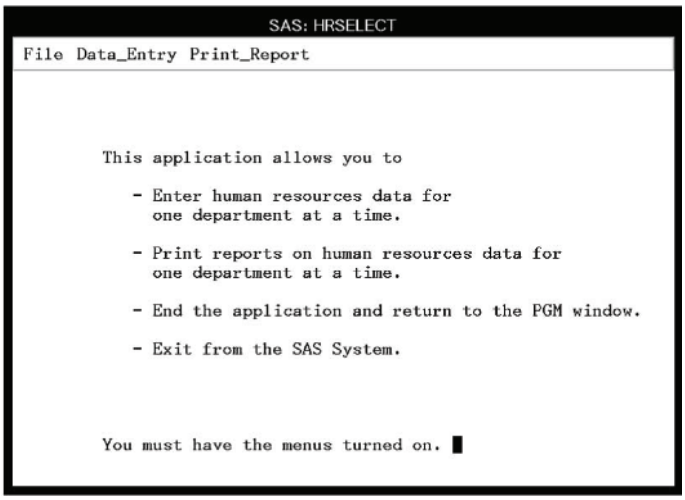
```
data _null_;
   window hrselect menu=proclib.menus.select
   #4  @10 'This application allows you to'
   #6  @13 '- Enter human resources data for'
   #7  @15 'one department at a time.'
   #9  @13 '- Print reports on human resources data for'
   #10 @15 'one department at a time.'
   #12 @13 '- End the application and return to the PGM window.'
   #14 @13 '- Exit from the SAS System.'
   #19 @10 'You must have the menus turned on.';
```

The DISPLAY statement displays the HRSELECT window.

```
   display hrselect;
run;
```

The HRSELECT window that is displayed by the DISPLAY statement:

Figure 46.6 *The HRSELECT Window*



Using a Data Entry Program

When the user selects `Data_Entry` from the menu bar in the HRSELECT window, a menu is displayed. When the user selects one of the listed departments or chooses to enter a different department, the following statements are invoked. These statements are stored in the file that is referenced by the DE fileref.

The WINDOW statement creates the HRDATA window. MENU= associates the PROCLIB.MENUS.ENTRDATA.PMENU entry with the window.

```
data proclib.deptxx;
    window hrdata menu=proclib.menus.entrdata
    #5  @10 'Employee Number'
    #8  @10 'Salary'
    #11 @10 'Employee Name'
    #5  @31 empno $4.
    #8  @31 salary 10.
    #11 @31 name $30.
    #19 @10 'Press ENTER to add the observation to the data set.';
```

The DISPLAY statement displays the HRDATA window.

```
    display hrdata;
run;
```

The %INCLUDE statement recalls the statements in the file HRWDW. The statements in HRWDW redisplay the primary window. See the HRSELECT window on page 1732

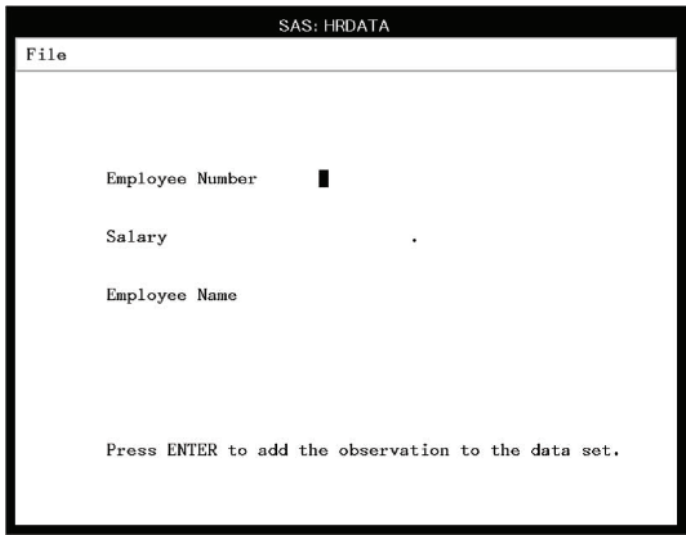
```
filename hrwdw 'external-file';
%include hrwdw;
run;
```

The SELECTION and DIALOG statements in the PROC PMENU step modify the DATA statement in this program so that the correct department name is used when the data set is created. That is, if the user selects `Other Departments` and enters `DEPT05`, then the DATA statement is changed by the command string in the DIALOG statement to

```
 data proclib.dept05;
```

The following display contains the data entry window, HRDATA.

Figure 46.7 The HRDATA Window



Printing a Program

When the user selects `Print_Report` from the menu bar, a menu is displayed. When the user selects one of the listed departments or chooses to enter a different department, the following statements are invoked. These statements are stored in the external file referenced by the PRT fileref.

PROC PRINTTO routes the output to an external file.

```
   proc printto
file='external-file' new;
   run;

   libname proclib
'SAS-data-library';

   proc print data=proclib.deptxx;
      title 'Information for deptxx';
   run;
```

This PROC PRINTTO step restores the default output destination. See Chapter 49, "PRINTTO Procedure," on page 1857.

```
   proc printto;
   run;
```

The %INCLUDE statement recalls the statements in the file HRWDW. The statements in HRWDW redisplay the primary window.

```
   filename hrwdw 'external-file';
   %include hrwdw;
   run;
```

Example 5: Associating Menus with a FRAME Application

Features: ITEM statement
MENU statement
SAS/AF software

Details

This example creates menus for a FRAME entry and gives the steps necessary to associate the menus with a FRAME entry from SAS/AF software.

Program

```
libname proclib
'SAS-data-library';

proc pmenu catalog=proclib.menucat;

   menu frame;

      item 'File' menu=f;
      item 'Help' menu=h;

      menu f;
         item 'Cancel';
         item 'End';

      menu h;
         item 'About the application' selection=a;
         item 'About the keys'   selection=k;

            selection a 'sethelp proclib.menucat.app.help;help';
            selection k 'sethelp proclib.menucat.keys.help;help';
run;
quit;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store menu definitions.

```
libname proclib
'SAS-data-library';
```

Specify the catalog for storing menu definitions. Menu definitions will be stored in the PROCLIB.MENUCAT catalog.

```
proc pmenu catalog=proclib.menucat;
```

Specify the name of the catalog entry. The MENU statement specifies FRAME as the name of the catalog entry. The menus are stored in the catalog entry PROCLIB.MENUS.FRAME.PMENU.

```
menu frame;
```

Design the menu bar. The ITEM statements specify the items in the menu bar. The value of MENU= corresponds to a subsequent MENU statement.

```
item 'File' menu=f;
item 'Help' menu=h;
```

Design the File menu. The MENU statement equates to the MENU= option in a preceding ITEM statement. The ITEM statements specify the selections that are available under File on the menu bar.

```
menu f;
   item 'Cancel';
   item 'End';
```

Design the Help menu. The MENU statement equates to the MENU= option in a preceding ITEM statement. The ITEM statements specify the selections that are available under Help on the menu bar. The value of the SELECTION= option equates to a subsequent SELECTION statement.

```
menu h;
   item 'About the application' selection=a;
   item 'About the keys'   selection=k;
```

Specify commands for the Help menu. The SETHELP command specifies a HELP entry that contains user-written information for this application. The semicolon that appears after the HELP entry name enables the HELP command to be included in the string. The HELP command invokes the HELP entry.

```
            selection a 'sethelp proclib.menucat.app.help;help';
            selection k 'sethelp proclib.menucat.keys.help;help';
run;
quit;
```

Steps to Associate Menus with a FRAME

1. In the BUILD environment for the FRAME entry, from the menu bar, select **View** ⇨ **Properties Window**.
2. In the Properties window, select the **Value** field for the pmenuEntry Attribute Name. The Select An Entry window appears.
3. In the Select An Entry window, enter the name of the catalog entry that is specified in the PROC PMENU step that creates the menus.

4 Test the FRAME as follows from the menu bar of the FRAME:**Build** ⇨ **Test**
Notice in the following display that the menus are now associated with the FRAME.

Figure 46.8 *The FRAME Window*

For more information about programming with FRAME entries, see *Getting Started with SAS/AF(R) 9.3 and Frames*.

47

PRESENV Procedure

Overview: PRESENV Procedure

What Does the PRESENV Procedure Do?

The PRESENV procedure preserves all global statements and macro variables in your SAS code from one SAS session to another. When this procedure is invoked at the end of a SAS session, all of the global statements and macro variables are written to a file. The Work data sets and the macro catalog are written to an auxiliary directory. You can then terminate the SAS session. You can restart the session at a later time, and the saved global statements and macro variable settings can be re-executed. The Work data sets can be copied back to the current Work directory, thereby allowing the session to resume.

Note: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

The PRESENV procedure works with the PRESENV system option to preserve your SAS program and data sets. You can turn the option on or off at any time. When the PRESENV system option is turned off, the global statements collection is suspended. When turned back on, the collection resumes. At no point is the collection discarded. However, the collection does not begin until the first time the option is turned on.

This functionality is very useful in a grid environment where an Enterprise Guide (EG) session needs to be terminated and started again on another node at a later time.

Concepts: PRESENV Procedure

Global Statements That Can Be Saved

If you turn on the PRESENV system option in an OPTIONS statement or at invocation time, and execute PROC PRESENV at the end of your job, then all of the following global statements that are used in your program are collected in memory:

- AXIS
- CATNAME
- FILENAME
- FOOTNOTE
- GOPTIONS
- LEGEND
- LIBNAME
- LOCK
- MISSING
- OPTIONS
- PATTERN
- SASFILE
- SYMBOL
- TITLE

Macro variables that are used in your program are also collected in memory, but other global statements, such as the X command, are not collected. Macros that are compiled during the program execution are stored in a Work directory, and that directory is copied as part of the PROC PRESENV execution.

Syntax: PRESENV Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Requirement: You must set the PRESENV system option to PRESENV (the default is NOPRESENV) to preserve the global statements. PROC PRESENV then saves a copy of those global statements to a file that you specify. Global statements are preserved from the time that the PRESENV system option is in effect.

PROC PRESENV PERMDIR=*libref* SASCODE=*fileref* <SHOW_COMMENTS>;

RUN;

Statement	Task	Example
PROC PRESENV	Preserve all global statements and macro variables from one SAS session to another	Ex. 1

PROC PRESENV Statement

Preserves all global statements and macro variables from one SAS session to another.

Syntax

PROC PRESENV PERMDIR=*libref* SASCODE=*fileref* <SHOW_COMMENTS>;

Required Arguments

PERMDIR=*libref*
specifies a libref where all of the Work data sets, catalogs, and macros are written.

SASCODE=*fileref*
specifies a fileref where a SAS program is written. The SAS program contains all of the code that is necessary to restore the environment.

Optional Argument

SHOW_COMMENTS
displays all global statements. Redundant global statements are commented out.

If this option is not used, then the global statements are suppressed.

Tip Use this option only for debugging your program, because this option can greatly increase the amount of text that is being generated.

Usage: PRESENV Procedure

Executing PROC PRESENV

To preserve your environment, execute the PRESENV procedure at the end of your job:

```
proc presenv save permdir=permdir sascode=sascode;
run;
```

The value of PERMDIR is a libref where all of the Work data sets and catalogs (including work.sasmacr) are written. The value of SASCODE is a fileref where a SAS program is written. The SAS program contains all of the code that is necessary to restore the environment.

Restoring the Environment in a Subsequent Job

To restore the environment in a subsequent job, invoke SAS without the PRESENV system option and submit the following code:

```
%include 'restore-file';
run;
```

Restore-file is the filename that is associated with the fileref in the SASCODE= argument of the original job. When you execute the program, all macros, macro variables, options, and global statements are restored to their original values.

Examples: PRESENV Procedure

Example 1: Preserve a SAS Environment

Features: PROC PRESENV statement
Macro variable definition
Macro definition
OPTIONS statement
DATA step

Details

This example shows a program with features that you want to save to use again in a later SAS session. Before you run this program, you invoke SAS and specify the PRESENV system option. Your SAS invocation command might look like this:

```
sas -presenv
```

Alternatively, you could specify the PRESENV system option in an OPTIONS statement at the beginning of your program.

This program sets the PS= and LS= system options and creates a data set called Mydata1 in the Work directory. This program also defines a macro variable MYMACVAR, defines a macro SOMEMAC, and creates a protected data set called Protected in the Work directory. At the end of the program, you define the location to save any data sets and variable definitions and you specify the name of the SAS code that restores these items in a subsequent SAS session.

Program

```
options ps=100 ls=100;

data mydata1;
a=1; b=2; c=3;
run;

%let mymacvar=123;
```

```
%macro somemac;
data mydata2;
y=3;
run;
%put Data set Mydata2 is from the saved macro somemac;
%mend;


data protected (read=mypass alter=mypass);
  x=1;
  y=2;
run;


libname preslib 'C:\Users\<userid>\sasuser\projectA\';
filename prescode 'my_sas_env';

proc presenv permdir=preslib sascode=prescode ;
run;
```

Program Description

Define system options. In the OPTIONS statement, you define the PS= and LS= system options.

```
options ps=100 ls=100;
```

Create a data set in the Work directory. You use a DATA step to create the Mydata1 data set. This data set contains one observation and three variables: A, B, and C.

```
data mydata1;
a=1; b=2; c=3;
run;
```

Define a macro variable and a macro. Use the %LET statement to define the macro variable MYMACVAR. Use the %MACRO and %MEND statements to define a new macro called SOMEMAC. The SOMEMAC macro creates a data set called Mydata2 with one observation and one variable. Then the function prints a message to the log.

```
%let mymacvar=123;

%macro somemac;
data mydata2;
y=3;
run;
%put Data set Mydata2 is from the saved macro somemac;
%mend;
```

Create a protected data set. Use a DATA step to create a data set called Protected that requires a password for Read and Write access. The data set contains one observation with two variables.

```
data protected (read=mypass alter=mypass);
  x=1;
  y=2;
run;
```

Save the data sets, variable definition, and macro definition for use in a later SAS session. Use the LIBNAME statement to define a location in which to save the data sets and macro definitions. Specify a fileref, Prescode, to use as a reference that you use to restore the current SAS environment. Call the PRESENV procedure and specify the Preslib and Prescode values that correspond to the current SAS environment. Remember the name my_sas_env so that you can restore the SAS environment in a later session.

```
libname preslib 'C:\Users\<userid>\sasuser\projectA\';
filename prescode 'my_sas_env';

proc presenv permdir=preslib sascode=prescode ;
run;
```

Output 47.1 *Output from Program That Calls PROC PRESENV*

The SAS System

Directory	
Libref	PRESLIB
Engine	V9
Physical Name	C:\Users\[redacted]\sasuser\projectA
Filename	C:\Users\[redacted]\sasuser\projectA
Owner Name	[redacted]
File Size	0KB
File Size (bytes)	0

Example 2: Restore a SAS Environment

Features: %INCLUDE statement

Details

This example shows how to restore the SAS environment to the state that it was in after running the previous example program.

Program

```
%include 'my_sas_env';


data _null_;
optval = getoption('ps');
put " ps = " optval;
optval = getoption('ls');
put " ls = " optval;
run;


%somemac;

data newdata;
x=&mymacvar;
y=2;
run;

proc print data=newdata; run;


data mydata3;
set mydata1;
run;

proc print data=mydata3; run;

proc print data=protected (read=mypass); run;
```

Program Description

Restore the previous SAS environment. Use the %INCLUDE statement to restore the SAS environment that is associated with the my_sas_env file. This restores the SAS environment to match the state when PROC PRESENV was run in a previous SAS session.

```
%include 'my_sas_env';
```

Verify the system options that were set for the my_sas_env environment. Use the GETOPTION function to request the values for the PS= and LS= system options. The PUT statement prints the values to the SAS log. These values match the values that were set in the previous example.

```
data _null_;
optval = getoption('ps');
put " ps = " optval;
optval = getoption('ls');
put " ls = " optval;
run;
```

Use a macro and a macro variable that were defined in the my_sas_env environment. Run the %SOMEMAC macro to generate the Mydata2 data set and print a message to the SAS log. Use the DATA step to create a data set called Newdata that contains the value of the MYMACVAR macro variable. Call PROC PRINT to print the contents of Newdata.

```
%somemac;

data newdata;
x=&mymacvar;
y=2;
run;

proc print data=newdata; run;
```

Work with data sets that were created in the my_sas_env environment. Use the DATA step to create a data set Mydata3 from the existing data set Mydata1. Mydata1 was created in the previous example. Call PROC PRINT to print the contents of the new data set Mydata3. Call PROC PRINT again to print the contents of the existing data set Protected. The Protected data set was created in the previous example and the protected status of the data set, which requires a password to Read or Alter it, remains in place.

```
data mydata3;
set mydata1;
run;

proc print data=mydata3; run;

proc print data=protected (read=mypass); run;
```

Output 47.2 *SAS Log That Shows Saved System Options*

```
1
2    %include 'my_sas_env';
NOTE: Libref PRESLIB was successfully assigned as follows:
      Engine:        V9
      Physical Name: C:\Users\<userid>\sasuser\projectA
40
41   data _null_;
42   optval = getoption('ps');
43   put " ps = " optval;
44   optval = getoption('ls');
45   put " ls = " optval;
46   run;

 ps = 100
 ls = 100
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

Output 47.3 *SAS Log That Shows Saved Macro Data*

```
47
48   %somemac;

NOTE: The data set WORK.MYDATA2 has 1 observations and 1 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.00 seconds

Data set Mydata2 is from the saved macro somemac
49
50   data newdata;
51   x=&mymacvar;
52   y=2;
53   run;

NOTE: The data set WORK.NEWDATA has 1 observations and 2 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.00 seconds
54
55   proc print data=newdata; run;

NOTE: There were 1 observations read from the data set WORK.NEWDATA.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.01 seconds
      cpu time            0.00 seconds
```

Output 47.4 *SAS Log That Shows Saved Data Sets*

```
56
57   data mydata3;
58   set mydata1;
59   run;

NOTE: There were 1 observations read from the data set WORK.MYDATA1.
NOTE: The data set WORK.MYDATA3 has 1 observations and 3 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.00 seconds

60
61   proc print data=mydata3; run;

NOTE: There were 1 observations read from the data set WORK.MYDATA3.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds

62
63   proc print data=protected (read=XXXXXX); run;

NOTE: There were 1 observations read from the data set WORK.PROTECTED.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.03 seconds
      cpu time            0.00 seconds
```

Output 47.5 *Results from Program to Restore a SAS Environment*

Data Set Work.Newdata

Obs	x	y
1	123	2

Data Set Work.Mydata3

Obs	a	b	c
1	1	2	3

Data Set Work.Protected

Obs	x	y
1	1	2

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PRINT Procedure

Overview: PRINT Procedure

What Does the PRINT Procedure Do?

The PRINT procedure prints the observations in a SAS data set or rows from a SAS Cloud Analytic Services (CAS) table using all or some of the variables. You can create a variety of reports ranging from a simple table to a highly customized report that groups the data and calculates totals and subtotals for numeric variables.

A Simple Report

The following output illustrates the simplest type of report that you can produce. The statements that produce the output follow. "Example 2: Selecting Variables to Print" on page 1797 creates the data set EXPREV.

```
options obs=10;
proc print data=exprev;
run;
```

TIP The OBS= system option is valid for all steps during your current SAS session or until you change the setting. To set the number of observations for a single PROC step, use the OBS= data set option:

```
proc print data=exprev(obs=10);
```

For more information, see "OBS= Data Set Option" in *SAS Data Set Options: Reference* and "OBS= System Option" in *SAS System Options: Reference* .

The SAS System

Obs	Country	Emp_ID	Order_Date	Ship_Date	Sale_Type	Quantity	Price	Cost
1	Antarctica	99999999	1/1/12	1/7/12	Internet	2	92.6	20.70
2	Puerto Rico	99999999	1/1/12	1/5/12	Catalog	14	51.2	12.10
3	Virgin Islands (U.S.)	99999999	1/1/12	1/4/12	In Store	25	31.1	15.65
4	Aruba	99999999	1/1/12	1/4/12	Catalog	30	123.7	59.00
5	Bahamas	99999999	1/1/12	1/4/12	Catalog	8	113.4	28.45
6	Bermuda	99999999	1/1/12	1/4/12	Catalog	7	41.0	9.25
7	Belize	120458	1/2/12	1/2/12	In Store	2	146.4	36.70
8	British Virgin Islands	99999999	1/2/12	1/5/12	Catalog	11	40.2	20.20
9	Canada	99999999	1/2/12	1/5/12	Catalog	100	11.8	5.00
10	Cayman Islands	120454	1/2/12	1/2/12	In Store	20	71.0	32.30

This next example creates the CAS table Mycas.Cars as a subset of the Sashelp.cars data set:

```
options cashost="cloud.example.com" casport=5555;
cas casauto;
libname mycas cas;

proc casutil outcaslib="casuser";
load data=sashelp.cars replace;
run;

data mycas.cars;
   set mycas.cars(where=(weight>6000));
   keep make model type;
run;

proc print data=mycas.cars;
   title "Cars Greater Than 6000 Pounds";
run;
```

Cars Greater Than 6000 Pounds

Obs	Make	Model	Type
1	Ford	Excursion 6.8 XLT	SUV
2	Hummer	H2	SUV
3	GMC	Yukon XL 2500 SLT	SUV

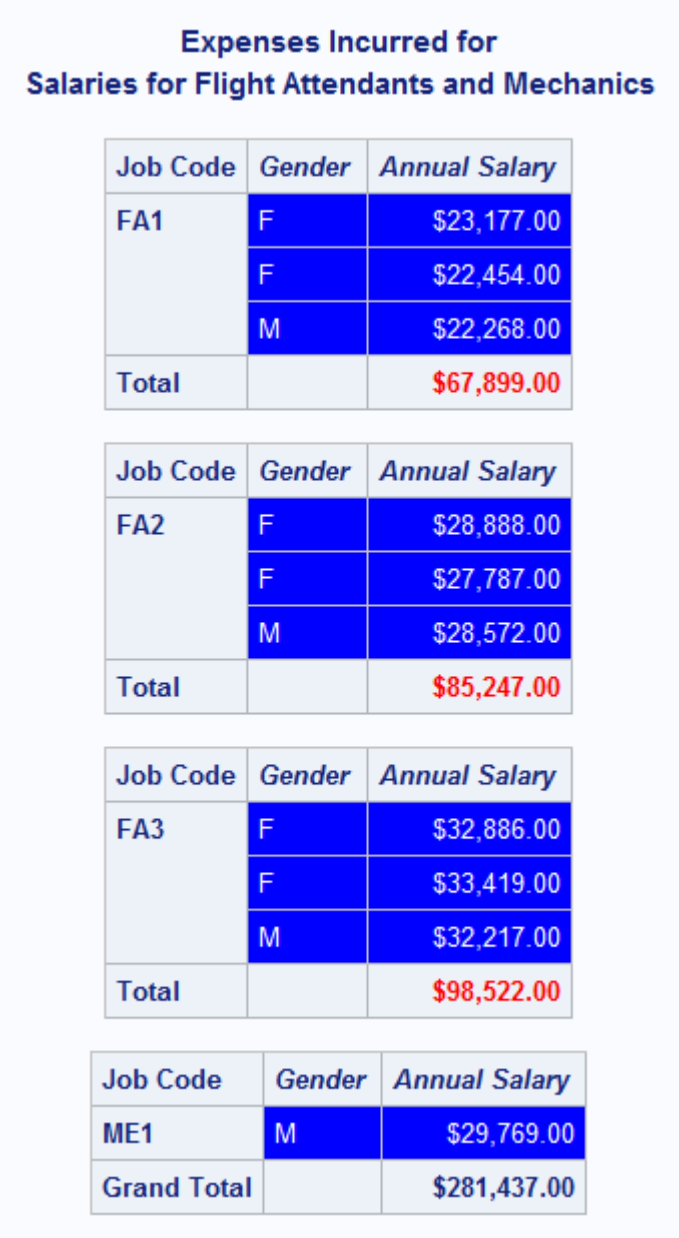
Customized Report

The following HTML report is a customized report that is produced by PROC PRINT using ODS. The statements that create this report do the following:

- customize the title and the column headings
- customize the appearance of the report
- place dollar signs and commas in numeric output
- selectively include and control the order of variables in the report
- group the data by JobCode
- sum the values for Salary for each job code and for all job codes, and add a label for the summary line and the grand total line

For an explanation of the program that produces this report, see "Program: Creating an HTML Report with the STYLE Option" on page 1849.

Figure 48.1 Customized Report Produced by PROC PRINT Using ODS



Expenses Incurred for
Salaries for Flight Attendants and Mechanics

Job Code	Gender	Annual Salary
FA1	F	$23,177.00
	F	$22,454.00
	M	$22,268.00
Total		$67,899.00

Job Code	Gender	Annual Salary
FA2	F	$28,888.00
	F	$27,787.00
	M	$28,572.00
Total		$85,247.00

Job Code	Gender	Annual Salary
FA3	F	$32,886.00
	F	$33,419.00
	M	$32,217.00
Total		$98,522.00

Job Code	Gender	Annual Salary
ME1	M	$29,769.00
Grand Total		$281,437.00

Syntax: PRINT Procedure

Interaction: A common practice is to sort a data set using PROC SORT before you use the PROC PRINT BY statement. If you sort a CAS table with VARCHAR variables using PROC SORT, VARCHAR variables are converted to CHAR variables.

Note: PROC PRINT supports the VARCHAR data type for CAS tables.

Tips:

Each password and encryption key option must be coded on a separate line to ensure that they are properly blotted in the log.

Supports the Output Delivery System. For details, see "Output Delivery System: Basic Concepts" in *SAS Output Delivery System: User's Guide*.

You can use the ATTRIB, FORMAT, LABEL, TITLE, and WHERE statements. See *SAS DATA Step Statements: Reference*. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

SAS includes checks to verify that the PROC PRINT output is accessible for the visually impaired. You can set the ACCESSIBLECHECK system option to have SAS verify if the output is accessible. For best practices about creating accessible output, see Creating Accessible Output in SAS Using ODS and ODS Graphics.

PROC PRINT <*options*>;

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...> <NOTSORTED>;

PAGEBY *BY-variable*;

SUMBY *BY-variable*;

ID *variable(s)*
</ STYLE <(*location(s)*)>=<*style-override*>>;

SUM *variable(s)*
</ STYLE <(*location(s)*)>=<*style-override*>>;

VAR *variable(s)*
</ STYLE <(*location(s)*)>=<*style-override*> >;

Statement	Task	Example
PROC PRINT	Print observations in a data set	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 6, Ex. 9
BY	Produce a separate section of the report for each BY group	Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 9
ID	Identify observations by the formatted values of the variables that you list instead of by observation numbers	Ex. 8
PAGEBY	Control page ejects that occur before a page is full	Ex. 4
SUMBY	Limit the number of sums that appear in the report	Ex. 5, Ex. 6, Ex. 7, Ex. 9
SUM	Total values of numeric variables	Ex. 7
VAR	Select variables that appear in the report and determine their order	Ex. 2, Ex. 3, Ex. 9

PROC PRINT Statement

Prints observations in a SAS data set using some or all of the variables.

Syntax

PROC PRINT <*options*>;

Summary of Optional Arguments

CONTENTS=*link-text* <#BYLINE> <#BYVAL> <#BYVAR>
: specifies text for the links in the table of contents.

DATA=*SAS-data-set*
: specifies the SAS data set to print.

Control column format

GRANDTOTAL_LABEL='*label*'
: displays a label on the grand total line.

HEADING=HORIZONTAL | VERTICAL
: controls the orientation of the column headings.

LABEL
: specifies to use the variables' labels as column headings.

SPLIT='*split-character*'
: specifies the split character, which controls line breaks in column headings.

STYLE <(*location(s)*)>=<*style-override(s)*>
: specify one or more ODS style overrides to modify the default style element and attributes in a specific area of a report.

SUMLABEL

NOSUMLABEL

SUMLABEL='*label*'
: specifies whether to display a label on the summary line for a BY group.

Control general format

BLANKLINE=*n*

BLANKLINE=(COUNT=*n* <STYLE=[*style-attibute-specification(s)*]>)
: writes a blank line after *n* observations.

DOUBLE
: writes a blank line between observations.

N<="*string-1*" <"*string-2*">>

prints the number of observations in the data set, in BY groups, or both and specifies explanatory text to print with the number.

NOOBS
suppresses the column in the output that identifies each observation by number.

OBS="*column-header*"
specifies a column heading for the column that identifies each observation by number.

ROUND
rounds unformatted numeric values to two decimal places.

Control page format

ROWS=*page-format*
formats the rows on a page.

UNIFORM
specifies to use each variable's formatted width as its column width on all pages.

WIDTH=FULL | MINIMUM | UNIFORM | UNIFORMBY
determines the column width for each variable.

Optional Arguments

BLANKLINE=*n*
BLANKLINE=(COUNT=*n* <STYLE=[*style-attibute-specification(s)*]>)
specifies to insert a blank line after every *n* observations. The observation count is reset to 0 at the beginning of each BY group for all ODS destinations.

n
COUNT=*n*
specifies the observation number after which SAS inserts a blank line.

STYLE=[*style-attribute-specification(s)*]
specifies the style attribute to use for the blank line.

Default DATA

Tip You can use the BACKGROUNDCOLOR style attribute to make a visual distinction between observations using color.

See The STYLE= option on page 1764 for valid style attributes.

Example "Example 2: Selecting Variables to Print" on page 1797

Tip SAS includes checks to verify that the PROC PRINT output is accessible for the visually impaired. When you specify the BLANKLINE= option, the output that PROC PRINT creates includes one or more lines that are not data. Screen readers and users might interpret these lines incorrectly. When you set the ACCESSIBLECHECK system option, SAS checks to see if the BLANKLINE option has been used to add blank lines to the output. If blank lines are in the output, SAS writes a warning message to the SAS log. For best practices about creating accessible output, see Creating Accessible Output in SAS Using ODS and ODS Graphics.

CONTENTS=*link-text* <#BYLINE> <#BYVAL> <#BYVAR>
specifies the text for the links in the table contents file to the output produced by the PROC PRINT statement.

link-text
specifies text to use in the table of contents.

#BYLINE
substitutes the entire BY line without leading or trailing blanks for #BYLINE in the text string. The BY line uses the format *variable-name=value*.

#BYVAL*n*
#BYVAL(*BY-variable-name*)
substitutes the current value of the specified BY variable for #BYVAL in the text string. Specify the variable with one of these values:

n
specifies a variable by its position in the BY statement. For example, #BYVAL2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAL(YEAR) specifies the BY variable, YEAR. *variable-name* is not case sensitive.

#BYVAR*n*
#BYVAR(*BY-variable-name*)
substitutes the name of the BY variable or the label associated with the variable (whatever the BY line would normally display) for #BYVAR in the text string. Specify the variable with one of these values:

n
specifies a variable by its position in the BY statement. For example, #BYVAR2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAR(SITES) specifies the BY variable, SITES. *variable-name* is not case sensitive.

Restrictions CONTENTS= does not affect the HTML body file. It affects only the HTML contents file.

CONTENTS= is not valid for the ODS LISTING destination.

See For information about HTML output, see Files Produced by the HTML Destination and "ODS HTML Statement" in *SAS Output Delivery System: User's Guide*.

DATA=*SAS-data-set*
specifies the SAS data set to print.

See "Input Data Sets" on page 26

DOUBLE
writes a blank line between observations.

Alias D

Restriction DOUBLE is valid only for the ODS LISTING destination.

Example "Example 2: Selecting Variables to Print" on page 1797

GRANDTOTAL_LABEL='*label*'
displays a label on the grand total line. You can include the #BYVAR and #BYVAL variables in '*label*'.

Aliases GRAND_LABEL

GRANDTOT_LABEL

GTOT_LABEL

GTOTAL_LABEL

Restriction The #BYVAR and #BYVAL variables are not sup ported for the LISTING destination.

Tip SAS includes checks to verify that the PROC PRINT output is accessible for the visually impaired. When you set the ACCESSIBLECHECK system option, SAS verifies whether a label is available for both the SUMLABEL and the GRANDTOTAL_LABEL options. If SAS detects that the output does not have a label for the summary and grand total values, SAS writes a message to the log. For best practices about creating accessible output, see Creating Accessible Output in SAS Using ODS and ODS Graphics.

Example "Example 6: Summing Numeric Variables with Multiple BY Variables" on page 1824

HEADING=HORIZONTAL | VERTICAL
controls the orientation of the column headings.

HORIZONTAL
prints all column headings horizontally.

Alias H

VERTICAL
prints all column headings vertically.

Alias V

Restriction For LISTING output, if the column heading is too long for the page, the variable name is used in place of a label.

Default Headings are either all horizontal or all vertical. If you omit HEADING=, PROC PRINT determines the direction of the column headings as follows:

If you do not use LABEL, spacing specifies whether column headings are vertical or horizontal.

If you use LABEL and at least one variable has a label, all headings are horizontal.

LABEL
specifies to use the variables' labels as column headings.

Alias L

Default PROC PRINT uses the name of the variable as the column heading in the following two circumstances:

1. if you omit the LABEL option in the PROC PRINT statement, even if the PROC PRINT step contains a LABEL statement
2. if a variable does not have a label

Interactions By default, if you specify LABEL and at least one variable has a label, PROC PRINT prints all column headings horizontally. Therefore, using LABEL might increase the number of pages of output. (Use HEADING=VERTICAL in the PROC PRINT statement to print vertical column headings.)

PROC PRINT sometimes conserves space by splitting labels across multiple lines. Use SPLIT= in the PROC PRINT statement to control where these splits occur. You do not need to use LABEL if you use SPLIT=.

Note The SAS system option LABEL must be in effect in order for any procedure to use labels. For more information see "LABEL System Option" in *SAS System Options: Reference*.

Tip To create a blank column heading for a variable, use this LABEL statement in your PROC PRINT step:

```
label variable-name='00'x;
```

See For information about using the LABEL statement to create temporary labels in procedures, see Chapter 3, "Statements with the Same Function in Multiple Procedures," on page 73.

For information about using the LABEL statement in a DATA step to create permanent labels, see "LABEL" in *SAS DATA Step Statements: Reference*.

Example "Example 4: Creating Separate Sections of a Report for Groups of Observations" on page 1809

N<="*string-1*" <"*string-2*">>
prints the number of observations in the data set, in BY groups, or both and specifies explanatory text to print with the number.

N Option Use	PROC PRINT Action
With neither a	Prints the number of observations in the data set at the end of the report and labels the number with the value of *string-1*.

N Option Use	PROC PRINT Action
BY nor a SUM statement	
With a BY statement	Prints the number of observations in the BY group at the end of each BY group and labels the number with the value of *string-1*.
With a BY statement and a SUM statement	Prints the number of observations in the BY group at the end of each BY group and prints the number of observations in the data set at the end of the report. The numbers for BY groups are labeled with *string-1*; the number for the entire data set is labeled with *string-2*.

Tip SAS includes checks to verify that the PROC PRINT output is accessible for the visually impaired. When you specify the N= option, the output that PROC PRINT creates includes a text line that is not data. Screen readers might interpret this line of text as data. When you set the ACCESSIBLECHECK system option, SAS verifies whether the output is accessible. If the output contains the text that is not data, SAS writes a warning message to the SAS log. For best practices about creating accessible output, see Creating Accessible Output in SAS Using ODS and ODS Graphics.

Examples "Example 3: Customizing Text in Column Headings" on page 1803

"Example 4: Creating Separate Sections of a Report for Groups of Observations" on page 1809

"Example 5: Summing Numeric Variables with One BY Group" on page 1819

NOOBS
suppresses the column in the output that identifies each observation by number.

Example "Example 4: Creating Separate Sections of a Report for Groups of Observations" on page 1809

OBS="*column-header*"
specifies a column heading for the column that identifies each observation by number.

Tip OBS= honors the split character. (See the discussion of the SPLIT= option on page 1764.)

Example "Example 3: Customizing Text in Column Headings" on page 1803

ROUND

rounds unformatted numeric values to two decimal places. (Formatted values are already rounded by the format to the specified number of decimal places.) For both formatted and unformatted variables, PROC PRINT uses these rounded values to calculate any sums in the report.

If you omit ROUND, PROC PRINT adds the actual values of the rows to obtain the sum *even though it displays the formatted (rounded) values*. Any sums are also rounded by the format, but they include only one rounding error, that of rounding the sum of the actual values. The ROUND option, on the other hand, rounds values before summing them, so there might be multiple rounding errors. The results without ROUND are more accurate, but ROUND is useful for published reports where it is important for the total to be the sum of the printed (rounded) values.

Be aware that the results from PROC PRINT with the ROUND option might differ from the results of summing the same data with other methods such as PROC MEANS or the DATA step. Consider a simple case in which the following is true:

- The data set contains three values for X: .003, .004, and .009.
- X has a format of 5.2.

Depending on how you calculate the sum, you can get three different answers: 0.02, 0.01, and 0.016. The following figure shows the results of calculating the sum with PROC PRINT (without and with the ROUND option) and PROC MEANS.

Figure 48.2 *Three Methods of Summing Variables*

```
                   PROC  PRINT  without        PROC  PRINT  with
 Actual  Va lues   the  ROUND   optio n        t he  ROUND  option          PROC  MEANS
===============================================================================
               ||                        ||                       ||
               ||   OBS             X    ||  OB S             X   || Analysis  Variable  : X
               ||                        ||                       ||
  .003         ||    1           0.00    ||   1            0.00   ||          Sum
  .004         ||    2           0.00    ||   2            0.00   ||-----------
  .009         ||    3           0.01    ||   3            0.01   ||  0.0160000
 =====         ||                =====   ||                =====  || -----------
  .016         ||                0.02    ||                0.01   ||
               ||                        ||                       ||
===============================================================================
```

Notice that the sum produced without the ROUND option (.02) is closer to the actual result (0.16) than the sum produced with ROUND (0.01). However, the sum produced with ROUND reflects the numbers that are displayed in the report.

Alias R

CAUTION **Do not use ROUND with PICTURE formats.** ROUND is for use with numeric values. SAS procedures treat variables that have picture formats as character variables. Using ROUND with such variables might lead to unexpected results.

ROWS=*page-format*
formats the rows on a page. Currently, PAGE is the only value that you can use for *page-format*:

PAGE
prints only one row of variables for each observation per page. When you use ROWS=PAGE, PROC PRINT does not divide the page into sections; it prints as many observations as possible on each page. If the observations do not fill the last page of the output, PROC PRINT divides the last page into sections and prints all the variables for the last few observations.

Restriction ROWS= is valid only for the ODS LISTING destination. Therefore, HTML output from PROC PRINT appears the same if you use ROWS=.

Tip The PAGE value can reduce the number of pages in the output if the data set contains large numbers of variables and observations. However, if the data set contains a large number of variables but few observations, the PAGE value can increase the number of pages in the output.

See "Page Layout for Limited Page Sizes" on page 1792 for discussion of the default layout.

Example "Example 8: Controlling the Layout of a Report with Many Variables" on page 1839

SPLIT='*split-character*'
specifies the split character, which controls line breaks in column headings. It also uses labels as column headings. PROC PRINT breaks a column heading when it reaches the split character and continues the header on the next line. The split character is not part of the column heading although each occurrence of the split character counts toward the 256-character maximum for a label.

Alias S=

Interactions You do not need to use both LABEL and SPLIT= because SPLIT= implies the use of labels.

The OBS= option honors the split character. (See the discussion of "OBS="*column-header*"" on page 1762.)

Note PROC PRINT does not split labels of BY variables in the heading preceding each BY group, a summary label, or a grand total level, even if you specify SPLIT=. Instead, PROC PRINT replaces the split character with a blank.

Example "Example 3: Customizing Text in Column Headings" on page 1803

STYLE <(*location(s)*)>=<*style-override(s)*>
specify one or more ODS style overrides to modify the default style element and attributes in a specific area of a report.

You can specify a style override in two ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.

style-override has the following form:

style-element-name | [*style-attribute-name-1=style-attribute-value-1*

<*style-attribute-name-2=style-attribute-value-2 ...*>]

location

identifies the part of the report that the STYLE option affects. If *location(s)* is not specified, PROC PRINT determines the location to where the style override is applied based on the statement, the specified style element, and the style attribute.

The following table shows the available locations and the other statements in which you can specify them.

Table 48.1 *Specifying Locations in the STYLE Option*

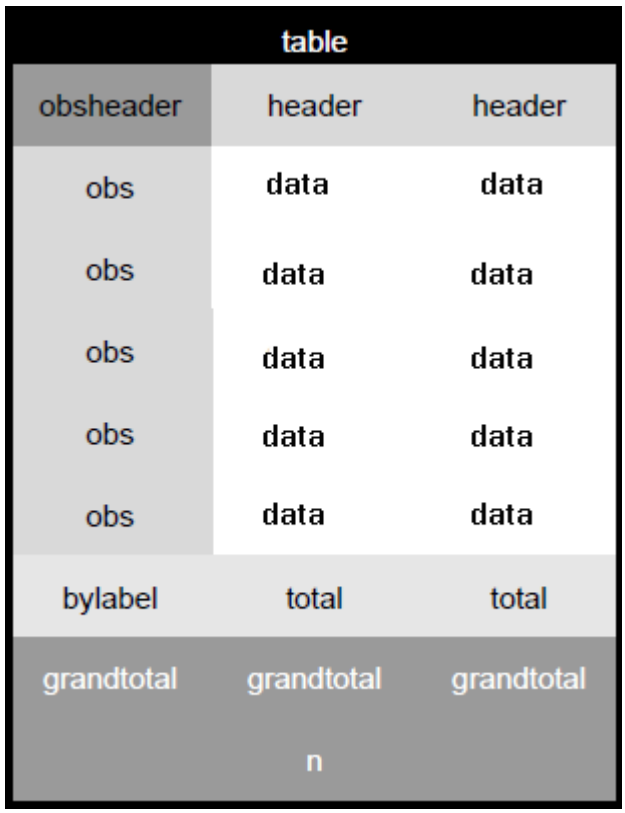
Location	Location Alias	Affected Report Part	Can Also Be Used in These Statements
BYLABEL	BYSUMLABEL BYLBL BYSUMLBL	Label for the BY variable on the line containing the SUM totals	None
DATA	COLUMN COL	All data except for data in the OBS column or the ID columns Or Data in the ID columns when the DATA location is specified in the STYLE= option of the ID statement	VAR ID SUM
GRANDTOTAL	GRANDTOT GRAND GTOTAL GTOT	SUM line containing the grand totals for the whole report	SUM
HEADER	HEAD HDR	All column headings except for the OBS	VAR ID

Location	Location Alias	Affected Report Part	Can Also Be Used in These Statements
		column or the ID columns [1] Or All column headings of the ID columns when the HEADER location is specified in the STYLE= option of the ID statement	SUM
N	None	N= table and contents	None
OBS	OBSDATA OBSCOLUMN OBSCOL	Data in the OBS column or the ID columns unless the DATA location is specified in the STYLE= option of the ID statement	None
OBSHEADER	OBSHEAD OBSHDR	Header of the OBS column or the ID columns unless the HEADER location is specified in the STYLE= option of the ID statement [1]	None
TABLE	REPORT	Structural part of the report - that is, the underlying table used to set things like the width of the border and the space between cells	None
TOTAL	TOT BYSUMLINE BYLINE	SUM line containing totals for each BY group	SUM

Location	Location Alias	Affected Report Part	Can Also Be Used in These Statements
	BYSUM		

1 Prior to SAS 9.4, if you specified the HEADER location in the STYLE= option of the PROC PRINT statement, all column headings rendered using the HEADER style attributes. In SAS 9.4, you use the OBSHEADER location in the STYLE= option of the PROC PRINT statement to format the OBS column and the ID columns. The PROC PRINT statement STYLE= option in your existing programs might need to include the OBSHEADER location as well as the HEADER location.

Figure 48.3 *PROC PRINT Areas and Corresponding Statements*



Style specifications in a statement other than the PROC PRINT statement override the same style specification in the PROC PRINT statement. However, style attributes that you specify in the PROC PRINT statement are inherited, provided that you do not override the style with style specifications in another statement. For example, if you specify a blue background and a white foreground for all column headings in the PROC PRINT statement, and you specify a light gray background for an ID column heading, the background for the ID column heading is light gray, and the foreground is white (as specified in the PROC PRINT statement). This PRINT procedure shows the inheritance of the color white in the ID column heading:

```
proc print data=exprev style(header)={backgroundcolor=blue color=white};
   id country / style(obsheader)=[backgroundcolor=light gray];
run;
```

The SAS System

Country	Emp_ID	Order_Date	Ship_Date	Sale_Type	Quantity	Price	Cost
Antarctica	99999999	1/1/12	1/7/12	Internet	2	92.6	20.70

If the same style attributes appear for the OBSHEADER location in the PROC PRINT statement and the HEADER location in the ID statement, the HEADER location attributes override the OBSHEADER attributes. All other style attributes for the ID columns in both the PROC PRINT statement and the ID statement are merged to create the style for the ID columns. For example, in the PROC PRINT statement, the attributes for the OBSHEADER location are `{fontsize=5 fontweight=bold}`. In the ID statement, the attributes for the HEADER location are `[fontsize=6 fontstyle=italic]`. The resulting style for the ID column is `[fontsize=6 fontweight=bold fontstyle=italic]`.

```
proc print data=exprev style(obsheader)={fontsize=5 fontweight=bold};
   id country / style(header)=[fontsize=6 fontstyle=italic];
run;
```

The SAS System

Country	Emp_ID	Order_Date	Ship_Date	Sale_Type	Quantity	Price	Cost
Antarctica	99999999	1/1/12	1/7/12	Internet	2	92.6	20.70

If the same style attributes appear for the OBS location in the PROC PRINT statement and the DATA location in the ID statement, the DATA location attributes override the OBS attributes. All other style attributes for the ID columns in both the PROC PRINT statement and the ID statement are merged to create the style for the ID columns. For example, in the PROC PRINT statement, the attributes for the OBS location are `{backgroundcolor=light gray color=blue}`. In the ID statement, the attributes for the DATA location are `[color=white fontstyle=italic]`. The resulting style for the ID column is `[backgroundcolor=light gray color=white fontstyle=italic]`.

```
proc print data=exprev style(obs)={backgroundcolor=light gray color=blue};
   id country / style(data)=[color=white fontstyle=italic];
run;
```

The SAS System

Country	Emp_ID	Order_Date	Ship_Date	Sale_Type	Quantity	Price	Cost
Antarctica	99999999	1/1/12	1/7/12	Internet	2	92.6	20.70
Puerto Rico	99999999	1/1/12	1/5/12	Catalog	14	51.2	12.10
Virgin Islands (U.S.)	99999999	1/1/12	1/4/12	In Store	25	31.1	15.65

style-element-name
is the name of a style element in a style template that is registered with the Output Delivery System. SAS provides some style templates. Users can create their own style templates with the TEMPLATE procedure. See *SAS Output Delivery System: Procedures Guide*.

When style elements are processed, more specific style elements override less specific style elements. For a table of default style elements and style attributes for each PROC PRINT location, see Table 48.95 on page 1789.

Tip You can use compound names and formats for style element names. An example of using a compound style element name is `style(obsheader)=data.italic.red;`. An example of using a format element name is `style=$cities`. For more information about using formats, see the *SAS Output Delivery System: Procedures Guide*.

style-attribute-specification
describes the style attribute to change. Each *style-attribute-specification* has this general form:

style-attribute-name=style-attribute-value

You can set these style attributes in the TABLE location:

BACKGROUNDCOLOR=	FONTWIDTH= [1]
BACKGROUNDIMAGE=	COLOR= [1]
BORDERCOLOR=	FRAME=
BORDERCOLORDARK=	HTMLCLASS=
BORDERCOLORLIGHT=	TEXTALIGN=
BORDERWIDTH=	OUTPUTWIDTH=
CELLPADDING=	POSTHTML=
CELLSPACING=	POSTIMAGE=
FONT= [1]	POSTTEXT=
FONTFAMILY= [1]	PREHTML=
FONTSIZE= [1]	PREIMAGE=
FONTSTYLE= [1]	PRETEXT=
FONTWEIGHT= [1]	RULES=

1 When you use these attributes, they affect only the text that is specified with the PRETEXT=, POSTTEXT=, PREHTML=, and POSTHTML= attributes. To alter the foreground color or the font for the text that appears in the table, you must set the corresponding attribute in a location that affects the cells rather than the table.

You can set these style attributes in all locations other than TABLE:

ASIS=	FONTWIDTH=
BACKGROUNDCOLOR=	HREFTARGET=
BACKGROUNDIMAGE=	CLASS=
BORDERCOLOR=	TEXTALIGN=
BORDERCOLORDARK=	NOBREAKSPACE=
BORDERCOLORLIGHT=	POSTHTML=
BORDERWIDTH=	POSTIMAGE=
HEIGHT=	POSTTEXT=
CELLWIDTH=	PREHTML=
FLYOVER=	PREIMAGE=
FONT=	PRETEXT=
FONTFAMILY=	PROTECTSPECIALCHARACTERS=
FONTSIZE=	TAGATTR=
FONTSTYLE=	URL=
FONTWEIGHT=	VERTICALALIGN=

Restriction STYLE= is not valid for the ODS LISTING or ODS OUTPUT destinations.

See For a table of style attributes that can be used with PROC TABULATE, PROC REPORT, and PROC PRINT, see Table 48.94 on page 1786.

For a table of default style elements and style attributes for each PROC PRINT location, see Table 48.95 on page 1789.

For more information about using styles with PROC PRINT, see "Use ODS Styles with PROC PRINT" on page 1780.

For information about style attributes and PROC TEMPLATE, see DEFINE Style Statement in *SAS Output Delivery System: Procedures Guide*.

SUMLABEL
NOSUMLABEL
SUMLABEL='*label*'
specifies whether to display a label on the summary line for a BY group.

SUMLABEL
specifies to use the variable label, if it exists, as the label on the summary line in place of the variable name.

NOSUMLABEL
specifies to leave the label on the summary line blank. Alternatively, you can use SUMLABEL="" (two single or double quotation marks with no space between them) to indicate a blank on the summary line.

SUMLABEL='*label*'
specifies the text to use as a label on the summary line of a BY group. You can include the #BYVAR and #BYVAL variables in '*label*'.

Restriction The #BYVAR and #BYVAL variables are not supported for the LISTING destination.

Default If you omit SUMLABEL, PROC PRINT uses the BY variable names in the summary line.

Tip SAS includes checks to verify that the PROC PRINT output is accessible for the visually impaired. When you set the ACCESSIBLECHECK system option, SAS verifies whether a label is available for both the SUMLABEL and the GRANDTOTAL_LABEL options. If SAS detects that the output does not have a label for the summary and grand total values, SAS writes a message to the log. For best practices about creating accessible output, see Creating Accessible Output in SAS Using ODS and ODS Graphics.

Examples "Example 5: Summing Numeric Variables with One BY Group" on page 1819

"Example 6: Summing Numeric Variables with Multiple BY Variables" on page 1824

UNIFORM
See WIDTH=UNIFORM on page 1771.

WIDTH=FULL | MINIMUM | UNIFORM | UNIFORMBY
determines the column width for each variable.

FULL
uses a variable's formatted width as the column width. If the variable does not have a format that explicitly specifies a field width, PROC PRINT uses the default width. For a character variable, the default width is the length of the variable. For a numeric variable, the default width is 12. When you use WIDTH=FULL, the column widths do not vary from page to page.

Tip Using WIDTH=FULL can reduce execution time.

MINIMUM
uses for each variable the minimum column width that accommodates all values of the variable.

Alias MIN

UNIFORM
uses each variable's formatted width as its column width on all pages. If the variable does not have a format that explicitly specifies a field width, PROC PRINT uses the widest data value as the column width. When you specify WIDTH=UNIFORM, PROC PRINT normally needs to read the data set twice. However, if all the variables in the data set have formats that explicitly specify a field width (for example, BEST12. but not BEST.), PROC PRINT reads the data set only once.

Alias U

Restriction When not all variables have formats that explicitly specify a width, you cannot use WIDTH=UNIFORM with an engine that supports concurrent access if another user is updating the data set at the same time.

Tips If the data set is large and you want a uniform report, you can save computer resources by using formats that explicitly specify a field width so that PROC PRINT reads the data only once.

WIDTH=UNIFORM is the same as UNIFORM.

UNIFORMBY
formats all columns uniformly within a BY group, using each variable's formatted width as its column width. If the variable does not have a format that explicitly specifies a field width, PROC PRINT uses the widest data value as the column width.

Alias UBY

Restriction You cannot use UNIFORMBY with a sequential data set.

Default If you omit WIDTH= and do not specify the UNIFORM option, PROC PRINT individually constructs each page of output. The procedure analyzes the data for a page and decides how best to display them. Therefore, column widths might differ from one page to another.

Restriction WIDTH= is valid only for the LISTING destination.

Tip Column width is affected not only by variable width but also by the length of column headings. Long column headings might lessen the usefulness of WIDTH=.

See For a discussion of default column widths, see "Column Width" on page 1794.

BY Statement

Produces a separate section of the report for each BY group.

See: Chapter 3, "Statements with the Same Function in Multiple Procedures," on page 73

Examples: "Example 4: Creating Separate Sections of a Report for Groups of Observations" on page 1809

"Example 5: Summing Numeric Variables with One BY Group" on page 1819

"Example 6: Summing Numeric Variables with Multiple BY Variables" on page 1824

"Example 7: Limiting the Number of Sums in a Report" on page 1835

"Example 9: Creating a Customized Layout with BY Groups and ID Variables" on page 1845

Syntax

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...> <NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, the observations in the data set must either be sorted using PROC SORT by all the variables that you specify, or they must be indexed appropriately. Variables in a BY statement are called *BY variables*.

See PROC DATASETS MODIFY statement SORTEDBY option

Optional Arguments

DESCENDING
specifies that the data set is sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The data is grouped in another way, such as chronological order.

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, the procedure treats each contiguous set as a separate BY group.

Details

Use the BY Statement with an ID Statement

PROC PRINT uses a special layout if all BY variables appear in the same order at the beginning of the ID statement. (See "Example 9: Creating a Customized Layout with BY Groups and ID Variables" on page 1845.)

Use the BY Statement with the NOBYLINE Option

If you use the BY statement with the SAS system option NOBYLINE, which suppresses the BY line that normally appears in output produced with BY-group processing, PROC PRINT always starts a new page for each BY group. This behavior ensures that if you create customized BY lines by putting BY-group information in the title and suppressing the default BY lines with NOBYLINE, the information in the titles matches the report on the pages.

Use a BY Variable When You Print Unsorted Data

If you specify a BY variable whose values are not sorted, SAS stops printing the data set when it processes the first unsorted group. A message is written to the SAS log.

ID Statement

Identifies observations by using the formatted values of the variables that you list instead of by using observation numbers.

Examples: "Example 8: Controlling the Layout of a Report with Many Variables" on page 1839
"Example 9: Creating a Customized Layout with BY Groups and ID Variables" on page 1845

Syntax

ID *variable(s)*
</ STYLE <(*location(s)*)>=<*style-override(s)*> >;

Required Argument

variable(s)
specifies one or more variables to print instead of the observation number at the beginning of each row of the report.

Restriction If the ID variables occupy so much space that no room remains on the line for at least one other variable, PROC PRINT writes a

warning to the SAS log and does not treat all ID variables as ID variables.

Interaction If a variable in the ID statement also appears in the VAR statement, the output contains two columns for that variable.

Optional Argument

STYLE <(*location(s)*)>=<*style-override(s)*>
specifies one or more style overrides to use for ID columns created with the ID statement.

You can specify a style override in two ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.

style-override has the following form:

style-element-name | [*style-attribute-name-1*=*style-attribute-value-1*

<*style-attribute-name-2*=*style-attribute-value-2* ...>]

Restriction Style specifications for the OBSHEADER location is not valid in the ID statement.

Interaction If the STYLE(HEADER)= option is specified in the ID statement and the STYLE(OBSHEADER)= is specified in the PROC PRINT statement, the style attributes that are specified for the ID statement take precedence over the style elements that are specified in the PROC PRINT statement. Then, the style attributes in the PROC PRINT statement STYLE(OBSHEADER)= option are merged with the style attributes in the ID statement STYLE(HEADER)= option to render the output for the ID column heading.

Tip To specify different style overrides for different ID columns, use a separate ID statement for each variable and add a different STYLE option to each ID statement.

See For information about the arguments of this option and how it is used, see the STYLE= on page 1764 option in the PROC PRINT statement.

Details

Use the BY Statement with an ID Statement

PROC PRINT uses a special layout if all BY variables appear in the same order at the beginning of the ID statement. (See "Example 9: Creating a Customized Layout with BY Groups and ID Variables" on page 1845.)

PAGEBY Statement

Controls page ejects that occur before a page is full.

Requirement: BY statement

Example: "Example 4: Creating Separate Sections of a Report for Groups of Observations" on page 1809

Syntax

PAGEBY *BY-variable*;

Required Argument

BY-variable
identifies a variable appearing in the BY statement in the PROC PRINT step. If the value of the BY variable changes, or if the value of any BY variable that precedes it in the BY statement changes, PROC PRINT begins printing a new page.

Interaction If you use the BY statement with the SAS system option NOBYLINE, which suppresses the BY line that normally appears in output produced with BY-group processing, PROC PRINT always starts a new page for each BY group. This behavior ensures that if you create customized BY lines by putting BY-group information in the title and suppressing the default BY lines with NOBYLINE, the information in the titles matches the report on the pages. (See "Creating Titles That Contain BY-Group Information " on page 57.)

SUM Statement

Totals values of numeric variables.

Tip: SAS includes checks to verify that the PROC PRINT output is accessible for the visually impaired. When you use the SUM statement and set the

ACCESSIBLECHECK system option, SAS verifies whether a label has been specified for both the SUMLABEL and the GRANDTOTAL_LABEL options in the PROC PRINT statement. If the output does not have labels for the summary and grand total values, SAS writes a message to the SAS log. For best practices about creating accessible output, see Creating Accessible Output in SAS Using ODS and ODS Graphics.

Examples:

"Example 5: Summing Numeric Variables with One BY Group" on page 1819

"Example 6: Summing Numeric Variables with Multiple BY Variables" on page 1824

"Example 7: Limiting the Number of Sums in a Report" on page 1835

"Example 9: Creating a Customized Layout with BY Groups and ID Variables" on page 1845

Syntax

SUM *variable(s)*
</ STYLE <(*location(s)*)>=<*style-override(s)*> >;

Required Argument

variable(s)
identifies the numeric variables to total in the report.

Optional Argument

STYLE <(*location(s)*)>=<*style-override(s)*>
specifies one or more style overrides to use for cells containing sums that are created with the SUM statement.

You can specify a style override in two ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.

style-override has the following form:

style-element-name | [*style-attribute-name-1=style-attribute-value-1*

<*style-attribute-name-2=style-attribute-value-2* ...>]

Tips To specify different style overrides for different cells reporting sums, use a separate SUM statement for each variable and add a different STYLE option to each SUM statement.

If the STYLE option is used in multiple SUM statements that affect the same location, the STYLE option in the last SUM statement will be used.

See For information about the arguments of this option and how it is used, see the option STYLE= on page 1758 in the PROC PRINT statement.

Details

Use the SUM and BY Statements Together

When you use a SUM statement and a BY statement with one BY variable, PROC PRINT sums the SUM variables for each BY group that contains more than one observation and totals them over all BY groups. (See "Example 5: Summing Numeric Variables with One BY Group" on page 1819.)

When you use a SUM statement and a BY statement with multiple BY variables, PROC PRINT sums the SUM variables for each BY group that contains more than one observation, just as it does if you use only one BY variable. However, it provides sums only for those BY variables whose values change when the BY group changes. (See "Example 6: Summing Numeric Variables with Multiple BY Variables" on page 1824.)

Note: When the value of a BY variable changes, the SAS System considers that the values of all variables listed after it in the BY statement also change.

SUMBY Statement

Limits the number of sums that appear in the report.

Requirement: BY statement

Example: "Example 7: Limiting the Number of Sums in a Report" on page 1835

Syntax

SUMBY *BY-variable*;

Required Argument

BY-variable
identifies a variable that appears in the BY statement in the PROC PRINT step. If the value of the BY variable changes, or if the value of any BY variable that precedes it in the BY statement changes, PROC PRINT prints the sums of all variables listed in the SUM statement.

Details

What Variables Are Summed?

If you use a SUM statement, PROC PRINT subtotals only the SUM variables. Otherwise, PROC PRINT subtotals all the numeric variables in the data set except for the variables listed in the ID and BY statements.

VAR Statement

Selects variables that appear in the report and determines their order.

Tip: If you omit the VAR statement, PROC PRINT prints all variables in the data set.

Examples: "Example 2: Selecting Variables to Print" on page 1797

"Example 9: Creating a Customized Layout with BY Groups and ID Variables" on page 1845

Syntax

VAR *variable(s)*
</ STYLE <(*location(s)*)>=<*style-override(s)*> >;

Required Argument

variable(s)
identifies the variables to print. PROC PRINT prints the variables in the order in which you list them.

Interaction In the PROC PRINT output, variables that are listed in the ID statement precede variables that are listed in the VAR statement. If a variable in the ID statement also appears in the VAR statement, the output contains two columns for that variable.

Optional Argument

STYLE <(*location(s)*)>=<*style-override(s)*>
specifies one or more style overrides to use for all columns that are created by a VAR statement.

You can specify a style override in two ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.

style-override has the following form:

style-element-name | [*style-attribute-name-1=style-attribute-value-1*
<*style-attribute-name-2=style-attribute-value-2* ...>]

Tip To specify different style overrides for different columns, use a separate VAR statement to create a column for each variable and add a different STYLE option to each VAR statement.

See For information about the arguments of this option and how it is used, see the option STYLE= on page 1764 in the PROC PRINT statement.

Usage: PRINT Procedure

Use ODS Styles with PROC PRINT

Using Styles with Base SAS Procedures

Most Base SAS procedures that support ODS use one or more table templates to produce output objects. These table templates include templates for table elements: columns, headers, and footers. Each table element can specify the use of one or more style elements for various parts of the output. These style elements cannot be specified within the syntax of the procedure, but you can use customized styles for the ODS destinations that you use. For more information about customizing tables and styles, see "TEMPLATE Procedure: Creating a Style Template" in *SAS Output Delivery System: Procedures Guide*.

The Base SAS reporting procedures, PROC PRINT, PROC REPORT, and PROC TABULATE, enable you to quickly analyze your data and organize it into easy-to-read tables. You can use the STYLE= option with these procedure statements to modify the appearance of your report. The STYLE= option enables you to make changes in sections of output without changing the default style for all of the output. You can customize specific sections of procedure output by specifying the STYLE= option in specific statements within the procedure.

The following program uses the STYLE= option to create the colors in the PROC PRINT output below. For the complete input data set, see "EXPREV" on page 2790.

```
proc print data=exprev noobs sumlabel='Total' GRANDTOTAL_LABEL="Grand
Total"
      style(table)=[frame=box rules=groups]
      style(bysumline)=[background=red foreground=linen]
```

```
      style(grandtotal)=[foreground=green]
      style(header)=[font_style=italic background=orange];
   by sale_type order_date;
   sum price quantity;
   sumby sale_type;
   label sale_type='Sale Type' order_date='Sale Date';
format price dollar10.2 cost dollar10.2;
   var Country / style(data)=[font_face=arial font_weight=bold
background=linen];
   var Price / style(data)=[font_style=italic background=yellow];
   var Cost / style(data)=[foreground=hgt. background=lightgreen];
title 'Retail and Quantity Totals for Each Sale Type';
run;
```

Output 48.1 *Enhanced PROC PRINT Output*

Retail and Quantity Totals for Each Sale Type

Sale Type=Catalog Sale Date=1/1/12

Country	Price	Cost	Quantity
Puerto Rico	$51.20	$12.10	14
Aruba	$123.70	$59.00	30
Bahamas	$113.40	$28.45	8
Bermuda	$41.00	$9.25	7

Sale Type=Catalog Sale Date=1/2/12

Country	Price	Cost	Quantity
British Virgin Islands	$40.20	$20.20	11
Canada	$11.80	$5.00	100
Total	$381.30		170

Sale Type=In Store Sale Date=1/1/12

Country	Price	Cost	Quantity
Virgin Islands (U.S.)	$31.10	$15.65	25

Sale Type=In Store Sale Date=1/2/12

Country	Price	Cost	Quantity
Belize	$146.40	$36.70	2
Cayman Islands	$71.00	$32.30	20
Total	$248.50		47

Sale Type=Internet Sale Date=1/1/12

Country	Price	Cost	Quantity
Antarctica	$92.60	$20.70	2
Grand Total	$722.40		219

Styles, Style Elements, and Style Attributes

Understanding Styles, Style Elements, and Style Attributes

The appearance of SAS output is controlled by ODS style templates (ODS styles). ODS styles are produced from compiled STYLE templates written in PROC TEMPLATE style syntax. An ODS style template is a collection of style elements that provides specific visual attributes for your SAS output.

- A style element is a named collection of style attributes that apply to a particular part of the output. Each area of ODS output has a style element name that is associated with it. The style element name specifies where the style attributes are applied. For example, a style element might contain instructions for the presentation of column headings or for the presentation of the data inside the cells. Style elements might also specify default colors and fonts for output that uses the style.
- A style attribute is a visual property, such as color, font properties, and line characteristics, that is defined in ODS with a reserved name and value. Style attributes are collectively referenced by a style element within a style template. Each *style attribute* specifies a value for one aspect of the presentation. For example, the BACKGROUNDCOLOR= attribute specifies the color for the background of an HTML table or for a colored table in printed output. The FONTSTYLE= attribute specifies whether to use a Roman font or an italic font.

Note: Because styles control the presentation of the data, they have no effect on output objects that go to the LISTING, DOCUMENT, or OUTPUT destination.

Available styles are in the SASHELP.TMPLMST item store. In SAS Enterprise Guide, the list of style sheets is shown by the Style Wizard. In batch mode or SAS Studio, you can display the list of available style templates by using the LIST statement in PROC TEMPLATE:

```
proc template;
   list styles / store=sashelp.tmplmst;
run;
```

For complete information about viewing ODS styles, see "Viewing ODS Styles Supplied by SAS" in *SAS Output Delivery System: Advanced Topics*.

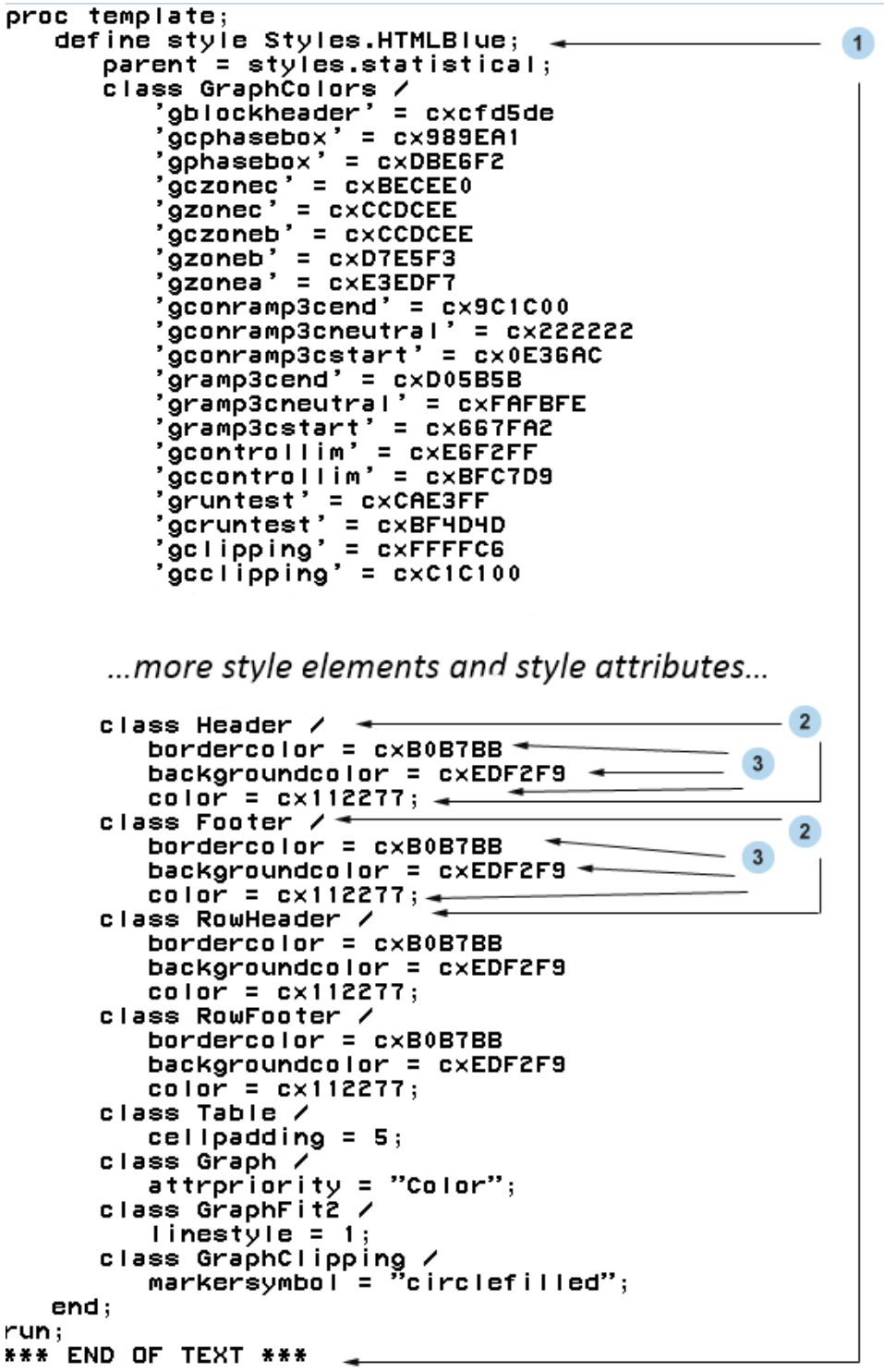
By default, HTML 4 output uses the HTMLBlue style template and HTML 5 output uses the HTMLEncore style template. To help you become familiar with styles, style elements, and style attributes, look at the relationship between them.

You can use the SOURCE statement in PROC TEMPLATE to display the structure of a style template. The following code prints the structure of the HTMLBlue style template to the SAS log:

```
proc template;
   source styles.HTMLBlue;
run;
```

The following figure illustrates the structure of a style. The figure shows the relationship between the style, the style elements, and the style attributes.

Figure 48.4 *Diagram of the HtmlBlue Style*



The following list corresponds to the numbered items in the preceding figure:

1 Styles.HtmlBlue is the *style*. Styles describe how to display presentation aspects (color, font, font size, and so on) of the SAS output. A style determines

the overall appearance of the ODS documents that use it. The default style for HTML output is HtmlBlue. Each style consists of style elements.

You can create new styles with the "DEFINE STYLE Statement" in *SAS Output Delivery System: Procedures Guide*. New styles can be created independently or from an existing style. You can use "PARENT= Statement" in *SAS Output Delivery System: Procedures Guide* to create a new style from an existing style. For complete documentation about ODS styles, see "Style Templates" in *SAS Output Delivery System: Advanced Topics*.

2 Header and Footer are examples of *style elements*. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program. For example, a style element might contain instructions for the presentation of column headings or for the presentation of the data inside table cells. Style elements might also specify default colors and fonts for output that uses the style. Style elements exist inside styles and consist of one or more style attributes. Style elements can be user-defined or supplied by SAS. User-defined style elements can be created by the "STYLE Statement" in *SAS Output Delivery System: Procedures Guide*.

Note: For a list of the default style elements used for HTML and markup languages and their inheritance, see "Style Elements" in *SAS Output Delivery System: Advanced Topics*.

3 BORDERCOLOR=, BACKGROUNDCOLOR=, and COLOR= are examples of *style attributes*. Style attributes specify a value for one aspect of the area of the output that its style element applies to. For example, the COLOR= attribute specifies the value `cx112277` for the font color. For a list of style attributes supplied by SAS, see "Style Attributes" in *SAS Output Delivery System: Advanced Topics*.

Style attributes can be referenced with style references. See "style-reference" in *SAS Output Delivery System: Advanced Topics* for more information about style references.

The following table shows commonly used style attributes that you can set with the STYLE= option in PROC PRINT, PROC TABULATE, and PROC REPORT. Most of these attributes apply to parts of the table other than cells (for example, table borders and the lines between columns and rows). Note that not all attributes are valid in all destinations. For more information about these style attributes, their valid values, and their applicable destinations, see "Style Attributes Tables" in *SAS Output Delivery System: Advanced Topics*.

Table 48.2 Style Attributes for PROC REPORT, PROC TABULATE, and PROC PRINT

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
ASIS=	X	X		X		X
BACKGROUNDCOLOR=	X	X	X	X	X	X
BACKGROUNDIMAGE=	X	X	X	X	X	X
BORDERBOTTOMCOLOR=	X	X		X		
BORDERBOTTOMSTYLE=	X	X	X	X		
BORDERBOTTOMWIDTH=	X	X	X	X		
BORDERLEFTCOLOR=	X	X		X		
BORDERLEFTSTYLE=	X	X	X	X		
BORDERLEFTWIDTH=	X	X	X	X		
BORDERCOLOR=	X	X		X	X	X
BORDERCOLORDARK=	X	X	X	X	X	X
BORDERCOLORLIGHT=	X	X	X	X	X	X
BORDERRIGHTCOLOR=	X	X		X		
BORDERRIGHTSTYLE=	X	X	X	X		
BORDERRIGHTWIDTH=	X	X	X	X		

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
BORDERTOPCOLOR=	X	X		X		
BORDERTOPSTYLE=	X	X	X	X		
BORDERTOPWIDTH=	X	X	X	X		
BORDERWIDTH=	X	X	X	X	X	X
CELLPADDING=	X		X		X	
CELLSPACING=	X		X		X	
CELLWIDTH=	X	X	X	X		X
CLASS=	X	X	X	X	X	X
COLOR=	X	X	X			
FLYOVER=	X	X		X		X
FONT=	X	X	X	X	X	X
FONTFAMILY=	X	X	X	X	X	X
FONTSIZE=	X	X	X	X	X	X
FONTSTYLE=	X	X	X	X	X	X
FONTWEIGHT=	X	X	X	X	X	X
FONTWIDTH=	X	X	X	X		X
FRAME=	X		X		X	
HEIGHT=	X	X		X	X	X
HREFTARGET=		X		X		X
HTMLSTYLE=	X	X	X	X	X	
NOBREAKSPACE=[2]	X	X		X		X
OUTPUTWIDTH=	X	X	X	X	X	

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
POSTHTML=[1]	X	X	X	X	X	X
POSTIMAGE=	X	X	X	X	X	X
POSTTEXT=[1]	X	X	X	X	X	X
PREHTML=[1]	X	X	X	X	X	X
PREIMAGE=	X	X	X	X	X	X
PRETEXT=[1]	X	X	X	X	X	X
PROTECTSPECIALCHARS=		X		X	X	X
RULES=	X		X		X	
TAGATTR=	X	X	X	X	X	X
TEXTALIGN=	X	X	X	X	X	X
URL=		X		X		X
VERTICALALIGN=		X		X		X
WIDTH=	X	X	X	X	X	

1 When you use these attributes in this location, they affect only the text that is specified with the PRETEXT=, POSTTEXT=, PREHTML=, and POSTHTML= attributes. To alter the foreground color or the font for the text that appears in the table, you must set the corresponding attribute in a location that affects the cells rather than the table. For complete documentation about style attributes and their values, see "Style Attributes" in *SAS Output Delivery System: Advanced Topics*.

2 To help prevent unexpected wrapping of long text strings when using PROC REPORT with the ODS RTF destination, set NOBREAKSPACE=OFF in a location that affects the LINE statement. The NOBREAKSPACE=OFF attribute must be set in the PROC REPORT code either on the LINE statement or on the PROC REPORT statement where style(lines) is specified.

Default Style Elements and Style Attributes for Table Regions

The following table lists the default style elements and style attributes for various locations of PROC PRINT output. The locations in this table correspond to the locations in Table 48.93 on page 1765. The table lists defaults for the most

commonly used ODS destinations: HTML, PDF, and RTF. Each destination has a default style template that is applied to all output that is written to the destination.

- The default style for HTML output is HTMLBlue.
- The default style for PRINTER output is Pearl.
- The default style for RTF output is RTF.

For complete documentation about the ODS destinations and their default styles, see "Style Templates" in *SAS Output Delivery System: Advanced Topics*.

Table 48.3 *Default Style Elements and Style Attributes for Report Regions*

Location	Style Element	HTML Style Attributes	PDF Style Attributes	RTF Style Attributes
BYLABEL	Byline	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = bold FONTSTYLE = roman COLOR = cx112277 BACKGROUNDCOLOR = cxedf2f9	FONTFAMILY = "Arial, 'Albany AMT'" FONTSIZE = 8pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxffffff	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 11pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BORDERWIDTH = NaN
GRANDTOTAL OBSHEADER HEADER TOTAL	Header	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = bold FONTSTYLE = roman COLOR = cx112277 BACKGROUNDCOLOR = cxedf2f9	FONTFAMILY = "Arial, 'Albany AMT'" FONTSIZE = 8pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxffffff BORDERWIDTH = NaN	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 11pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxbbbbbb
N	Linecontent	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = medium FONTSTYLE = roman COLOR = cx112277 BACKGROUNDCOLOR = cxfafbfe	FONTFAMILY = "Arial, 'Albany AMT'" FONTSIZE = 8pt FONTWEIGHT =medium FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxffffff	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 10pt FONTWEIGHT = medium FONTSTYLE = roman COLOR =cx000000

Location	Style Element	HTML Style Attributes	PDF Style Attributes	RTF Style Attributes
			BORDERWIDTH = NaN	
OBS	Rowheader	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = bold FONTSTYLE = roman COLOR = cx112277 BACKGROUNDCOLOR = cxedf2f9	FONTFAMILY = "Arial, 'Albany AMT'" FONTSIZE = 8pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxffffff BORDERWIDTH = NaN	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 11pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxbbbbbb
DATA	Data	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = medium FONTSTYLE = roman BACKGROUNDCOLOR = cxffffff	FONTFAMILY ="'Albany AMT', Albany" FONTSIZE = 8pt FONTWEIGHT = medium FONTSTYLE = roman COLOR = cx000000 BORDERWIDTH = NaN COLOR = cx000000	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 10pt FONTWEIGHT = medium FONTSTYLE = roman COLOR = cx000000
Titles	SystemTitle	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 3 FONTWEIGHT = bold FONTSTYLE = roman BACKGROUNDCOLOR = cxfafbfe	FONTFAMILY ="'Albany AMT', Albany" FONTSIZE = 11pt FONTWEIGHT = bold FONTSTYLE = roman COLOR = cx000000 BACKGROUNDCOLOR = cxffffff	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 13pt FONTWEIGHT = bold FONTSTYLE = italic COLOR = cx000000
Footnotes	Footers	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = medium	FONTFAMILY ="'Albany AMT', Albany" FONTSIZE = 11pt FONTWEIGHT = bold FONTSTYLE = roman	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 13pt FONTWEIGHT = bold FONTSTYLE = italic

Location	Style Element	HTML Style Attributes	PDF Style Attributes	RTF Style Attributes
		FONTSTYLE = roman BACKGROUNDCOLOR = cxffffff	COLOR = cx000000 BACKGROUNDCOLOR = cxffffff	COLOR = cx000000

Error Processing in the PRINT Procedure Output

If an error occurs in the PRINT procedure or if the procedure is halted, output might be created for the observations that were processed until the error. SAS writes a message to the SAS log and ends the PRINT procedure.

For LISTING output, if the page size is set too small, SAS cannot print both the data and any titles or footnotes on the same page. If this happens, only the data is printed to the LISTING destination and SAS writes a warning message to the log. To write both the data and titles or footnotes on the same page, make sure that the page size is adequate.

Results: PRINT Procedure

About PROC PRINT Output

By default, PROC PRINT produces an HTML5 report when you run SAS in the windowing environment. In all other operating modes, the default destination is LISTING. The PRINT procedure statements, PROC PRINT, BY, PAGEBY, SUMBY, ID, SUM, and VAR control the content of the report. The options for each statement control the appearance of the report.

To change the ODS destination for the report, use ODS statements before the PROC PRINT statement. If you do not want HTML output, be sure to close the ODS HTML destination before you run the procedure. For more information about using ODS, see the *SAS Output Delivery System: User's Guide*.

See the PRINT procedure examples on page 1797 for a sampling of the types of reports that the procedure produces.

Page Layout for HTML, the Default ODS Destination

A page of ODS HTML output is not limited in width or length. Therefore, each observation in a table is printed on a single line and all observations that are specified to print by the report appear on a single page of HTML output.

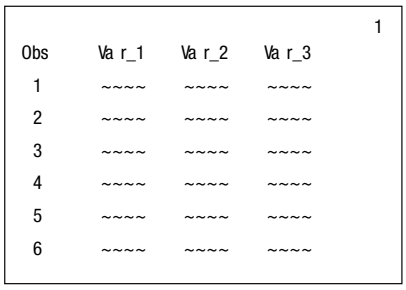
Each time that PROC PRINT runs, by default, SAS adds a page break after the output. A page break is rendered by separating output with a horizontal rule. For more information, see "ODS HTML Statement" in *SAS Output Delivery System: User's Guide*.

Page Layout for Limited Page Sizes

Observations

PROC PRINT uses an identical layout for all observations on a page for ODS destinations that produce output whose page size is limited in width and length. Some of these ODS destinations are RTF, PDF, and LISTING. First, it attempts to print observations on a single line, as shown in the following figure.

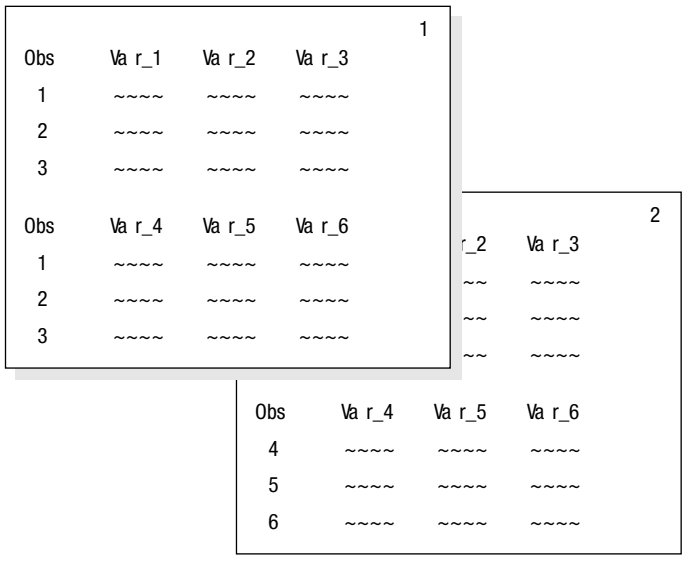
Figure 48.5 *Printing Observations on a Single Line*



				1
Obs	Var_1	Var_2	Var_3	
1	~~~~	~~~~	~~~~	
2	~~~~	~~~~	~~~~	
3	~~~~	~~~~	~~~~	
4	~~~~	~~~~	~~~~	
5	~~~~	~~~~	~~~~	
6	~~~~	~~~~	~~~~	

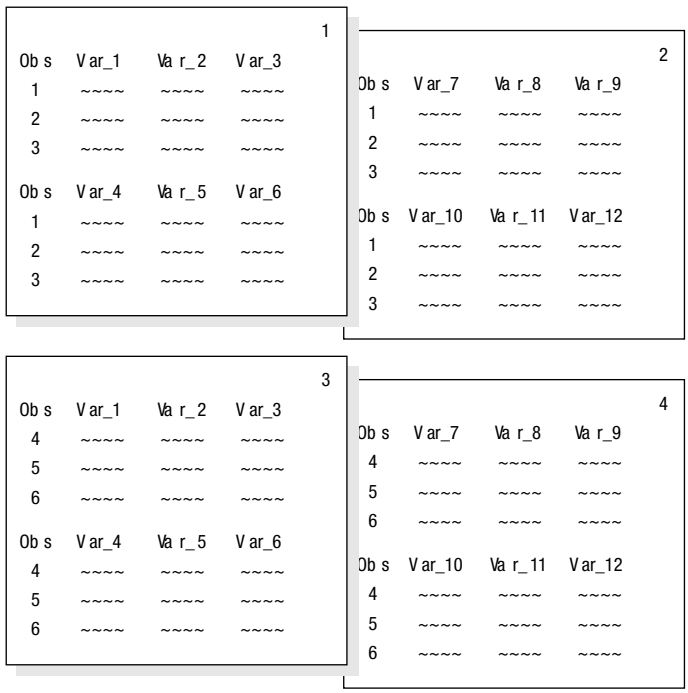
If PROC PRINT cannot fit all the variables on a single line, it splits the observations into two or more sections and prints the observation number or the ID variables at the beginning of each line. For example, in the following figure, PROC PRINT prints the values for the first three variables in the first section of each page and the values for the second three variables in the second section of each page.

Figure 48.6 *Splitting Observations into Multiple Sections on One Page*



If PROC PRINT cannot fit all the variables on one page, the procedure prints subsequent pages with the same observations until it has printed all the variables. For example, in the following figure, PROC PRINT uses the first two pages to print values for the first three observations and the second two pages to print values for the rest of the observations.

Figure 48.7 *Splitting Observations across Multiple Pages*



Note: For the LISTING destination, you can alter the page layout with the ROWS= option in the PROC PRINT statement. (See the discussion of ROWS= option on page 1764.)

Column Headings

The amount of spacing specifies whether PROC PRINT prints column headings horizontally or vertically. Figure 48.55 on page 1792, Figure 48.56 on page 1793, and Figure 48.57 on page 1793 all illustrate horizontal headings. The following figure illustrates vertical headings.

Figure 48.8 *Using Vertical Headings*

```
                                  1
        V      V      V
        a      a      a
  O     r      r      r
  b     _      _      _
  s     1      2      3

  1    ~~~~   ~~~~   ~~~~
  2    ~~~~   ~~~~   ~~~~
  3    ~~~~   ~~~~   ~~~~
  4    ~~~~   ~~~~   ~~~~
  5    ~~~~   ~~~~   ~~~~
  6    ~~~~   ~~~~   ~~~~
```

Note: If you use LABEL and at least one variable has a label, PROC PRINT prints all column headings horizontally unless you specify HEADING=VERTICAL.

Column Width

By default, PROC PRINT uses a variable's formatted width as the column width. (The WIDTH= option overrides this default behavior for the LISTING destination.) If the variable does not have a format that explicitly specifies a field width, PROC PRINT uses the widest data value for that variable on that page as the column width.

If the formatted value of a character variable or the data width of an unformatted character variable exceeds the line size minus the length of all the ID variables, PROC PRINT might truncate the value. Consider the following situation:

- The line size is 80.
- IdNumber is a character variable with a length of 10. It is used as an ID variable.
- State is a character variable with a length of 2. It is used as an ID variable.
- Comment is a character variable with a length of 200.

When PROC PRINT prints these three variables on a line, it uses 14 print positions for the two ID variables and the space after each one. This arrangement leaves 80–14, or 66, print positions for COMMENT. Longer values of COMMENT are truncated.

WIDTH= controls the column width for the LISTING destination.

Note: Column width is affected not only by variable width but also by the length of column headings. Long column headings might lessen the usefulness of WIDTH=.

Examples: PRINT Procedure

Example 1: Print a CAS Table

Features: PROC PRINT DATA=*CAS-table*

CAS language elements:
- CAS statement
- LIBNAME statement for the CAS engine
- PROC CASUTIL
- PROC MDSUMMARY

Data set: Sashelp.cars

Details

This example demonstrates the following tasks:

- establishes a CAS session
- associates the Mycas libref with the CAS engine and the CAS session
- creates the CAS table mycas.cars
- uses PROC MDSUMMARY to summarize the cars data
- prints 15 rows of the summarized CAS table

Program: Run in the SAS Windowing Environment

```
options cashost="cloud.example.com" casport=5555;
cas mysess sessopts=(caslib='casuser');
libname mycas cas sessref=mysess;

proc casutil outcaslib="casuser";
  load data=sashelp.cars replace;
```

```
run;

proc mdsummary data=mycas.cars;
  var mpg_highway;
  groupby origin type / out=mycas.mpghw_sum;
run;

options obs=15;
proc print data=mycas.mpghw_sum;
   var origin type _mean_;
   title "Average Highway Milages";
run;
```

Program Description

Start the CAS server, set up the CAS session, create a libref for the CAS engine, and connect the engine to the CAS session. The OPTIONS statement connects SAS to the CAS server. The CAS statement creates the Mysess session using the CASUSER caslib. The LIBNAME statement creates the Mycas libref for the CAS engine, which uses the Mysess CAS session.

```
options cashost="cloud.example.com" casport=5555;
cas mysess sessopts=(caslib='casuser');
libname mycas cas sessref=mysess;
```

Load the table Sashelp.cars into the caslib Casuser. The OUTCASLIB= option names the caslib to where the table is loaded. Use the LOAD statement to load the table from Sashelp.cars. The REPLACE option replaces the table and names the table to load.

```
proc casutil outcaslib="casuser";
  load data=sashelp.cars replace;
run;
```

Summarize the data using PROC MDSUMMARY. The VAR statement specifies the analysis variable to order the results. The GROUPBY statement creates BY groups and saves the output to the table Mycas.mpghw_sum.

```
proc mdsummary data=mycas.cars;
  var mpg_highway;
  groupby origin type / out=mycas.mpghw_sum;
run;
```

Print the first 15 rows of the summary results. With OBS=15, PROC PRINT prints only 15 rows of the CAS table. The VAR statement limits the output table to three columns, Origin, Type, and _Mean_.

```
options obs=15;
proc print data=mycas.mpghw_sum;
   var origin type _mean_;
   title "Average Highway Milages";
run;
```

Average Highway Milages

Obs	Origin	Type	_Mean_
1	Asia	Wagon	28.181818182
2	Europe	Sedan	27.115384615
3	Europe	Wagon	26.583333333
4	USA	SUV	20.04
5	USA	Wagon	29.714285714
6	Asia	Hybrid	56
7	Asia	SUV	21.68
8	USA	Sedan	28.544444444
9	USA	Truck	20.5
10	Asia	Truck	22
11	Europe	SUV	18.7
12	Asia	Sedan	29.968085106
13	Asia	Sports	26.647058824
14	Europe	Sports	25.130434783
15	USA	Sports	24.222222222

Example 2: Selecting Variables to Print

Features:
- PROC PRINT statement options
  - BLANKLINE
  - DOUBLE
  - STYLE
- VAR statement
- DATA step
- FOOTNOTE statement
- ODS HTML statement
- OPTIONS statement
- TITLE statement

Data set: EXPREV

ODS destinations: HTML, LISTING

Details

This example demonstrates the following tasks:

- selects three variables for the reports

- uses variable labels as column headings
- double spaces between rows of the report in the LISTING output
- creates a report for the default HTML destination and the LISTING destination at the same time
- creates a stylized HTML report

Program: Creating an HTML Report

```
options obs=10;

ods listing;

proc print data=exprev;

   var country price sale_type;
   title 'Monthly Price Per Unit and Sale Type for Each Country';
   footnote '*prices in USD';
run;
```

Program Description

HTML is the default destination when SAS opens in the windowing environment.

Set the OBS= system option to process 10 observations.

```
options obs=10;
```

Open the LISTING destination. By default in the windowing environment, the HTML default is open. The ODS LISTING statement opens the LISTING destination in order to create HTML and LISTING output at the same time.

```
ods listing;
```

Print the output The VAR statement specifies the variables to print.

```
proc print data=exprev;

   var country price sale_type;
   title 'Monthly Price Per Unit and Sale Type for Each Country';
   footnote '*prices in USD';
run;
```

Output: HTML and LISTING

Output 48.2 *Selecting Variables: Default HTML Output*

Monthly Price Per Unit and Sale Type for Each Country

Obs	Country	Price	Sale_Type
1	Antarctica	92.6	Internet
2	Puerto Rico	51.2	Catalog
3	Virgin Islands (U.S.)	31.1	In Store
4	Aruba	123.7	Catalog
5	Bahamas	113.4	Catalog
6	Bermuda	41.0	Catalog
7	Belize	146.4	In Store
8	British Virgin Islands	40.2	Catalog
9	Canada	11.8	Catalog
10	Cayman Islands	71.0	In Store

*prices in USD

Output 48.3 *Selecting Variables: LISTING Output*

```
                    Monthly Price Per Unit and Sale Type for Each
Country

                                                          Sale_
                     Obs    Country                Price   Type

                       1    Antarctica              92.6   Internet

                       2    Puerto Rico             51.2   Catalog

                       3    Virgin Islands (U.S.)   31.1   In Store

                       4    Aruba                  123.7   Catalog

                       5    Bahamas                113.4   Catalog

                       6    Bermuda                 41.0   Catalog

                       7    Belize                 146.4   In Store

                       8    British Virgin Islands  40.2   Catalog

                       9    Canada                  11.8   Catalog

                      10    Cayman Islands          71.0   In Store


                                        *prices in USD
```

Program: Create an HTML Report with the STYLE and BLANKLINE Options

```
options obs=5;

ods html file='your_file_styles.html';


proc print data=exprev
   style(header)={fontstyle=italic color= green}
   style(obs)={backgroundcolor=#a8a44ff8a color=blue}
   blankline=(count= 1 style={backgroundcolor=cx456789});

   var country price sale_type;

   title 'Monthly Price Per Unit and Sale Type for Each Country';
   footnote '*prices in USD';
run;
```

Program Description

You can go a step further and add more formatting to your HTML output. The following example uses the STYLE option to add shading and spacing to your HTML report.

```
options obs=5;

ods html file='your_file_styles.html';
```

Create stylized HTML output. The first STYLE option specifies that the column headings are written in green italic font. The second STYLE option specifies that observation number column has a background color of the RGB color a8a44ff8a and a text color of blue. The BLANKLINE option specifies to add a blank line between each observation and use a background color of the CMYK color cx456789. Because a style has not been defined for the OBSHEADER location, the Obs column heading in the output uses the default style color and not green.

```
proc print data=exprev
   style(header)={fontstyle=italic color= green}
   style(obs)={backgroundcolor=#a8a44ff8a color=blue}
   blankline=(count= 1 style={backgroundcolor=cx456789});

   var country price sale_type;

   title 'Monthly Price Per Unit and Sale Type for Each Country';
   footnote '*prices in USD';
run;
```

Output: HTML Output with Styles

Output 48.4 *Selecting Variables: HTML Output Using Styles*

Monthly Price Per Unit and Sale Type for Each Country

Obs	Country	Price	Sale_Type
1	Antarctica	92.6	Internet
2	Puerto Rico	51.2	Catalog
3	Virgin Islands (U.S.)	31.1	In Store
4	Aruba	123.7	Catalog
5	Bahamas	113.4	Catalog

*prices in USD

Program: Create a LISTING Report

```
options nodate pageno=1 linesize=80 pagesize=30 obs=10;

ods html close;
ods listing;

proc print data=exprev double;

   var country price sale_type;

   title 'Monthly Price Per Unit and Sale Type for Each Country';
   footnote '*prices in USD';
run;

ods listing close;
ods html;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. The PAGENO= option specifies the starting page number. The LINESIZE= option specifies the output line length, and the PAGESIZE= option specifies the number of lines on an output page. The OBS= option specifies the number of observations to display.

```
options nodate pageno=1 linesize=80 pagesize=30 obs=10;
```

Close the HTML destination and open the LISTING destination. HTML is the default destination when you start SAS. To create only a LISTING report, you can close the HTML destination and open the LISTING destination.

```
ods html close;
ods listing;
```

Print the data set EXPREV. EXPREV contains information about a company's product order type and price per unit for two months. DOUBLE inserts a blank line between observations. The DOUBLE option has no effect on the HTML output.

```
proc print data=exprev double;
```

Select the variables to include in the report. The VAR statement creates columns for Country, Price, and Sale_Type, in that order.

```
   var country price sale_type;
```

Specify a title and a footnote. The TITLE statement specifies the title for the report. The FOOTNOTE statement specifies a footnote for the report.

```
   title 'Monthly Price Per Unit and Sale Type for Each Country';
   footnote '*prices in USD';
run;
```

Close the LISTING destination and reopen the HTML destination. When you close and reopen the HTML destination, SAS saves HTML output to the current directory and not the Work library.

```
ods listing close;
ods html;
```

Output: LISTING

By default, PROC PRINT identifies each observation by number under the column heading `Obs`.

Output 48.5 *Selecting Variables: LISTING Output*

Monthly Price Per Unit and Sale Type for Each Country 1

Obs	Country	Price	Sale_ Type
1	Antarctica	92.6	Internet
2	Puerto Rico	51.2	Catalog
3	Virgin Islands (U.S.)	31.1	In Store
4	Aruba	123.7	Catalog
5	Bahamas	113.4	Catalog
6	Bermuda	41.0	Catalog
7	Belize	146.4	In Store
8	British Virgin Islands	40.2	Catalog
9	Canada	11.8	Catalog
10	Cayman Islands	71.0	In Store

*prices in USD

Example 3: Customizing Text in Column Headings

Features:
PROC PRINT statement options
- N
- OBS=
- SPLIT=
- STYLE

VAR statement option
- STYLE

LABEL statement

ODS PDF statement

FORMAT statement

TITLE statement

Data set: EXPREV

ODS destinations: LISTING, PDF

Details

This example demonstrates the following tasks:

- underlines the text in column headings for variables in LISTING output
- adds background color to the column headings for variables in PDF output
- customizes the column heading for the column that identifies observations by number
- shows the number of observations in the report
- writes the values of the variable Price with dollar signs and periods

Program: Create a LISTING Report

```
options nodate pageno=1 linesize=80 pagesize=30 obs=10;

ods html close;
ods listing;

proc print data=exprev split='*' n
obs='Observation*Number*===========';

   var country sale_type price;

   label country='Country Name**============'
         sale_type='Order Type**==========='
         price='Price Per Unit*in USD*==============';

   format price dollar10.2;
   title 'Order Type and Price Per Unit in Each Country';
run;

ods listing close;
ods html;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. The PAGENO= option specifies the starting page number. The LINESIZE= option specifies the output line length, and the PAGESIZE= option specifies the number of lines on an output page. The OBS= option specifies the number of observations to be displayed.

```
options nodate pageno=1 linesize=80 pagesize=30 obs=10;
```

Close the HTML destination and open the LISTING destination. By default, the HTML destination is open.

```
ods html close;
ods listing;
```

Print the report and define the column headings. SPLIT= identifies the asterisk as the character that starts a new line in column headings. The N option prints the number of observations at the end of the report. OBS= specifies the column heading for the column that identifies each observation by number. The split character (*) starts a new line in the column heading. The equal signs (=) in the value of OBS= underlines the column heading.

```
proc print data=exprev split='*' n
obs='Observation*Number*==========';
```

Select the variables to include in the report. The VAR statement creates columns for Country, Sale_Type, and Price, in that order.

```
    var country sale_type price;
```

Assign the variables' labels as column headings. The LABEL statement associates a label with each variable for the duration of the PROC PRINT step. When you use the SPLIT= option in the PROC PRINT statement, the procedure uses labels for column headings. The split character (*) starts a new line in the column heading. The equal signs (=) in the labels underlines the column headings.

```
    label country='Country Name**============'
          sale_type='Order Type**==========='
          price='Price Per Unit*in USD*==============';
```

Specify a title for the report, and format any variable containing numbers. The FORMAT statement assigns the DOLLAR10.2 format to the variable Price in the report. The TITLE statement specifies a title.

```
    format price dollar10.2;
    title 'Order Type and Price Per Unit in Each Country';
run;
```

Close the LISTING destination and re-open the HTML destination.

```
ods listing close;
ods html;
```

Output: LISTING

Output 48.6 *Customizing Column Headings: LISTING Output*

```
                Order Type and Price Per Unit in Each Country                1

    Observation    Country Name              Order Type    Price Per Unit
       Number                                                   in USD
    ===========    ============              ==========    ==============

          1        Antarctica                 Internet           $92.60
          2        Puerto Rico                Catalog            $51.20
          3        Virgin Islands (U.S.)      In Store           $31.10
          4        Aruba                      Catalog           $123.70
          5        Bahamas                    Catalog           $113.40
          6        Bermuda                    Catalog            $41.00
          7        Belize                     In Store          $146.40
          8        British Virgin Islands     Catalog            $40.20
          9        Canada                     Catalog            $11.80
         10        Cayman Islands             In Store           $71.00

                                    N = 10
```

Program: Creating a PDF Report

```
options obs=10;

ods pdf file='your_file.pdf';

proc print data=exprev n obs='Observation Number';


   var country sale_type price;
         label country='Country Name'
               sale_type='Order Type'
               price='Price Per Unit in USD';
         format price dollar10.2;
         title 'Order Type and Price Per Unit in Each Country';
run;

ods pdf close;
```

Program Description

You can easily create PDF output by adding a few ODS statements. In the following example, ODS statements were added to produce PDF output.

The OBS= system option specifies to process 10 observations.

```
options obs=10;
```

Create PDF output and specify the file to store the output in. The ODS PDF statement opens the PDF destination and creates PDF output. The FILE= argument specifies the external file that contains the PDF output.

```
ods pdf file='your_file.pdf';
```

Set the procedure options. The N option prints the number of observations at the end of the report. OBS= specifies the column heading for the column that identifies each observation by number.

```
proc print data=exprev n obs='Observation Number';
```

Process the variables in the data set. The VAR statement specifies the variables to print. The LABEL statement creates text to print in place of the variable names. The FORMAT statement specifies to format the price variables using the DOLLARw. format. The TITLE statement creates a title for the report.

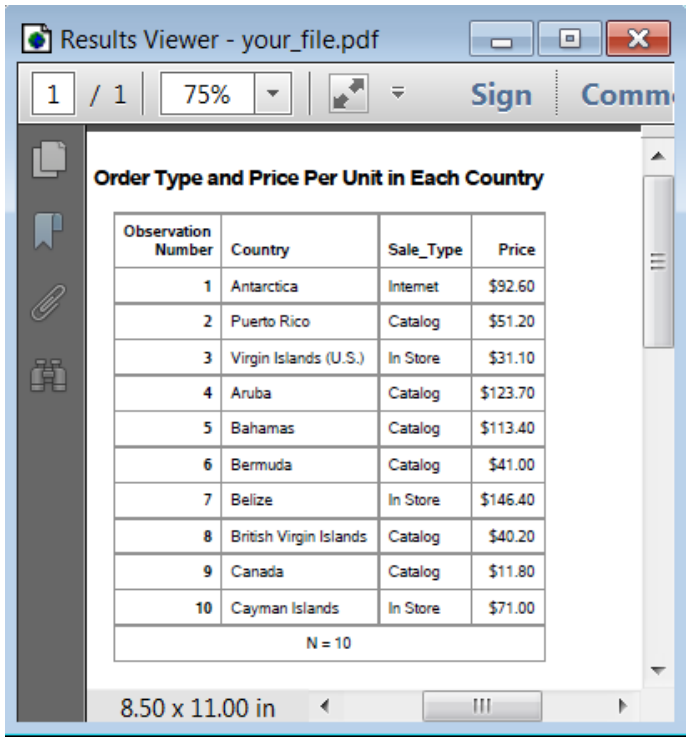
```
    var country sale_type price;
          label country='Country Name'
                sale_type='Order Type'
                price='Price Per Unit in USD';
          format price dollar10.2;
          title 'Order Type and Price Per Unit in Each Country';
run;
```

Close the PDF destination. The ODS PDF CLOSE statement closes the PDF destination.

```
ods pdf close;
```

Output: PDF

Output 48.7 *Customizing Column Heading: Default PDF Output*



Observation Number	Country	Sale_Type	Price
1	Antarctica	Internet	$92.60
2	Puerto Rico	Catalog	$51.20
3	Virgin Islands (U.S.)	In Store	$31.10
4	Aruba	Catalog	$123.70
5	Bahamas	Catalog	$113.40
6	Bermuda	Catalog	$41.00
7	Belize	In Store	$146.40
8	British Virgin Islands	Catalog	$40.20
9	Canada	Catalog	$11.80
10	Cayman Islands	In Store	$71.00
N = 10			

Program: Creating a PDF Report with the STYLE Option

```
options obs=10;

ods pdf file='your_file.pdf';

proc print data=exprev n obs='Observation Number'
     style(n)={backgroundcolor=light blue fontstyle=italic}
     style(header obs obsheader)={backgroundcolor=light yellow
color=blue
      fontstyle=italic};
     style(data)={backgroundcolor=very light blue}

   var country sale_type price / style(data)=[backgroundcolor=very
light blue];
   label country='Country Name'
         sale_type='Order Type'
         price='Price Per Unit in USD';
   format price dollar10.2;
run;

title 'Order Type and Price Per Unit in Each Country';

ods pdf close;
```

Program Description

The OBS= system option specifies to process 10 observations.

```
options obs=10;

ods pdf file='your_file.pdf';
```

Create stylized PDF output. The first STYLE option specifies that the background color of the cell containing the value for N be changed to light blue and that the font style be changed to italic. The second STYLE option specifies that the background color of the observation column, the observation header, and the other variable's headers be changed to a light yellow, the text color is changed to blue, and the font style is changed to italic.

```
proc print data=exprev n obs='Observation Number'
     style(n)={backgroundcolor=light blue fontstyle=italic}
     style(header obs obsheader)={backgroundcolor=light yellow
color=blue
      fontstyle=italic};
     style(data)={backgroundcolor=very light blue}
```

Create stylized PDF output. The STYLE option changes the color of the cells containing data to a very light blue.

```
   var country sale_type price / style(data)=[backgroundcolor=very
light blue];
   label country='Country Name'
         sale_type='Order Type'
         price='Price Per Unit in USD';
   format price dollar10.2;
```

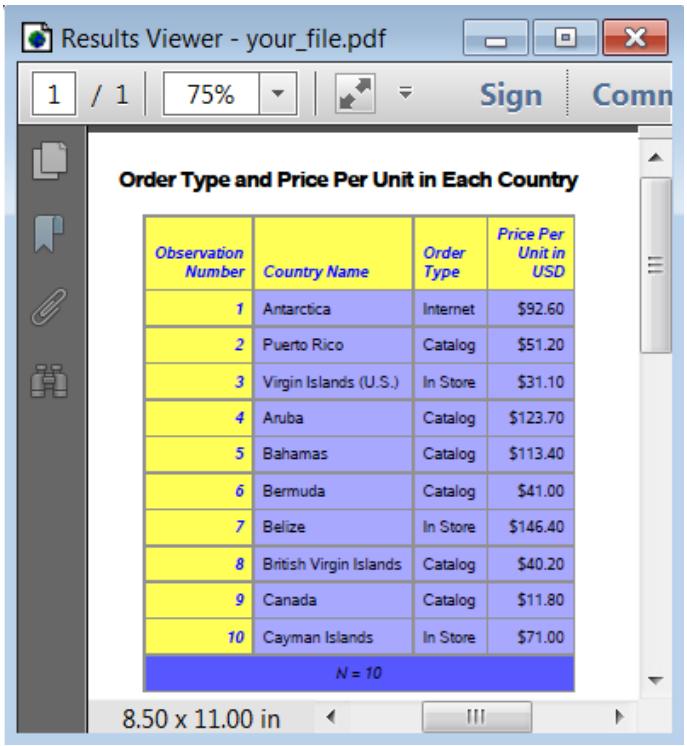
```
run;
title 'Order Type and Price Per Unit in Each Country';
```

Close the PDF destination. The ODS PDF CLOSE statement closes the PDF destination.

```
ods pdf close;
```

Output: PDF Report with Styles

Output 48.8 *Customizing Column Headings: PDF Using Styles*



Observation Number	Country Name	Order Type	Price Per Unit in USD
1	Antarctica	Internet	$92.60
2	Puerto Rico	Catalog	$51.20
3	Virgin Islands (U.S.)	In Store	$31.10
4	Aruba	Catalog	$123.70
5	Bahamas	Catalog	$113.40
6	Bermuda	Catalog	$41.00
7	Belize	In Store	$146.40
8	British Virgin Islands	Catalog	$40.20
9	Canada	Catalog	$11.80
10	Cayman Islands	In Store	$71.00
N = 10			

Example 4: Creating Separate Sections of a Report for Groups of Observations

Features:

PROC PRINT statement options
- LABEL
- N=
- NOOBS
- STYLE

BY statement

PAGEBY statement

SORT procedure

FORMAT statement

LABEL statement
ODS RTF statement
TITLE statement

Data set: EXPREV

ODS destinations: HTML, RTF

Details

This example demonstrates the following:

- suppresses the printing of observation numbers at the beginning of each row
- presents the data for each sale type in a separate section of the report
- creates a default HTML report
- creates default and stylized RTF reports

Program: Creating an HTML Report

```
options obs=10;

proc sort data=exprev;
   by sale_type order_date quantity;
run;

proc print data=exprev n='Number of observations for the month: '
           noobs label;

   var quantity cost price;

   by sale_type order_date;
   pageby order_date;

   label sale_type='Order Type' order_date='Order Date';

   format price dollar7.2 cost dollar7.2;
   title 'Prices and Cost Grouped by Date and Order Type';
   title2 'in USD';
run;

proc options option=bufno define;
run;
```

Program Description

The HTML destination is open by default. No ODS HTML statement is needed.

The OBS= system option specifies to process 10 observations.

```
options obs=10;
```

Sort the EXPREV data set. PROC SORT sorts the observations by Sale_Type, Order_Date, and Quantity.

```
proc sort data=exprev;
   by sale_type order_date quantity;
run;
```

Print the report, specify the total number of observations in each BY group, and suppress the printing of observation numbers. N= prints the number of observations in a BY group at the end of that BY group. The explanatory text that the N= option provides precedes the number. NOOBS suppresses the printing of observation numbers at the beginning of the rows. LABEL uses the variables' labels as column headings.

```
proc print data=exprev n='Number of observations for the month: '
           noobs label;
```

Specify the variables to include in the report. The VAR statement creates columns for Quantity, Cost, and Price, in that order.

```
   var quantity cost price;
```

Create a separate section for each order type and specify page breaks for each BY group of Order_Date. The BY statement produces a separate section of the report for each BY group and prints a heading above each one. The PAGEBY statement starts a new page each time the value of Order_Date changes.

```
   by sale_type order_date;
   pageby order_date;
```

Establish the column headings. The LABEL statement associates labels with the variables Sale_Type and Order_Date for the duration of the PROC PRINT step. When you use the LABEL option in the PROC PRINT statement, the procedure uses labels for column headings.

```
   label sale_type='Order Type' order_date='Order Date';
```

Format the columns that contain numbers and specify a title and footnote. The FORMAT statement assigns a format to Price and Cost for this report. The TITLE statement specifies a title. The TITLE2 statement specifies a second title.

```
   format price dollar7.2 cost dollar7.2;
   title 'Prices and Cost Grouped by Date and Order Type';
   title2 'in USD';
run;

proc options option=bufno define;
run;
```

Output: HTML

Output 48.9 *Creating Separate Sections of a Report for Groups of Observations: HTML Output*

Prices and Cost Grouped by Date and Order Type in USD

Order Type=Catalog Order Date=1/1/12

Quantity	Cost	Price
7	$9.25	$41.00
8	$28.45	$113.40
14	$12.10	$51.20
30	$59.00	$123.70
Number of observations for the month: 4		

Prices and Cost Grouped by Date and Order Type in USD

Order Type=Catalog Order Date=1/2/12

Quantity	Cost	Price
11	$20.20	$40.20
100	$5.00	$11.80
Number of observations for the month: 2		

Prices and Cost Grouped by Date and Order Type in USD

Order Type=In Store Order Date=1/1/12

Quantity	Cost	Price
25	$15.65	$31.10
Number of observations for the month: 1		

Prices and Cost Grouped by Date and Order Type in USD

Order Type=In Store Order Date=1/2/12

Quantity	Cost	Price
2	$36.70	$146.40
20	$32.30	$71.00
Number of observations for the month: 2		

Prices and Cost Grouped by Date and Order Type in USD

Order Type=Internet Order Date=1/1/12

Quantity	Cost	Price
2	$20.70	$92.60
Number of observations for the month: 1		

Program: Creating an RTF Report

```
options obs=10;

ods rtf file='your_file.rtf' startpage=no;

proc sort data=exprev;
   by sale_type order_date quantity;
run;

proc print data=exprev n='Number of observations for each order type:'
           noobs label;
   var quantity cost price;
   by sale_type order_date;
   pageby order_date;
   label sale_type='Order Type' order_date='Order Date';
```

```
   format price dollar7.2 cost dollar7.2;
   title 'Price and Cost Grouped by Date and Order Type';
   title2 'in USD';
run;

ods rtf close;
```

Program Description

The OBS= system option specifies to process 10 observations.

```
options obs=10;
```

Create output for Microsoft Word and specify the file to store the output in. The ODS RTF statement opens the RTF destination and creates output formatted for Microsoft Word. The FILE= option specifies the external file that contains the RTF output. The STARTPAGE=NO option specifies that no new pages be inserted explicitly at the start of each by group.

```
ods rtf file='your_file.rtf' startpage=no;

proc sort data=exprev;
   by sale_type order_date quantity;
run;

proc print data=exprev n='Number of observations for each order type:'
           noobs label;
   var quantity cost price;
   by sale_type order_date;
   pageby order_date;
   label sale_type='Order Type' order_date='Order Date';
   format price dollar7.2 cost dollar7.2;
   title 'Price and Cost Grouped by Date and Order Type';
   title2 'in USD';
run;
```

Close the RTF destination. The ODS RTF CLOSE statement closes the RTF destination.

```
ods rtf close;
```

Output: RTF

Output 48.10 *Creating Separate Sections of a Report for Groups of Observations: Default RTF Output*

Price and Cost Grouped by Date and Order Type in USD

Order Type=Catalog Order Date=1/1/12

Quantity	Cost	Price
7	$9.25	$41.00
8	$28.45	$113.40
14	$12.10	$51.20
30	$59.00	$123.70
Number of observations for each order type:4		

Order Type=Catalog Order Date=1/2/12

Quantity	Cost	Price
11	$20.20	$40.20
100	$5.00	$11.80
Number of observations for each order type:2		

Order Type=In Store Order Date=1/1/12

Quantity	Cost	Price
25	$15.65	$31.10
Number of observations for each order type:1		

Order Type=In Store Order Date=1/2/12

Quantity	Cost	Price
2	$36.70	$146.40
20	$32.30	$71.00
Number of observations for each order type:2		

Order Type=Internet Order Date=1/1/12

Quantity	Cost	Price
2	$20.70	$92.60
Number of observations for each order type:1		

Program: Creating an RTF Report with the STYLE Option

```
options obs=10;

ods rtf file='your_file.rtf' startpage=no;

proc sort data=exprev;
   by sale_type order_date quantity;
run;

proc print data=exprev n='Number of observations for the month: '
           noobs label style(N)={backgroundcolor=very light gray};
   var quantity / style(header)=[backgroundcolor=light yellow];
   var cost / style(header)=[backgroundcolor=light blue foreground =
white];
   var price / style(header)=[backgroundcolor=light green];
   by sale_type order_date;
   pageby order_date;
   label sale_type='Order Type' order_date='Order Date';
   format price dollar7.2 cost dollar7.2;

title 'Prices and Cost Grouped by Date and Order Type';
title2 '*prices in USD';
run;

ods rtf close;
```

Program Description

The OBS= system option specifies to process 10 observations.

```
options obs=10;

ods rtf file='your_file.rtf' startpage=no;

proc sort data=exprev;
   by sale_type order_date quantity;
run;
```

Create a stylized RTF report. The first STYLE option specifies that the background color of the cell containing the number of observations be changed to light gray. The second STYLE option specifies that the background color of the column heading for the variable Quantity be changed to light yellow. The third STYLE option specifies that the background color of the column heading for the variable Cost be changed to light blue and the font color be changed to white. The fourth STYLE option specifies that the background color of the column heading for the variable Price be changed to light green.

```
proc print data=exprev n='Number of observations for the month: '
           noobs label style(N)={backgroundcolor=very light gray};
   var quantity / style(header)=[backgroundcolor=light yellow];
   var cost / style(header)=[backgroundcolor=light blue foreground =
white];
   var price / style(header)=[backgroundcolor=light green];
   by sale_type order_date;
```

```
   pageby order_date;
   label sale_type='Order Type' order_date='Order Date';
   format price dollar7.2 cost dollar7.2;

title 'Prices and Cost Grouped by Date and Order Type';
title2 '*prices in USD';
run;

ods rtf close;
```

Output: RTF with Styles

Output 48.11 *Creating Separate Sections of a Report for Groups of Observations: RTF Output Using Styles*

Prices and Cost Grouped by Date and Order Type
**prices in USD*

Order Type=Catalog Order Date=1/1/12

Quantity	Cost	Price
7	$9.25	$41.00
8	$28.45	$113.40
14	$12.10	$51.20
30	$59.00	$123.70
Number of observations for the month: 4		

Order Type=Catalog Order Date=1/2/12

Quantity	Cost	Price
11	$20.20	$40.20
100	$5.00	$11.80
Number of observations for the month: 2		

Order Type=In Store Order Date=1/1/12

Quantity	Cost	Price
25	$15.65	$31.10
Number of observations for the month: 1		

Order Type=In Store Order Date=1/2/12

Quantity	Cost	Price
2	$36.70	$146.40
20	$32.30	$71.00
Number of observations for the month: 2		

Order Type=Internet Order Date=1/1/12

Quantity	Cost	Price
2	$20.70	$92.60
Number of observations for the month: 1		

Example 5: Summing Numeric Variables with One BY Group

Features:
- PROC PRINT statement options
  - N=
  - SUMLABEL
- BY statement
- SUM statement
- ODS CSVALL statement
- SORT procedure
- TITLE statement
  - #BYVAL specification
- SAS system options:
  - BYLINE
  - NOBYLINE

Data set: EXPREV

ODS destinations: HTML, CSV

Details

This example demonstrates the following tasks:

- sums expenses and revenues for each region and for all regions.
- shows the number of observations in each BY group and in the whole report.
- creates a customized title, containing the name of the region. This title replaces the default BY line for each BY group.
- creates a default HTML file.
- creates a CSV file.

Program: Creating an HTML Report

```
options obs=10 nobyline;

proc sort data=exprev;
   by sale_type;
run;

proc print data=exprev noobs label sumlabel
```

```
            n='Number of observations for the order type: '
            'Number of observations for the data set: ';

   var country order_date quantity price;

   label  sale_type='Sale Type'
          price='Total Retail Price* in USD'
          country='Country' order_date='Date' quantity='Quantity';

   sum price quantity;
   by sale_type;

   format price dollar7.2;

   title 'Retail and Quantity Totals for #byval(sale_type) Sales';
run;

options byline;
```

Program Description

The HTML destination is open by default. This program uses the default filename for the HTML output. No ODS HTML statement is needed.

Start each BY group on a new page and suppress the printing of the default BY line. The SAS system option NOBYLINE suppresses the printing of the default BY line. When you use PROC PRINT with the NOBYLINE option, each BY group starts on a new page. The OBS= option specifies the number of observations to process.

```
options obs=10 nobyline;
```

Sort the data set. PROC SORT sorts the observations by Sale_Type.

```
proc sort data=exprev;
   by sale_type;
run;
```

Print the report, suppress the printing of observation numbers, and print the total number of observations for the selected variables. NOOBS suppresses the printing of observation numbers at the beginning of the rows. SUMLABEL prints the BY variable label on the summary line of each. N= prints the number of observations in a BY group at the end of that BY group and (because of the SUM statement) prints the number of observations in the data set at the end of the report. The first piece of explanatory text that N= provides precedes the number for each BY group. The second piece of explanatory text that N= provides precedes the number for the entire data set.

```
proc print data=exprev noobs label sumlabel
           n='Number of observations for the order type: '
           'Number of observations for the data set: ';
```

Select the variables to include in the report. The VAR statement creates columns for Country, Order_Date, Quantity, and Price, in that order.

```
   var country order_date quantity price;
```

Assign the variables' labels as column headings. The LABEL statement associates a label with each variable for the duration of the PROC PRINT step.

```
   label  sale_type='Sale Type'
```

```
    price='Total Retail Price* in USD'
    country='Country' order_date='Date' quantity='Quantity';
```

Sum the values for the selected variables. The SUM statement alone sums the values of Price and Quantity for the entire data set. Because the PROC PRINT step contains a BY statement, the SUM statement also sums the values of Price and Quantity for each sale type that contains more than one observation.

```
    sum price quantity;
    by sale_type;
```

Format the numeric values for a specified column. The FORMAT statement assigns the DOLLAR7.2. format to Price for this report.

```
    format price dollar7.2;
```

Specify and format a dynamic (or current) title. The TITLE statement specifies a title. The #BYVAL specification places the current value of the BY variable Sale_Type in the title. Because NOBYLINE is in effect, each BY group starts on a new page, and the title serves as a BY line.

```
    title 'Retail and Quantity Totals for #byval(sale_type) Sales';
run;
```

Generate the default BY line. The SAS system option BYLINE resets the printing of the default BY line.

```
options byline;
```

Output: HTML

Output 48.12 *Summing Numeric Variables with One BY Group HTML Output*

Retail and Quantity Totals for Catalog Sales

Country	Date	Quantity	Total Retail Price* in USD
Bermuda	1/1/12	7	$41.00
Bahamas	1/1/12	8	$113.40
Puerto Rico	1/1/12	14	$51.20
Aruba	1/1/12	30	$123.70
British Virgin Islands	1/2/12	11	$40.20
Canada	1/2/12	100	$11.80
Sale Type		**170**	**$381.30**
Number of observations for the order type: 6			

Retail and Quantity Totals for In Store Sales

Country	Date	Quantity	Total Retail Price* in USD
Virgin Islands (U.S.)	1/1/12	25	$31.10
Belize	1/2/12	2	$146.40
Cayman Islands	1/2/12	20	$71.00
Sale Type		**47**	**$248.50**

Number of observations for the order type: 3

Retail and Quantity Totals for Internet Sales

Country	Date	Quantity	Total Retail Price* in USD
Antarctica	1/1/12	2	$92.60
		219	**$722.40**

Number of observations for the order type: 1
Number of observations for the data set: 10

Program: Creating a CSV File

```
options obs=10 nobyline;

ods csvall file='your_file.csv';

proc sort data=exprev;
   by sale_type;
run;

proc print data=exprev noobs label sumlabel
           n='Number of observations for the order type: '
           'Number of observations for the data set: ';

var country order_date quantity price;

   label  price='Total Retail Price* in USD'
          country='Country' order_date='Date' quantity='Quantity';

   sum price quantity;
   by sale_type;

   format price dollar7.2;

   title 'Retail and Quantity Totals for #byval(sale_type) Sales';
run;

options byline;

ods csvall close;
```

Program Description

```
options obs=10 nobyline;
```

Produce CSV formatted output and specify the file to store it in. The ODS CSVALL statement opens the CSVALL destination and creates a file containing tabular output with titles, notes, and BY lines. The FILE= argument specifies the external file that contains the CSV output.

```
ods csvall file='your_file.csv';

proc sort data=exprev;
   by sale_type;
run;

proc print data=exprev noobs label sumlabel
           n='Number of observations for the order type: '
           'Number of observations for the data set: ';

var country order_date quantity price;

   label  price='Total Retail Price* in USD'
          country='Country' order_date='Date' quantity='Quantity';

   sum price quantity;
   by sale_type;

   format price dollar7.2;

   title 'Retail and Quantity Totals for #byval(sale_type) Sales';
run;

options byline;
```

Close the CSVALL destination. The ODS CSVALL CLOSE statement closes the CSVALL destination.

```
ods csvall close;
```

Output: CSV File

Output 48.13 *Summing Numeric Variables with One BY Group: CSV Output Viewed with Microsoft Excel*

your_file.csv

	A	B	C	D	E	F
1	Retail and Quantity Totals for Catalog Sales					
2						
3	Country	Date	Quantity	Total Retail Price* in USD		
4	Bermuda	1/1/12	7	$41.00		
5	Bahamas	1/1/12	8	$113.40		
6	Puerto Ric	1/1/12	14	$51.20		
7	Aruba	1/1/12	30	$123.70		
8	British Vir	1/2/12	11	$40.20		
9	Canada	1/2/12	100	$11.80		
10	Sale_Type		170	$381.30		
11	Number of observations for the order type: 6					
12						
13	Retail and Quantity Totals for In Store Sales					
14						
15	Country	Date	Quantity	Total Retail Price* in USD		
16	Virgin Isla	1/1/12	25	$31.10		
17	Belize	1/2/12	2	$146.40		
18	Cayman Is	1/2/12	20	$71.00		
19	Sale_Type		47	$248.50		
20	Number of observations for the order type: 3					
21						
22	Retail and Quantity Totals for Internet Sales					
23						
24	Country	Date	Quantity	Total Retail Price* in USD		
25	Antarctica	1/1/12	2	$92.60		
26			219	$722.40		
27	Number of observations for the order type: 1					
28	Number of observations for the data set: 10					

Example 6: Summing Numeric Variables with Multiple BY Variables

Features:

PROC PRINT statement options
- GRANDTOTAL_LABEL=
- N=
- NOOBS
- STYLE
- SUMLABEL=

BY statement

SUM statement

ODS HTML statement

LABEL statement
FORMAT statement
SORT procedure
TITLE statement

Data set: EXPREV

ODS destinations: HTML, LISTING

Details

This example demonstrates the following tasks:

- sums quantities and retail prices for the following items:
  - each order date
  - each sale type with more than one row in the report
  - all rows in the report
- shows the number of observations in each BY group and in the whole report
- displays a customized label in place of the BY group variable name on the summary line
- displays a customized label for the grand total line
- creates a default HTML report
- creates a stylized HTML report

Program: Creating an HTML Report

```
options obs=10;

proc sort data=exprev;
   by sale_type order_date;
run;

proc print data=exprev n noobs sumlabel='Totals'
grandtotal_label='Grand Total';
   by sale_type order_date;
   sum price quantity cost;

   label  sale_type='Sale Type' order_date='Sale Date';
   format price dollar10.2 cost dollar10.2;
   title 'Retail and Quantity Totals for Each Sale Date and Sale Type';
run;
```

Program Description

```
options obs=10;
```

Produce HTML output and specify the file to store the output in. The HTML destination is open by default. The ODS HTML FILE= statement creates a file that contains HTML output. The FILE= argument specifies the external file that contains the HTML output.

```
proc sort data=exprev;
   by sale_type order_date;
run;

proc print data=exprev n noobs sumlabel='Totals'
grandtotal_label='Grand Total';
   by sale_type order_date;
   sum price quantity cost;

   label  sale_type='Sale Type' order_date='Sale Date';
   format price dollar10.2 cost dollar10.2;
   title 'Retail and Quantity Totals for Each Sale Date and Sale Type';
run;
```

Output: HTML

Output 48.14 *Summing Numeric Variables with Multiple BY Variables: In Store Sales: Default HTML Output*

Retail and Quantity Totals for Each Sale Date and Sale Type

Sale Type=Catalog Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Puerto Rico	99999999	1/5/12	14	$51.20	$12.10
Aruba	99999999	1/4/12	30	$123.70	$59.00
Bahamas	99999999	1/4/12	8	$113.40	$28.45
Bermuda	99999999	1/4/12	7	$41.00	$9.25
Totals			**59**	**$329.30**	**$108.80**
N = 4					

Sale Type=Catalog Sale Date=1/2/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
British Virgin Islands	99999999	1/5/12	11	$40.20	$20.20
Canada	99999999	1/5/12	100	$11.80	$5.00
Totals			**111**	**$52.00**	**$25.20**
Totals			**170**	**$381.30**	**$134.00**
N = 2					

Sale Type=In Store Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Virgin Islands (U.S.)	99999999	1/4/12	25	$31.10	$15.65
N = 1					

Sale Type=In Store Sale Date=1/2/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Belize	120458	1/2/12	2	$146.40	$36.70
Cayman Islands	120454	1/2/12	20	$71.00	$32.30
Totals			**22**	**$217.40**	**$69.00**
Totals			**47**	**$248.50**	**$84.65**
N = 2					

Sale Type=Internet Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Antarctica	99999999	1/7/12	2	$92.60	$20.70
Grand Total			**219**	**$722.40**	**$239.35**
N = 1 Total N = 10					

Program: Creating an HTML Report with the STYLE Option

```
options obs=10;

proc sort data=exprev;
   by sale_type order_date;
run;

proc print data=exprev n noobs sumlabel='Totals'
grandtotal_label='Grand Total;

   by sale_type order_date;
sum price / style(GRANDTOTAL)=[backgroundcolor=white color=blue];
sum quantity / style(TOTAL)=[backgroundcolor=dark blue color=white];

   label  sale_type='Sale Type' order_date='Sale Date';
   format price dollar10.2 cost dollar10.2;
   title 'Retail and Quantity Totals for Each Sale Date and Sale Type';
run;
```

Program Description

```
options obs=10;

proc sort data=exprev;
   by sale_type order_date;
run;

proc print data=exprev n noobs sumlabel='Totals'
grandtotal_label='Grand Total;
```

Create stylized HTML output. The STYLE option in the first SUM statement specifies that the background color of the cell containing the grand total for the variable Price be changed to white and the font color be changed to blue. The STYLE option in the second SUM statement specifies that the background color of cells containing totals for the variable Quantity be changed to dark blue and the font color be changed to white.

```
   by sale_type order_date;
sum price / style(GRANDTOTAL)=[backgroundcolor=white color=blue];
sum quantity / style(TOTAL)=[backgroundcolor=dark blue color=white];

   label  sale_type='Sale Type' order_date='Sale Date';
   format price dollar10.2 cost dollar10.2;
   title 'Retail and Quantity Totals for Each Sale Date and Sale Type';
run;
```

Output: HTML with Styles

Output 48.15 *Summing Numeric Variables with Multiple BY Variables: Catalog Sales: HTML Output Using Styles*

Retail and Quantity Totals for Each Sale Date and Sale Type

Sale Type=Catalog Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Puerto Rico	99999999	1/5/12	14	$51.20	$12.10
Aruba	99999999	1/4/12	30	$123.70	$59.00
Bahamas	99999999	1/4/12	8	$113.40	$28.45
Bermuda	99999999	1/4/12	7	$41.00	$9.25
Totals			**59**	**$329.30**	
N = 4					

Sale Type=Catalog Sale Date=1/2/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
British Virgin Islands	99999999	1/5/12	11	$40.20	$20.20
Canada	99999999	1/5/12	100	$11.80	$5.00
Totals			**111**	**$52.00**	
Totals			**170**	**$381.30**	
N = 2					

Sale Type=In Store Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Virgin Islands (U.S.)	99999999	1/4/12	25	$31.10	$15.65
N = 1					

Sale Type=In Store Sale Date=1/2/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Belize	120458	1/2/12	2	$146.40	$36.70
Cayman Islands	120454	1/2/12	20	$71.00	$32.30
Totals			**22**	**$217.40**	
Totals			**47**	**$248.50**	
N = 2					

Sale Type=Internet Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Antarctica	99999999	1/7/12	2	$92.60	$20.70
Grand Total			**219**	**$722.40**	
N = 1 Total N = 10					

Program: Creating a LISTING Report

```
options nodate pageno=1 linesize=80 pagesize=40 obs=15;

ods html close;
ods listing;


proc sort data=exprev;
   by sale_type order_date;
run;

proc print data=exprev n noobs sumlabel=Totals'
grandtotal_label='Grand Total';

   by sale_type order_date;
   sum price quantity;

   label  sale_type='Sale Type'
          order_date='Sale Date';
   format price dollar10.2 cost dollar10.2;
   title 'Retail and Quantity Totals for Each Sale Date and Sale Type';
run;
```

```
ods listing close;
ods html;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. The PAGENO= option specifies the starting page number. The LINESIZE= option specifies the output line length, and the PAGESIZE= option specifies the number of lines on an output page. OBS= specifies to stop process in the data set after observation 15.

```
options nodate pageno=1 linesize=80 pagesize=40 obs=15;
```

Close the HTML destination and open the LISTING destination. The HTML destination is open by default.

```
ods html close;
ods listing;
```

Sort the data set. PROC SORT sorts the observations by Sale_Type and Order_Date.

```
proc sort data=exprev;
   by sale_type order_date;
run;
```

Print the report, suppress the printing of observation numbers, print the total number of observations for the selected variables and use the BY variable labels in place of the BY variable names in the summary line. The N option prints the number of observations in a BY group at the end of that BY group and prints the total number of observations used in the report at the bottom of the report. NOOBS suppresses the printing of observation numbers at the beginning of the rows. The SUMLABEL option prints 'Totals' in the summary line in place of the BY variable labels.

```
proc print data=exprev n noobs sumlabel=Totals'
grandtotal_label='Grand Total';
```

Create a separate section of the report for each BY group, and sum the values for the selected variables. The BY statement produces a separate section of the report for each BY group. The SUM statement alone sums the values of Price and Quantity for the entire data set. Because the program contains a BY statement, the SUM statement also sums the values of Price and Quantity for each BY group that contains more than one observation.

```
   by sale_type order_date;
   sum price quantity;
```

Establish a label for selected variables, format the values of specified variables, and create a title. The LABEL statement associates a label with the variables Sale_Type and Order_Date for the duration of the PROC PRINT step. The labels are used in the BY line at the beginning of each BY group and in the summary line in place of BY variables. The FORMAT statement assigns a format to the variables Price and Cost for this report. The TITLE statement specifies a title.

```
   label  sale_type='Sale Type'
```

```
          order_date='Sale Date';
   format price dollar10.2 cost dollar10.2;
   title 'Retail and Quantity Totals for Each Sale Date and Sale Type';
run;
```

Close the LISTING destination and re-open the HTML destination.

```
ods listing close;
ods html;
```

Output: LISTING

The report uses default column headings (variable names) because neither the SPLIT= nor the LABEL option is used. Nevertheless, the BY line at the top of each section of the report shows the BY variables' labels and their values. The BY variables' labels identifies the subtotals in the report summary line.

PROC PRINT sums Price and Quantity for each BY group that contains more than one observation. However, sums are shown only for the BY variables whose values change from one BY group to the next. For example, in the first BY group, where the sale type is **`Catalog Sale`** and the sale date is **`>1/1/12`**, Quantity and Price are summed only for the sale date because the next BY group is for the same sale type.

Output 48.16 *PROC PRINT LISTING Output Showing Total Values for Price and Quantity*

```
          Retail and Quantity Totals for Each Sale Date and Sale Type          1

---------------------- Sale Type=Catalog Sale Date=1/1/12 ----------------------

                            Ship_
   Country         Emp_ID    Date     Quantity         Price          Cost

   Puerto Rico    99999999   1/5/12       14          $51.20        $12.10
   Aruba          99999999   1/4/12       30         $123.70        $59.00
   Bahamas        99999999   1/4/12        8         $113.40        $28.45
   Bermuda        99999999   1/4/12        7          $41.00         $9.25
   -----------                           --------    ----------
   Totals                                   59         $329.30

                                    N = 4


---------------------- Sale Type=Catalog Sale Date=1/2/12 ----------------------

                                   Ship_
Country                   Emp_ID    Date    Quantity        Price         Cost

British Virgin Islands   99999999  1/5/12       11         $40.20       $20.20
Canada                   99999999  1/5/12      100         $11.80        $5.00
El Salvador              99999999  1/6/12       21        $266.40       $66.70
----------------------                         --------   ----------
Totals                                          132        $318.40
Totals                                          191        $647.70

                                    N = 3
```

```
 Retail and Quantity Totals for Each Sale Date and Sale Type          2

---------------------- Sale Type=In Store Sale Date=1/1/12 ----------------------

                                    Ship_
       Country           Emp_ID     Date    Quantity        Price         Cost

 Virgin Islands (U.S.)   99999999   1/4/12      25          $31.10       $15.65

                                    N = 1


---------------------- Sale Type=In Store Sale Date=1/2/12 ----------------------

                              Ship_
   Country           Emp_ID     Date     Quantity         Price          Cost

   Belize            120458    1/2/12        2           $146.40        $36.70
   Cayman Islands    120454    1/2/12       20            $71.00        $32.30
   Guatemala         120931    1/2/12       13           $144.40        $65.70
   --------------                          --------    ----------
   Totals                                    35          $361.80
   Totals                                    60          $392.90

                                    N = 3


---------------------- Sale Type=Internet Sale Date=1/1/12 ----------------------

                             Ship_
     Country       Emp_ID      Date     Quantity         Price          Cost

    Antarctica    99999999    1/7/12        2           $92.60        $20.70

                                    N = 1
```

```
Retail and Quantity Totals for Each Sale Date and Sale Type          3

---------------------- Sale Type=Internet Sale Date=1/2/12 ----------------------

                                   Ship_
Country                Emp_ID      Date     Quantity         Price          Cost

Costa Rica             99999999    1/6/12        31          $53.00        $26.60
Cuba                   121044      1/2/12        12          $42.40        $19.35
Dominican Republic     121040      1/2/12        13          $48.00        $23.95
------------------                             --------    ----------
Totals                                            56         $143.40
Totals                                            58         $236.00
==================                             ========    ==========
Grand Total                                      309       $1,276.60

                                     N = 3
                                Total N = 15
```

Example 7: Limiting the Number of Sums in a Report

Features:	BY statement SUM statement SUMBY statement FORMAT statement LABEL statement ODS PDF statement SORT procedure TITLE statement
Data set:	EXPREV
ODS destination:	PDF

Details

This example demonstrates the following tasks:

- creates a separate section of the report for each combination of sale type and sale date
- sums quantities and retail prices only for each sale type and for all sale types, not for individual dates
- creates a PDF file

Program: Creating a PDF File

```
options obs=10;

ods html close;
ods pdf file='your_file.pdf';

proc sort data=exprev;
   by sale_type order_date;
run;

proc print data=exprev noobs sumlabel='Total' grandtotal_label='Grand
Total';

   by sale_type order_date;
   sum price quantity;
```

```
   sumby sale_type;

   label sale_type='Sale Type' order_date='Sale Date';

   format price dollar10.2 cost dollar10.2;
   title 'Retail and Quantity Totals for Each Sale Type';
run;

ods pdf close;
```

Program Description

The OBS= system option specifies to process 10 observations.

```
options obs=10;
```

Produce PDF output and specify the file to store the output in. The ODS HTML CLOSE statement closes the default destination. The ODS PDF statement opens the PDF destination and creates a file that contains PDF output. The FILE= argument specifies the external file that contains the PDF output.

```
ods html close;
ods pdf file='your_file.pdf';
```

Sort the data set. PROC SORT sorts the observations by Sales_Type and Order_Date.

```
proc sort data=exprev;
   by sale_type order_date;
run;
```

Print the report and remove the observation numbers. NOOBS suppresses the printing of observation numbers at the beginning of the rows. SUMLABEL uses the label for the BY variables on the summary line of each BY group.

```
proc print data=exprev noobs sumlabel='Total' grandtotal_label='Grand
Total';
```

Sum the values for each region. The SUM and BY statements work together to sum the values of Price and Quantity for each BY group as well as for the whole report. The SUMBY statement limits the subtotals to one for each type of sale.

```
   by sale_type order_date;
   sum price quantity;
   sumby sale_type;
```

Assign labels to specific variables. The LABEL statement associates a label with the variables Sale_Type and Order_Date for the duration of the PROC PRINT step. These labels are used in the BY group title or the summary line.

```
   label sale_type='Sale Type' order_date='Sale Date';
```

Assign a format to the necessary variables and specify a title. The FORMAT statement assigns the COMMA10. format to Cost and Price for this report. The TITLE statement specifies a title.

```
   format price dollar10.2 cost dollar10.2;
   title 'Retail and Quantity Totals for Each Sale Type';
run;
```

Close the PDF destination. The ODS PDF CLOSE statement closes the PDF destination.

```
ods pdf close;
```

Output: PDF

Output 48.17 *Limiting the Number of Sums in a Report: PDF Output*

Retail and Quantity Totals for Each Sale Type

Sale Type=Catalog Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Puerto Rico	99999999	1/5/12	14	$51.20	$12.10
Aruba	99999999	1/4/12	30	$123.70	$59.00
Bahamas	99999999	1/4/12	8	$113.40	$28.45
Bermuda	99999999	1/4/12	7	$41.00	$9.25

Sale Type=Catalog Sale Date=1/2/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
British Virgin Islands	99999999	1/5/12	11	$40.20	$20.20
Canada	99999999	1/5/12	100	$11.80	$5.00
Total			**170**	**$381.30**	

Sale Type=In Store Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Virgin Islands (U.S.)	99999999	1/4/12	25	$31.10	$15.65

Sale Type=In Store Sale Date=1/2/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Belize	120458	1/2/12	2	$146.40	$36.70
Cayman Islands	120454	1/2/12	20	$71.00	$32.30
Total			**47**	**$248.50**	

Sale Type=Internet Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Antarctica	99999999	1/7/12	2	$92.60	$20.70
Grand Total			**219**	**$722.40**	

Program: Creating a PDF Report with the STYLE Option

```
options obs=10;
```

```
ods pdf file='your_file.pdf';

proc sort data=exprev;
   by sale_type order_date;
run;

proc print data=exprev noobs sumlabel='Total' grandtotal_label='Grand
Total';

   by sale_type order_date;


   sum quantity price / style(TOTAL)=[backgroundcolor=light blue
color=white];
   sum quantity price / style(GRANDTOTAL)=[backgroundcolor=green
color=white];
   sumby sale_type;

   label sale_type='Sale Type' order_date='Sale Date';

   format price dollar10.2 cost dollar10.2;
   title 'Retail and Quantity Totals for Each Sale Type';
run;

ods pdf close;
```

Program Description

```
options obs=10;

ods pdf file='your_file.pdf';

proc sort data=exprev;
   by sale_type order_date;
run;

proc print data=exprev noobs sumlabel='Total' grandtotal_label='Grand
Total';

   by sale_type order_date;
```

Create stylized PDF output. The STYLE option in the first SUM statement specifies that the background color of cells containing totals for the variable Price be changed to light blue and the font color be changed to white. The STYLE option in the second SUM statement specifies that the background color of the cell containing the grand total for the Quantity variable be changed to yellow and the font color be changed to red.

```
   sum quantity price / style(TOTAL)=[backgroundcolor=light blue
color=white];
   sum quantity price / style(GRANDTOTAL)=[backgroundcolor=green
color=white];
   sumby sale_type;

   label sale_type='Sale Type' order_date='Sale Date';

   format price dollar10.2 cost dollar10.2;
   title 'Retail and Quantity Totals for Each Sale Type';
run;
```

```
ods pdf close;
```

Output: PDF with Styles

Output 48.18 *Limiting the Number of Sums in a Report: PostScript Output Using Styles*

Retail and Quantity Totals for Each Sale Type

Sale Type=Catalog Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Puerto Rico	99999999	1/5/12	14	$51.20	$12.10
Aruba	99999999	1/4/12	30	$123.70	$59.00
Bahamas	99999999	1/4/12	8	$113.40	$28.45
Bermuda	99999999	1/4/12	7	$41.00	$9.25

Sale Type=Catalog Sale Date=1/2/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
British Virgin Islands	99999999	1/5/12	11	$40.20	$20.20
Canada	99999999	1/5/12	100	$11.80	$5.00
Total			170	$381.30	

Sale Type=In Store Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Virgin Islands (U.S.)	99999999	1/4/12	25	$31.10	$15.65

Sale Type=In Store Sale Date=1/2/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Belize	120458	1/2/12	2	$146.40	$36.70
Cayman Islands	120454	1/2/12	20	$71.00	$32.30
Total			47	$248.50	

Sale Type=Internet Sale Date=1/1/12

Country	Emp_ID	Ship_Date	Quantity	Price	Cost
Antarctica	99999999	1/7/12	2	$92.60	$20.70
Grand Total			219	$722.40	

Example 8: Controlling the Layout of a Report with Many Variables

Features: PROC PRINT statement options
ROWS=
ID statement options

STYLE

ODS RTF statement

SAS data set options

OBS=

Data set: EMPDATA

ODS destinations: LISTING, RTF

Details

This example shows two ways of printing a data set with a large number of variables: one is the default, printing multiple rows when there are a large number of variables, and the other uses ROWS= option to print one row. The ROWS= option is valid only for the LISTING destination. For detailed explanations of the layouts of these two reports, see the option ROWS= on page 1764 and "Page Layout for Limited Page Sizes" on page 1792.

These reports use a page size of 24 and a line size of 64 to help illustrate the different layouts.

Program: Creating a LISTING Report

```
data empdata;
   input IdNumber $ 1-4 LastName $ 8-18 FirstName $ 19-28
      City $ 29-41 State $ 42-43
      Gender $ 45 JobCode $ 49-51 Salary 55-60 @63 Birth date7.
      @73 Hired date7. HomePhone $ 83-95;
   format birth hired date9.;
   datalines;
1919   Adams      Gerald    Stamford     CT M   TA2   34376   15SEP70   07JUN05
203/781-1255
1653   Alexander  Susan     Bridgeport   CT F   ME2   35108   18OCT72   12AUG98
203/675-7715

. . . more lines of data . . .

1407   Grant      Daniel    Mt. Vernon   NY M   PT1   68096   26MAR77   21MAR98
914/468-1616
1114   Green      Janice    New York     NY F   TA2   32928   21SEP77   30JUN06
212/588-1092
;

                  proc print data=empdata(obs=12);
                     id idnumber;
                     title 'Personnel Data';
                  run;

                  proc print data=empdata(obs=12) rows=page;
```

```
   id idnumber;
   title 'Personnel Data';
run;
```

Program Description

Create the EMPDATA data set. The data set EMPDATA contains personal and job-related information about a company's employees. The DATA step creates this data set.

```
data empdata;
   input IdNumber $ 1-4 LastName $ 8-18 FirstName $ 19-28
      City $ 29-41 State $ 42-43
      Gender $ 45 JobCode $ 49-51 Salary 55-60 @63 Birth date7.
      @73 Hired date7. HomePhone $ 83-95;
   format birth hired date9.;
   datalines;
1919   Adams      Gerald    Stamford     CT M   TA2   34376   15SEP70   07JUN05
203/781-1255
1653   Alexander  Susan     Bridgeport   CT F   ME2   35108   18OCT72   12AUG98
203/675-7715

. . . more lines of data . . .

1407   Grant      Daniel    Mt. Vernon   NY M   PT1   68096   26MAR77   21MAR98
914/468-1616
1114   Green      Janice    New York     NY F   TA2   32928   21SEP77   30JUN06
212/588-1092
;
```

Print only the first 12 observations in a data set. The OBS= data set option uses only the first 12 observations to create the report. (This is just to conserve space here.) The ID statement identifies observations with the formatted value of IdNumber rather than with the observation number. This report is shown in "Output: LISTING" on page 1842.

```
proc print data=empdata(obs=12);
   id idnumber;
   title 'Personnel Data';
run;
```

Print a report that contains only one row of variables on each page. ROWS=PAGE prints only one row of variables for each observation on a page. This report is shown in Output 48.283 on page 1843.

```
proc print data=empdata(obs=12) rows=page;
   id idnumber;
   title 'Personnel Data';
run;
```

Output: LISTING

In the traditional procedure output, each page of this report contains values for all variables in each observation. In the HTML output, this report is identical to the report that uses ROWS=PAGE.

Note that PROC PRINT automatically splits the variable names that are used as column headings at a change in capitalization if the entire name does not fit in the column. Compare the column headings for LastName (which fits in the column) and FirstName (which does not fit in the column).

Output 48.19 *Default Layout for a Report with Many Variables: LISTING Output*

```
                Personnel Data                          1

  Id                    First
Number    LastName      Name           City        State    Gender

 1919     Adams         Gerald      Stamford        CT         M
 1653     Alexander     Susan       Bridgeport      CT         F
 1400     Apple         Troy        New York        NY         M
 1350     Arthur        Barbara     New York        NY         F
 1401     Avery         Jerry       Paterson        NJ         M
 1499     Barefoot      Joseph      Princeton       NJ         M
 1101     Baucom        Walter      New York        NY         M

  Id      Job
Number    Code     Salary      Birth       Hired      HomePhone

 1919     TA2       34376    15SEP70     07JUN05    203/781-1255
 1653     ME2       35108    18OCT72     12AUG98    203/675-7715
 1400     ME1       29769    08NOV85     19OCT06    212/586-0808
 1350     FA3       32886    03SEP63     01AUG00    718/383-1549
 1401     TA3       38822    16DEC68     20NOV93    201/732-8787
 1499     ME3       43025    29APR62     10JUN95    201/812-5665
 1101     SCP       18723    09JUN80     04OCT98    212/586-8060
```

```
                Personnel Data                          2

  Id                    First
Number    LastName      Name           City        State    Gender

 1333     Blair         Justin      Stamford        CT         M
 1402     Blalock       Ralph       New York        NY         M
 1479     Bostic        Marie       New York        NY         F
 1403     Bowden        Earl        Bridgeport      CT         M
 1739     Boyce         Jonathan    New York        NY         M

  Id      Job
Number    Code     Salary      Birth       Hired      HomePhone

 1333     PT2       88606    02APR79     13FEB03    203/781-1777
 1402     TA2       32615    20JAN71     05DEC98    718/384-2849
 1479     TA3       38785    25DEC66     08OCT03    718/384-8816
 1403     ME1       28072    31JAN79     24DEC99    203/675-3434
 1739     PT1       66517    28DEC82     30JAN00    212/587-1247
```

Each page of this report contains values for only some of the variables in each observation. However, each page contains values for more observations than the default report does.

Output 48.20 *Layout Produced by the ROWS=PAGE Option: LISTING Output*

```
                          Personnel Data                          3

  Id                   First
Number    LastName     Name           City        State    Gender

 1919     Adams        Gerald      Stamford        CT         M
 1653     Alexander    Susan       Bridgeport      CT         F
 1400     Apple        Troy        New York        NY         M
 1350     Arthur       Barbara     New York        NY         F
 1401     Avery        Jerry       Paterson        NJ         M
 1499     Barefoot     Joseph      Princeton       NJ         M
 1101     Baucom       Walter      New York        NY         M
 1333     Blair        Justin      Stamford        CT         M
 1402     Blalock      Ralph       New York        NY         M
 1479     Bostic       Marie       New York        NY         F
 1403     Bowden       Earl        Bridgeport      CT         M
 1739     Boyce        Jonathan    New York        NY         M
```

```
                          Personnel Data                          4

  Id      Job
Number    Code     Salary      Birth      Hired     HomePhone

 1919     TA2       34376    15SEP70    07JUN05    203/781-1255
 1653     ME2       35108    18OCT72    12AUG98    203/675-7715
 1400     ME1       29769    08NOV85    19OCT06    212/586-0808
 1350     FA3       32886    03SEP63    01AUG00    718/383-1549
 1401     TA3       38822    16DEC68    20NOV93    201/732-8787
 1499     ME3       43025    29APR62    10JUN95    201/812-5665
 1101     SCP       18723    09JUN80    04OCT98    212/586-8060
 1333     PT2       88606    02APR79    13FEB03    203/781-1777
 1402     TA2       32615    20JAN71    05DEC98    718/384-2849
 1479     TA3       38785    25DEC66    08OCT03    718/384-8816
 1403     ME1       28072    31JAN79    24DEC99    203/675-3434
 1739     PT1       66517    28DEC82    30JAN00    212/587-1247
```

Program: Creating an RTF Report

```
options pageno=1;

ods rtf file='your_file.rtf';

proc print data=empdata(obs=12);
   id idnumber;
   title 'Personnel Data';
run;

ods rtf close;
```

Program Description

The RTF output shows all data in one row. The ROWS= option is valid only for the LISTING destination.

```
options pageno=1;
```

Create output for Microsoft Word and specify the file to store the output in. The ODS RTF statement opens the RTF destination and creates output formatted for Microsoft Word. The FILE= argument specifies the external file that contains the RTF output.

```
ods rtf file='your_file.rtf';

proc print data=empdata(obs=12);
   id idnumber;
   title 'Personnel Data';
run;
```

Close the RTF destination. The ODS RTF CLOSE statement closes the RTF destination.

```
ods rtf close;
```

Output: RTF

Output 48.21 *Layout for a Report with Many Variables: RTF Output*

1

Personnel Data

IdNumber	LastName	FirstName	City	State	Gender	JobCode	Salary	Birth	Hired	HomePhone
1919	Adams	Gerald	Stamford	CT	M	TA2	34376	15SEP70	07JUN05	203/781-1255
1653	Alexander	Susan	Bridgeport	CT	F	ME2	35108	18OCT72	12AUG98	203/675-7715
1400	Apple	Troy	New York	NY	M	ME1	29769	08NOV85	19OCT06	212/586-0808
1350	Arthur	Barbara	New York	NY	F	FA3	32886	03SEP63	01AUG00	718/383-1549
1401	Avery	Jerry	Paterson	NJ	M	TA3	38822	16DEC68	20NOV93	201/732-8787
1499	Barefoot	Joseph	Princeton	NJ	M	ME3	43025	29APR62	10JUN95	201/812-5665
1101	Baucom	Walter	New York	NY	M	SCP	18723	09JUN80	04OCT98	212/586-8060
1333	Blair	Justin	Stamford	CT	M	PT2	88606	02APR79	13FEB03	203/781-1777
1402	Blalock	Ralph	New York	NY	M	TA2	32615	20JAN71	05DEC98	718/384-2849
1479	Bostic	Marie	New York	NY	F	TA3	38785	25DEC66	08OCT03	718/384-8816
1403	Bowden	Earl	Bridgeport	CT	M	ME1	28072	31JAN79	24DEC99	203/675-3434
1739	Boyce	Jonathan	New York	NY	M	PT1	66517	28DEC82	30JAN00	212/587-1247

Example 9: Creating a Customized Layout with BY Groups and ID Variables

Features: PROC PRINT statement options
SUMLABEL
GRANDTOTAL_LABEL
BY statement
ID statement
SUM statement
VAR statement
SORT procedure

Data set: EMPDATA

ODS destinations: LISTING, HTML

Details

This customized report demonstrates the following tasks:

- selects variables to include in the report and the order in which they appear
- selects observations to include in the report
- groups the selected observations by JobCode
- sums the salaries for each job code and for all job codes
- displays numeric data with commas and dollar signs

Program: Creating a LISTING Report

```
options nodate pageno=1 linesize=64 pagesize=60;
proc sort data=empdata out=tempemp;
   by jobcode gender;
run;

proc print data=tempemp split='*' sumlabel='Total'
grandtotal_label='Grand Total';

   id jobcode;
   by jobcode;
   var gender salary;

   sum salary;
```

```
   label jobcode='Job Code*========'
         gender='Gender*======'
         salary='Annual Salary*=============';
   format salary dollar11.2;
   where jobcode contains 'FA' or jobcode contains 'ME';
   title 'Salary Expenses';
run;
```

Program Description

Create and sort a temporary data set. PROC SORT creates a temporary data set in which the observations are sorted by JobCode and Gender.

```
options nodate pageno=1 linesize=64 pagesize=60;
proc sort data=empdata out=tempemp;
   by jobcode gender;
run;
```

Identify the character that starts a new line in column headings. SPLIT= identifies the asterisk as the character that starts a new line in column headings.

```
proc print data=tempemp split='*' sumlabel='Total'
grandtotal_label='Grand Total';
```

Specify the variables to include in the report. The VAR statement and the ID statement together select the variables to include in the report. The ID statement and the BY statement produce the special format.

```
   id jobcode;
   by jobcode;
   var gender salary;
```

Calculate the total value for each BY group. The SUM statement totals the values of Salary for each BY group and for the whole report.

```
   sum salary;
```

Assign labels to the appropriate variables. The LABEL statement associates a label with each variable for the duration of the PROC PRINT step. When you use SPLIT= in the PROC PRINT statement, the procedure uses labels for column headings.

```
   label jobcode='Job Code*========'
         gender='Gender*======'
         salary='Annual Salary*=============';
```

Create formatted columns. The FORMAT statement assigns a format to Salary for this report. The WHERE statement selects for the report only the observations for job codes that contain the letters 'FA' or 'ME'. The TITLE statement specifies the report title.

```
   format salary dollar11.2;
   where jobcode contains 'FA' or jobcode contains 'ME';
   title 'Salary Expenses';
run;
```

Output: LISTING

The ID and BY statements work together to produce this layout. The ID variable is listed only once for each BY group. The BY lines are suppressed. Instead, the value of the ID variable, JobCode, identifies each BY group.

Output 48.22 *Creating a Customized Layout with BY Groups and ID Variables: LISTING Output*

```
Salary Expenses                                    1

   Job Code      Gender    Annual Salary
   ========      ======    =============

   FA1             F         $23,177.00
                   F         $22,454.00
                   M         $22,268.00
   -----------             -------------
   Total                     $67,899.00


   FA2             F         $28,888.00
                   F         $27,787.00
                   M         $28,572.00
   -----------             -------------
   Total                     $85,247.00


   FA3             F         $32,886.00
                   F         $33,419.00
                   M         $32,217.00
   -----------             -------------
   Total                     $98,522.00


   ME1             M         $29,769.00
                   M         $28,072.00
                   M         $28,619.00
   -----------             -------------
   Total                     $86,460.00


   ME2             F         $35,108.00
                   F         $34,929.00
                   M         $35,345.00
                   M         $36,925.00
                   M         $35,090.00
                   M         $35,185.00
   -----------             -------------
   Total                    $212,582.00


   ME3             M         $43,025.00
   ===========             =============
   Grand Total              $593,735.00
```

Program: Creating an HTML Report

```
proc sort data=empdata out=tempemp;
```

```
   by jobcode gender;
run;

ods html file='your_file.html';

proc print data=tempemp (obs=10) sumlabel='Total'
grandtotal_lable='Grand Total';

 id jobcode;
   by jobcode;
   var gender salary;

   sum salary;

   label jobcode='Job Code'
         gender='Gender'
         salary='Annual Salary';

   format salary dollar11.2;
   where jobcode contains 'FA' or jobcode contains 'ME';
   title 'Salary Expenses';
run;
```

Program Description

```
proc sort data=empdata out=tempemp;
   by jobcode gender;
run;
```

Produce HTML output and specify the file to store the output in. The HTML destination is the default ODS destination. The ODS HTML statement FILE= option specifies the external file that contains the HTML output.

```
ods html file='your_file.html';
```

Define the procedure options. The (obs=10) data set option sets the number of observations to process. The SUMLABEL option indicates to use the label 'Total' on the summary line for each BY group. The GRANDTOTAL_LABEL option indicates to use the label 'Grand Total' on the grand total line after all BY groups in the report.

```
proc print data=tempemp (obs=10) sumlabel='Total'
grandtotal_lable='Grand Total';

 id jobcode;
   by jobcode;
   var gender salary;

   sum salary;

   label jobcode='Job Code'
         gender='Gender'
         salary='Annual Salary';

   format salary dollar11.2;
   where jobcode contains 'FA' or jobcode contains 'ME';
   title 'Salary Expenses';
run;
```

Output: HTML

Output 48.23 *Creating a Customized Layout with BY Groups and ID Variables: Default HTML Output*

Salary Expenses

JobCode	Gender	Salary
FA1	F	$23,177.00
	F	$22,454.00
	M	$22,268.00
Total		$67,899.00

JobCode	Gender	Salary
FA2	F	$28,888.00
	F	$27,787.00
	M	$28,572.00
Total		$85,247.00

JobCode	Gender	Salary
FA3	F	$32,886.00
	F	$33,419.00
	M	$32,217.00
Total		$98,522.00

JobCode	Gender	Salary
ME1	M	$29,769.00
Grand Total		$281,437.00

Program: Creating an HTML Report with the STYLE Option

```
proc sort data=empdata out=tempemp;
   by jobcode gender;
run;

proc print data=tempemp (obs=10)sumlabel='Total'
grandtotal_label='Grand Total'
```

```
   style(HEADER)={fontstyle=italic}
   style(DATA)={backgroundcolor=blue foreground=white};
 id jobcode;
   by jobcode;
   var gender salary;
   sum salary  / style(total)={color=red};
   label jobcode='Job Code'
         gender='Gender'
         salary='Annual Salary';
   format salary dollar11.2;
   where jobcode contains 'FA' or jobcode contains 'ME';
   title 'Expenses Incurred for';
   title2 'Salaries for Flight Attendants and Mechanics';
run;
```

Program Description

```
proc sort data=empdata out=tempemp;
   by jobcode gender;
run;
```

Create stylized HTML output. The first STYLE option specifies that the font of the headers be changed to italic. The second STYLE option specifies that the background of cells that contain data be changed to blue and the foreground of these cells be changed to white. The SUMLABEL and GRANDTOTAL_LABEL options use a label in the summary and grand total lines, respectively, in place of variable names.

```
proc print data=tempemp (obs=10)sumlabel='Total'
grandtotal_label='Grand Total'
   style(HEADER)={fontstyle=italic}
   style(DATA)={backgroundcolor=blue foreground=white};
 id jobcode;
   by jobcode;
   var gender salary;
```

Create total values that are written in red. The STYLE option specifies that the color of the foreground of the cell that contain the totals be changed to red.

```
   sum salary  / style(total)={color=red};
   label jobcode='Job Code'
         gender='Gender'
         salary='Annual Salary';
   format salary dollar11.2;
   where jobcode contains 'FA' or jobcode contains 'ME';
   title 'Expenses Incurred for';
   title2 'Salaries for Flight Attendants and Mechanics';
run;
```

Output: HTML with Styles

Output 48.24 *Creating a Customized Layout with BY Groups and ID Variables: HTML Output Using Styles*

Expenses Incurred for
Salaries for Flight Attendants and Mechanics

Job Code	Gender	Annual Salary
FA1	F	$23,177.00
	F	$22,454.00
	M	$22,268.00
Total		$67,899.00

Job Code	Gender	Annual Salary
FA2	F	$28,888.00
	F	$27,787.00
	M	$28,572.00
Total		$85,247.00

Job Code	Gender	Annual Salary
FA3	F	$32,886.00
	F	$33,419.00
	M	$32,217.00
Total		$98,522.00

Job Code	Gender	Annual Salary
ME1	M	$29,769.00
Grand Total		$281,437.00

Example 10: Printing All the Data Sets in a SAS Library

Features: Macro facility
DATASETS procedure

	PRINT procedure
Data sets:	PROCLIB.DELAY and PROCLIB.INTERNAT from the Raw Data and DATA Steps appendix
ODS destination:	HTML

Details

This example prints all the data sets in a SAS library. You can use the same programming logic with any procedure. Just replace the PROC PRINT step near the end of the example with whatever procedure step you want to execute. The example uses the macro language. For details about the macro language, see *SAS Macro Language: Reference*.

Program: Printing All of the Data Sets in a Library

```
libname printlib 'SAS-data-library';
libname proclib 'SAS-data-library';
options nodate pageno=1;

proc datasets library=proclib memtype=data nolist;
   copy out=printlib;
      select delay internat;
run;

%macro printall(libname,worklib=work);

   %local num i;

   proc datasets library=&libname memtype=data nodetails;
      contents out=&worklib..temp1(keep=memname) data=_all_ noprint;
   run;

   data _null_;
      set &worklib..temp1 end=final;
      by memname notsorted;
      if last.memname;
      n+1;
      call symput('ds'||left(put(n,8.)),trim(memname));

      if final then call symput('num',put(n,8.));

   run;

   %do i=1 %to &num;
      proc print data=&libname..&&ds&i noobs;
         title "Data Set &libname..&&ds&i";
      run;
   %end;
%mend printall;

%printall(printlib)
```

Program Description

```
libname printlib 'SAS-data-library';
libname proclib 'SAS-data-library';
options nodate pageno=1;
```

Copy the desired data sets from the WORK library to a permanent library. PROC DATASETS copies two data sets from the WORK library to the PRINTLIB library in order to limit the number of data sets available to the example.

```
proc datasets library=proclib memtype=data nolist;
   copy out=printlib;
      select delay internat;
run;
```

Create a macro and specify the parameters. The %MACRO statement creates the macro PRINTALL. When you call the macro, you can pass one or two parameters to it. The first parameter is the name of the library whose data set you want to print. The second parameter is a library used by the macro. If you do not specify this parameter, the WORK library is the default.

```
%macro printall(libname,worklib=work);
```

Create the local macro variables. The %LOCAL statement creates two local macro variables, NUM and I, to use in a loop.

```
   %local num i;
```

Produce an output data set. This PROC DATASETS step reads the library that you specify as a parameter when you invoke the macro. The CONTENTS statement produces an output data set called TEMP1 in WORKLIB. This data set contains an observation for each variable in each data set in the library LIBNAME. By default, each observation includes the name of the data set that the variable is included in as well as other information about the variable. However, the KEEP= data set option writes only the name of the data set to TEMP1.

```
   proc datasets library=&libname memtype=data nodetails;
      contents out=&worklib..temp1(keep=memname) data=_all_ noprint;
   run;
```

Specify the unique values in the data set, assign a macro variable to each one, and assign DATA step information to a macro variable. This DATA step increments the value of N each time it reads the last occurrence of a data set name (when IF LAST.MEMNAME is true). The CALL SYMPUT statement uses the current value of N to create a macro variable for each unique value of MEMNAME in the data set TEMP1. The TRIM function removes extra blanks in the TITLE statement in the PROC PRINT step that follows.

```
   data _null_;
      set &worklib..temp1 end=final;
      by memname notsorted;
      if last.memname;
      n+1;
      call symput('ds'||left(put(n,8.)),trim(memname));
```

Determine the number of observations in the DATA step. When it reads the last observation in the data set (when FINAL is true), the DATA step assigns the value

of N to the macro variable NUM. At this point in the program, the value of N is the number of observations in the data set.

```
      if final then call symput('num',put(n,8.));
```

Run the DATA step. The RUN statement is crucial. It forces the DATA step to run, thus creating the macro variables that are used in the CALL SYMPUT statements before the %DO loop, which uses them, executes.

```
   run;
```

Print the data sets and end the macro. The %DO loop issues a PROC PRINT step for each data set. The %MEND statement ends the macro.

```
   %do i=1 %to &num;
      proc print data=&libname..&&ds&i noobs;
         title "Data Set &libname..&&ds&i";
      run;
   %end;
%mend printall;
```

Print all the data sets in the PRINTLIB library. This invocation of the PRINTALL macro prints all the data sets in the library PRINTLIB.

```
%printall(printlib)
```

Output: HTML

Output 48.25 *Data Set PRINTLIB.DELAY*

Data Set printlib.DELAY

flight	date	orig	dest	delaycat	destype	delay
114	01MAR12	LGA	LAX	1-10 Minutes	Domestic	8
202	01MAR12	LGA	ORD	No Delay	Domestic	-5
219	01MAR12	LGA	LON	11+ Minutes	International	18
622	01MAR12	LGA	FRA	No Delay	International	-5
132	01MAR12	LGA	YYZ	11+ Minutes	International	14
271	01MAR12	LGA	PAR	1-10 Minutes	International	5
302	01MAR12	LGA	WAS	No Delay	Domestic	-2
114	02MAR12	LGA	LAX	No Delay	Domestic	0
202	02MAR12	LGA	ORD	1-10 Minutes	Domestic	5
219	02MAR12	LGA	LON	11+ Minutes	International	18
622	02MAR12	LGA	FRA	No Delay	International	0
132	02MAR12	LGA	YYZ	1-10 Minutes	International	5
271	02MAR12	LGA	PAR	1-10 Minutes	International	4
302	02MAR12	LGA	WAS	No Delay	Domestic	0
114	03MAR12	LGA	LAX	No Delay	Domestic	-1

Output 48.26 *Data Set PRINTLIB.INTERNAT*

Data Set printlib.INTERNAT

flight	date	dest	boarded
219	01MAR12	LON	198
622	01MAR12	FRA	207
132	01MAR12	YYZ	115
271	01MAR12	PAR	138
219	02MAR12	LON	147
622	02MAR12	FRA	176
132	02MAR12	YYZ	106
271	02MAR12	PAR	172
219	03MAR12	LON	197
622	03MAR12	FRA	180
132	03MAR12	YYZ	75
271	03MAR12	PAR	147
219	04MAR12	LON	232
622	04MAR12	FRA	137
132	04MAR12	YYZ	117

49

PRINTTO Procedure

Overview: PRINTTO Procedure

What Does the PRINTTO Procedure Do?

The PRINTTO procedure defines destinations, other than ODS destinations, for SAS procedure output and for the SAS log. By default, SAS procedure output and the SAS log are routed to the default procedure output file and the default SAS log file for your method of operation. The PRINTTO procedure does not define ODS destinations. See the following table for SAS log and procedure output default destinations.

You can store the SAS log or procedure output in an external file or in a SAS catalog entry. To write SAS output to a file or a catalog entry, the ODS LISTING destination must be open. With additional programming, you can use SAS output as input data within the same job.

Table 49.1 *Default Destinations for SAS Log and Procedure Output*

Method of Running SAS	Default SAS Log Destination	Default Procedure Output Destination
Windowing environment	LOG window	Results Viewer window
Interactive line mode	Display monitor (as statements are entered)	Display monitor (as each step executes)
Noninteractive mode or batch mode	Depends on the host operating system	Depends on the operating environment

Operating Environment Information: For information and examples specific to your operating system or environment, see the documentation for your operating environment.

Syntax: PRINTTO Procedure

See: "PRINTTO Procedure: UNIX" in *SAS Companion for UNIX Environments*
"PRINTTO Procedure: Windows" in *SAS Companion for Windows*
"PRINTTO Procedure Statement: z/OS" in *SAS Companion for z/OS*

PROC PRINTTO <*options*>;

Statement	Task	Example
PROC PRINTTO	Define destinations, other than ODS destinations, for SAS procedure output and for the SAS log	Ex. 1, Ex. 2, Ex. 3, Ex. 4

PROC PRINTTO Statement

Defines destinations, other than ODS destinations, for SAS procedure output and for the SAS log.

Restrictions: To route SAS log and procedure output directly to a printer, you must use a FILENAME statement with the PROC PRINTTO statement. See "Route SAS Log or Procedure Output Directly to a Printer" on page 1864 and "Example 4: Routing to a Printer" on page 1878.

The PRINTTO procedure does not define ODS destinations.

When SAS is started in objectserver mode, the PRINTTO procedure does not route log messages to the log specified by the ALTLOG= system option.

Note: LOG=LOG and PRINT=PRINT route the log and procedure output to the default destinations. However, specifying LOG=PRINT or PRINT=LOG to route log or procedure output to the same default destination is not valid.

Tips: To reset the destination for the SAS log and procedure output to the default, use the PROC PRINTTO statement without options.

To route the SAS log and procedure output to the same file, specify the same file with both the LOG= and PRINT= options.

Examples: "Example 1: Routing to External Files" on page 1865

"Example 2: Routing to SAS Catalog Entries" on page 1869

"Example 3: Using Procedure Output as an Input File" on page 1873

"Example 4: Routing to a Printer" on page 1878

Syntax

PROC PRINTTO <*options*>;

Summary of Optional Arguments

LABEL='*description*'
: provides a description for a SAS log or procedure output stored in a SAS catalog entry.

LOG=LOG | *file-specification* | *SAS-catalog-entry*
: routes the SAS log to a permanent external file or SAS catalog entry.

NEW
: replaces the file instead of appending to it.

PRINT= PRINT | *file-specification* | *SAS-catalog-entry*
: routes procedure output to a permanent external file or SAS catalog entry or printer.

UNIT=*nn*
: routes the output to the file identified by the fileref.

Without Arguments

When no options are specified, the PROC PRINTTO statement does the following:

- closes any files opened by a PROC PRINTTO statement
- points both the SAS log and SAS procedure output to their default destinations

- closes the LISTING destination

Interaction: To close the appropriate file and to return only the SAS log or procedure output to its default destination, use LOG=LOG or PRINT=PRINT.

Examples:

"Example 1: Routing to External Files" on page 1865

"Example 2: Routing to SAS Catalog Entries" on page 1869

Optional Arguments

LABEL='*description*'

provides a description for a catalog entry that contains a SAS log or procedure output.

Range 1–256 characters

Interaction Use the LABEL= option only when you specify a catalog entry as the value for the LOG= option or the PRINT= option.

Example "Example 2: Routing to SAS Catalog Entries" on page 1869

LOG=LOG | *file-specification* | *SAS-catalog-entry*

routes the SAS log to one of three locations:

LOG

routes the SAS log to its default destination.

file-specification

routes the SAS log to an external file. *file-specification* can be one of the following:

'external-file'

the name of an external file specified in quotation marks.

Restriction *external-file* cannot be longer than 1024 characters.

log-filename

is an unquoted alphanumeric text string. SAS creates a log that uses *log-filename*.log as the log filename.

Operating environment For more information about *log-filename*, see the documentation for your operating environment.

fileref

a fileref previously assigned to an external file.

SAS-catalog-entry

routes the SAS log to a SAS catalog entry. By default, *libref* is SASUSER, *catalog* is PROFILE, and *type* is LOG. Express *SAS-catalog-entry* in one of the following ways:

***libref.catalog.entry*<.LOG>**

a SAS catalog entry stored in the SAS library and SAS catalog specified.

***catalog.entry*<.LOG>**

a SAS catalog entry stored in the specified SAS catalog in the default SAS library SASUSER.

***entry*.LOG**
a SAS catalog entry stored in the default SAS library and catalog: SASUSER.PROFILE.

fileref
a fileref previously assigned to a SAS catalog entry. Search for "FILENAME, CATALOG Access Method" in the SAS online documentation.

Default LOG

Interactions The SAS log and procedure output cannot be routed to the same catalog entry at the same time.

The NEW option replaces the existing contents of a file with the new log. Otherwise, the new log is appended to the file.

To route the SAS log and procedure output to the same file, specify the same file with both the LOG= and PRINT= options.

When routing the log to a SAS catalog entry, you can use the LABEL option to provide a description for the entry in the catalog directory.

When the log is routed to a file other than the default log file and programs are submitted from multiple sources, the final SAS system messages that contain the real and CPU times are written to the default SAS log.

Tips After routing the log to an external file or a catalog entry, you can specify LOG to route the SAS log back to its default destination.

When routing the SAS log, include a RUN statement in the PROC PRINTTO statement. If you omit the RUN statement, the first line of the following DATA or PROC step is not routed to the new file. (This occurs because a statement does not execute until a step boundary is crossed.)

If you create a macro that contains a password and you do not want the password to appear in the SAS log, use the LOG=*file-specification* option to redirect the log to an external file.

When you specify LOG=, SAS stores the path of the SAS log file in the &SYSPRINTTOLOG automatic macro variable. You can use this macro variable to restore the previous SAS log file location. For more information, see "Restore the Previous SAS Log or LISTING Output File Location" on page 1865.

Examples "Example 1: Routing to External Files" on page 1865

"Example 2: Routing to SAS Catalog Entries" on page 1869

"Example 3: Using Procedure Output as an Input File" on page 1873

NEW
clears any information that exists in a file and prepares the file to receive the SAS log or procedure output.

Default If you omit NEW, the new information is appended to the existing file.

Interaction If you specify both LOG= and PRINT=, NEW applies to both.

Examples "Example 1: Routing to External Files" on page 1865

"Example 2: Routing to SAS Catalog Entries" on page 1869

"Example 3: Using Procedure Output as an Input File" on page 1873

PRINT= PRINT | *file-specification* | *SAS-catalog-entry*
routes procedure output to one of three locations:

PRINT
routes procedure output to its default destination.

Tip After routing it to an external file or a catalog entry, you can specify PRINT to route subsequent procedure output to its default destination.

file-specification
routes procedure output to an external file. *file-specification* can be one of the following:

'external-file'
the name of an external file specified in quotation marks.

Restriction *external-file* cannot be longer than 1024 characters.

print-filename
is an unquoted alphanumeric text string. SAS creates a print file that uses *print-filename* as the print filename.

Operating Environment Information: For more information about using *print-filename*, see the documentation for your operating environment.

fileref
a fileref previously assigned to an external file.

Operating Environment Information: For additional information about *file-specification* for the PRINT option, see the documentation for your operating environment.

SAS-catalog-entry
routes procedure output to a SAS catalog entry. By default, *libref* is SASUSER, *catalog* is PROFILE, and *type* is OUTPUT. Express *SAS-catalog-entry* in one of the following ways:

***libref.catalog.entry*<.OUTPUT>**
a SAS catalog entry stored in the SAS library and SAS catalog specified.

***catalog.entry*<.OUTPUT>**
a SAS catalog entry stored in the specified SAS catalog in the default SAS library SASUSER.

***entry*.OUTPUT**
a SAS catalog entry stored in the default SAS library and catalog: SASUSER.PROFILE.

fileref
a fileref previously assigned to a SAS catalog entry. Search for "FILENAME, CATALOG Access Method" in the SAS online documentation.

Alias FILE=, NAME=

Default PRINT

Interactions When you specify PRINT, FILE=, or NAME=, and the LISTING destination is not open, the PRINTTO procedure opens the LISTING destination for the duration of routing the procedure output. If the LISTING destination was open before PRINT, FILE=, or NAME= was specified, it remains open after the output has been routed to its destination.

The procedure output and the SAS log cannot be routed to the same catalog entry at the same time.

The NEW option replaces the existing contents of a file with the new procedure output. If you omit NEW, the new output is appended to the file.

To route the SAS log and procedure output to the same file, specify the same file with both the LOG= and PRINT= options.

When routing procedure output to a SAS catalog entry, you can use the LABEL option to provide a description for the entry in the catalog directory.

Tip When you specify PRINT=, SAS stores the path of the LISTING output file in the &SYSPRINTTOLIST automatic macro variable. You can use this macro variable to restore the previous LISTING output file location. For more information, see "Restore the Previous SAS Log or LISTING Output File Location" on page 1865.

Example "Example 3: Using Procedure Output as an Input File" on page 1873

UNIT=*nn*
routes the output to the file identified by the fileref FT*nn*F001, where *nn* is an integer between 1 and 99.

Range 1–99, integer only.

Tips You can define this fileref yourself. However, some operating systems predefine certain filerefs in this form.

When you specify UNIT=, SAS stores the path of the LISTING output file in the &SYSPRINTTOLIST automatic macro variable. You can use this macro variable to restore the previous LISTING output file location. For

more information, see "Restore the Previous SAS Log or LISTING Output File Location" on page 1865.

Usage: PRINTTO Procedure

Set Page Numbers Using SAS System Options

When the NUMBER SAS system option is in effect, there is a single page-numbering sequence for all output in the current job or session. When NONUMBER is in effect, output pages are not numbered.

You can specify the beginning page number for the output that you are currently producing by using the PAGENO= in an OPTIONS statement.

Route SAS Log or Procedure Output Directly to a Printer

To route SAS log or procedure output directly to a printer, use a FILENAME statement to associate a fileref with the printer name, and then use that fileref in the LOG= or PRINT= option. For an example, see "Example 4: Routing to a Printer" on page 1878.

For more information, see "FILENAME Statement" in *SAS Global Statements: Reference*.

Operating Environment Information: For examples of printer names, see the documentation for your operating system.

The PRINTTO procedure does not support the COLORPRINTING system option. If you route the SAS log or procedure output to a color printer, the output does not print in color.

PROC PRINTTO and the LISTING Destination

The LISTING destination must be opened to route procedure output to an external file. When you specify the PRINT= option, SAS opens the LISTING destination if it is not already open. After the procedure output has been routed to the external file, SAS closes the LISTING destination. The LISTING destination is also closed if it is

opened when you use `proc printto;` to reset the output destinations. SAS does not open the LISTING destination when you specify the LOG= option.

If the LISTING destination is open before the PROC PRINTTO PRINT= option executes, it remains open after the output is routed to the external file.

Restore the Previous SAS Log or LISTING Output File Location

When you specify the LOG=, PRINT=, or the UNIT= options in the PROC PRINTTO statement, SAS stores the appropriate file location in automatic macro variables:

SYSPRINTTOLOG	contains the path of the SAS log file location prior to redirection by the PRINTTO procedure
SYSPRINTTOLIST	contains the path of the LISTING output file location prior to redirection by the PRINTTO procedure

To restore the previous file locations, you specify the appropriate automatic macro variable as the value of the LOG=, PRINT=, or UNIT= options. Here are some examples:

```
/* Restore the previous log and the listing file locations. */
proc printto log=&sysprinttolog print=&sysprinttolist;
   run;

/* Restore the previous listing file location. */
proc printto unit=&sysprinttolist;
   run;
```

Examples: PRINTTO Procedure

Example 1: Routing to External Files

Features:

PRINTTO statement without options

PRINTTO statement options

- LOG=
- NEW
- PRINT=

Details

This example uses PROC PRINTTO to route the log and procedure output to an external file and then reset both destinations to the default.

Program

```
options nodate pageno=1 linesize=80 pagesize=60 source;

proc printto log='log-file';
   run;

data numbers;
   input x y z;
   datalines;
 14.2   25.2   96.8
 10.8   51.6   96.8
  9.5   34.2  138.2
  8.8   27.6   83.2
 11.5   49.4  287.0
  6.3   42.0  170.7
;

proc printto print='output-file'
new;
run;

proc print data=numbers;
   title 'Listing of NUMBERS Data Set';
run;

proc printto;
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page. The SOURCE option writes lines of source code to the default destination for the SAS log.

```
options nodate pageno=1 linesize=80 pagesize=60 source;
```

Route the SAS log to an external file. PROC PRINTTO uses the LOG= option to route the SAS log to an external file. By default, this log is appended to the current contents of *log-file*.

```
proc printto log='log-file';
```

```
   run;
```

Create the NUMBERS data set. The DATA step uses list input to create the NUMBERS data set.

```
data numbers;
   input x y z;
   datalines;
 14.2   25.2   96.8
 10.8   51.6   96.8
  9.5   34.2  138.2
  8.8   27.6   83.2
 11.5   49.4  287.0
  6.3   42.0  170.7
;
```

Route the procedure output to an external file. PROC PRINTTO routes output to an external file. Because the LISTING destination must be open in order to route SAS output to an external file, SAS opens the LISTING destination if it is not already open. You do not need to include the ODS LISTING statement. Because NEW is specified, any output written to *output-file* will overwrite the file's current contents. If SAS opened the LISTING destination to process the PROC PRINTTO output, SAS closes the LISTING destination after the output is written to *output-file*.

```
proc printto print='output-file'
new;
run;
```

Print the NUMBERS data set. The PROC PRINT output is written to the specified external file.

```
proc print data=numbers;
   title 'Listing of NUMBERS Data Set';
run;
```

Reset the SAS log and procedure output destinations to default. PROC PRINTTO routes subsequent logs and procedure output to their default destinations and closes both of the current files.

```
proc printto;
run;
```

Log

Example Code 49.1 *Portion of Log Routed to the Default Destination*

```
01   options nodate pageno=1 linesize=80 pagesize=60 source;
02
03   proc printto log='c:\em\log1.log';
04   run;

NOTE: PROCEDURE PRINTTO used (Total process time):
      real time           0.01 seconds
      cpu time            0.00 seconds
```

Example Code 49.2 *Portion of Log Routed to an External File*

```
NOTE: PROCEDURE PRINTTO used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


5
6    data numbers;
7       input x y z;
8       datalines;

NOTE: The data set WORK.NUMBERS has 6 observations and 3 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds


15   ;
16
17   proc printto print='print1.out' new;
18   run;

NOTE: Writing HTML Body file: sashtml.htm
NOTE: PROCEDURE PRINTTO used (Total process time):
      real time           4.04 seconds
      cpu time            0.62 seconds

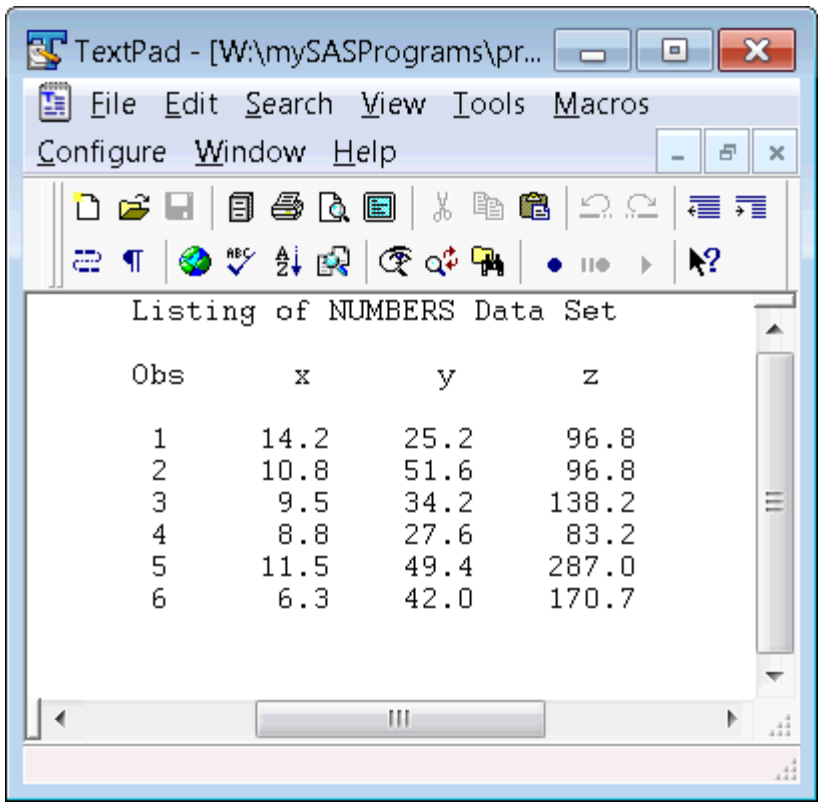

19
20   proc print data=numbers;
21      title 'Listing of NUMBERS Data Set';
22   run;

NOTE: There were 6 observations read from the data set WORK.NUMBERS.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.56 seconds
      cpu time            0.09 seconds


23
24   proc printto;
25   run;
```

Output

Output 49.1 *Procedure Output Routed to an External File*



Example 2: Routing to SAS Catalog Entries

Features:

PRINTTO statement without options

PRINTTO statement options

- LABEL=
- LOG=
- NEW
- PRINT=

Details

This example uses PROC PRINTTO to route the SAS log and procedure output to a SAS catalog entry and then to reset both destinations to the default.

Program

```
options source;

libname lib1 'SAS-library';

proc printto log=test.log label='Inventory program' new;
run;

data lib1.inventry;
   length Dept $ 4 Item $ 6 Season $ 6 Year 4;
   input dept item season year @@;
   datalines;
3070 20410  spring 2011 3070 20411  spring 2012
3070 20412  spring 2012 3070 20413  spring 2012
3070 20414  spring 2011 3070 20416  spring 2009
3071 20500  spring 2011 3071 20501  spring 2009
3071 20502  spring 2011 3071 20503  spring 2011
3071 20505  spring 2010 3071 20506  spring 2009
3071 20507  spring 2009 3071 20424  spring 2011
;

proc printto print=lib1.cat1.inventry.output
             label='Inventory program' new;
run;

proc report data=lib1.inventry nowindows headskip;
   column dept item season year;
   title 'Current Inventory Listing';
run;

proc printto;
run;
```

Program Description

Set the SAS system options. The SOURCE option specifies to write source statements to the SAS log.

```
options source;
```

Assign a libref.

```
libname lib1 'SAS-library';
```

Route the SAS log to a SAS catalog entry. PROC PRINTTO routes the SAS log to a SAS catalog entry named SASUSER.PROFILE.TEST.LOG. The PRINTTO procedure uses the default libref and catalog SASUSER.PROFILE because only the entry name and type are specified. LABEL= assigns a description for the catalog entry.

```
proc printto log=test.log label='Inventory program' new;
run;
```

Create the LIB1.INVENTORY data set. The DATA step creates a permanent SAS data set.

```
data lib1.inventry;
```

```
   length Dept $ 4 Item $ 6 Season $ 6 Year 4;
   input dept item season year @@;
   datalines;
3070 20410  spring 2011 3070 20411  spring 2012
3070 20412  spring 2012 3070 20413  spring 2012
3070 20414  spring 2011 3070 20416  spring 2009
3071 20500  spring 2011 3071 20501  spring 2009
3071 20502  spring 2011 3071 20503  spring 2011
3071 20505  spring 2010 3071 20506  spring 2009
3071 20507  spring 2009 3071 20424  spring 2011
;
```

Route the procedure output to a SAS catalog entry. PROC PRINTTO routes opens the LISTING destination in order to route the procedure output from the subsequent PROC REPORT step to the SAS catalog entry LIB1.CAT1.INVENTRY.OUTPUT. LABEL= assigns a description for the catalog entry. After the procedure output is routed to the SAS catalog, PROC PRINTTO closes the LISTING destination.

```
proc printto print=lib1.cat1.inventry.output
             label='Inventory program' new;
run;

proc report data=lib1.inventry nowindows headskip;
   column dept item season year;
   title 'Current Inventory Listing';
run;
```

Reset the SAS log and procedure output back to the default and close the file. PROC PRINTTO closes the current files that were opened by the previous PROC PRINTTO step and reroutes subsequent SAS logs and procedure output to their default destinations.

```
proc printto;
run;
```

Log

To view this log using SAS Explorer, select **Sasuser** ⇨ **Profile**. Double-click **Test**. The log opens in NOTEPAD.

Example Code 49.3 *SAS Log Routed to SAS Catalog Entry SASUSER.PROFILE.TEST.LOG.*

```
NOTE: PROCEDURE PRINTTO used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


49
50   data lib1.inventry;
51      length Dept $ 4 Item $ 6 Season $ 6 Year 4;
52      input dept item season year @@;
53      datalines;

NOTE: SAS went to a new line when INPUT statement reached past the end of a
      line.
NOTE: The data set LIB1.INVENTRY has 14 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.03 seconds
      cpu time            0.00 seconds


61   ;
62   ods listing;
63   proc printto print=lib1.cat1.inventry.output
64                label='Inventory program' new;
65   run;

NOTE: PROCEDURE PRINTTO used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


66
67   proc report data=lib1.inventry nowindows headskip;
68      column dept item season year;
69      title 'Current Inventory Listing';
70   run;

NOTE: There were 14 observations read from the data set LIB1.INVENTRY.
NOTE: PROCEDURE REPORT used (Total process time):
      real time           0.09 seconds
      cpu time            0.04 seconds

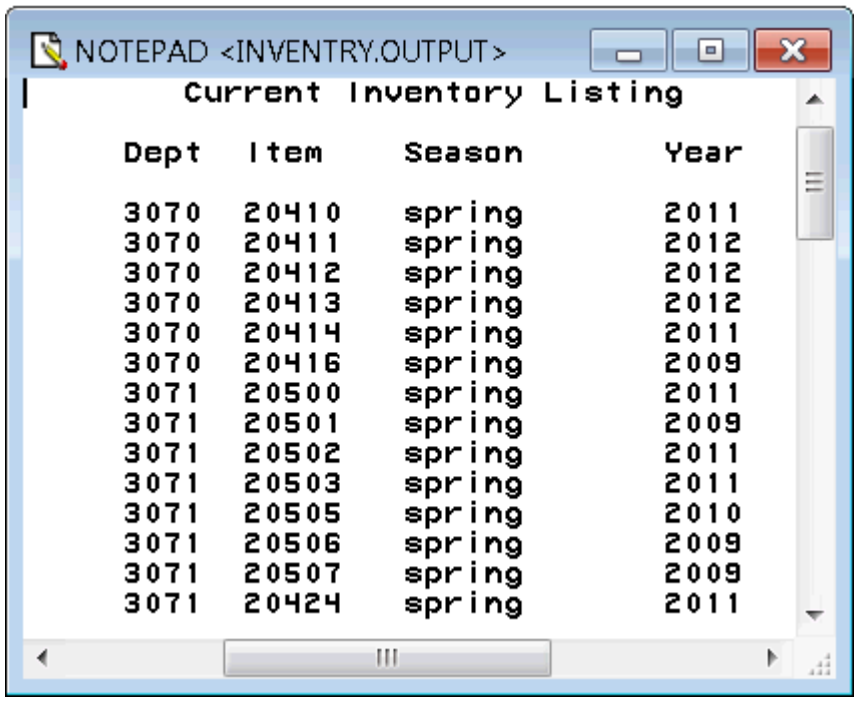

71
72   proc printto;
73   run;
NOTE: PROCEDURE PRINTTO used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


74   ods listing close;
```

Output

To view this log using SAS Explorer, select **Lib1** ⇨ **Cat1**. Double-click **Inventry**. The output opens in NOTEPAD.

Output 49.2 *Procedure Output Routed to SAS Catalog Entry LIB1.CAT1.INVENTRY.OUTPUT.*



Example 3: Using Procedure Output as an Input File

Features:

PRINTTO statement without options

PRINTTO statement options
- LOG=
- NEW
- PRINT=

Details

This example uses PROC PRINTTO to route procedure output to an external file and then uses that file as input to a DATA step.

Program

```
data test;
   do n=1 to 1000;
      x=int(ranuni(77777)*7);
      y=int(ranuni(77777)*5);
```

```
         output;
      end;
   run;

filename routed 'output-filename';

proc printto print=routed new;
   run;

   proc freq data=test;
      tables x*y / chisq;
   run;

   proc printto print=print;
   run;

   data probtest;
      infile routed;
      input word1 $ @;
      if word1='Chi-Squa' then
         do;
            input df chisq prob;
            keep chisq prob;
            output;
         end;
   run;

   proc print data=probtest;
      title 'Chi-Square Analysis for Table of X by Y';
   run;
```

Program Description

Generate random values for the variables. The DATA step uses the RANUNI function to randomly generate values for the variables X and Y in the data set A.

```
data test;
   do n=1 to 1000;
      x=int(ranuni(77777)*7);
      y=int(ranuni(77777)*5);
      output;
   end;
run;
```

Assign a fileref and route procedure output to the file that is referenced. The FILENAME statement assigns a fileref to an external file. PROC PRINTTO routes subsequent procedure output to the file that is referenced by the fileref ROUTED. PROC PRINTTO opens the LISTING destination for the duration of routing the procedure option. See PROC FREQ Output Routed to the External File Referenced as ROUTED below.

```
filename routed 'output-filename';

proc printto print=routed new;
   run;
```

Produce the frequency counts. PROC FREQ computes frequency counts and a chi-square analysis of the variables X and Y in the data set TEST. This output is routed to the file that is referenced as ROUTED.

```
proc freq data=test;
   tables x*y / chisq;
run;
```

Close the file. You must use another PROC PRINTTO to close the file that is referenced by fileref ROUTED so that the following DATA step can read it. The step also routes subsequent procedure output to the default destination. PRINT= causes the step to affect only procedure output, not the SAS log.

```
proc printto print=print;
run;
```

Create the data set PROBTEST. The DATA step uses ROUTED, the file containing PROC FREQ output, as an input file and creates the data set PROBTEST. This DATA step reads all records in ROUTED but creates an observation only from a record that begins with **`Chi-Squa`**.

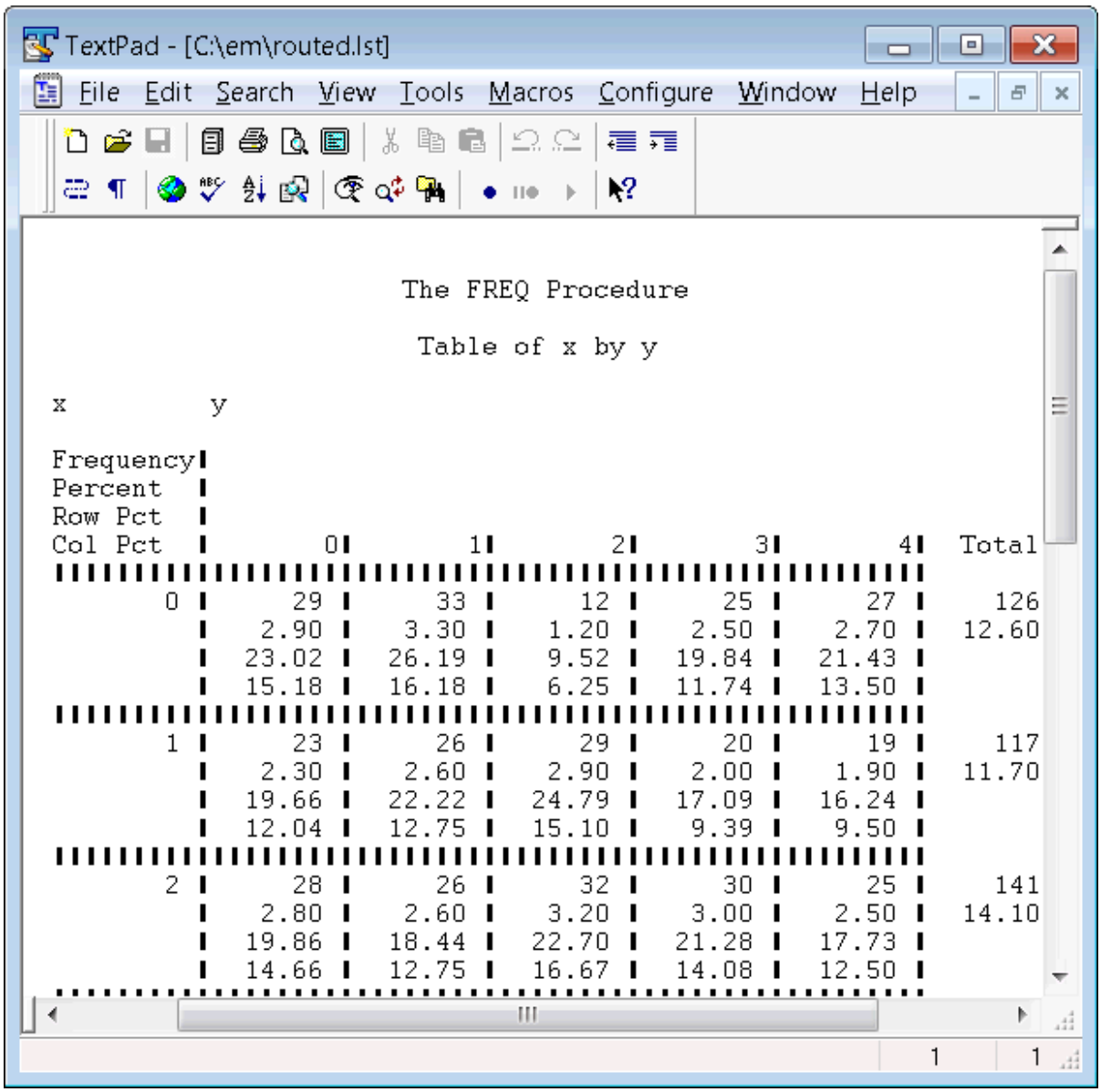
```
data probtest;
   infile routed;
   input word1 $ @;
   if word1='Chi-Squa' then
      do;
         input df chisq prob;
         keep chisq prob;
         output;
      end;
run;
```

Print the PROBTEST data set. PROC PRINT produces a simple listing of data set PROBTEST. This output is routed to the default destination. See PROC PRINT Output of Data Set PROBTEST, Routed to Default Destination in the Output section.

```
proc print data=probtest;
   title 'Chi-Square Analysis for Table of X by Y';
run;
```

Output

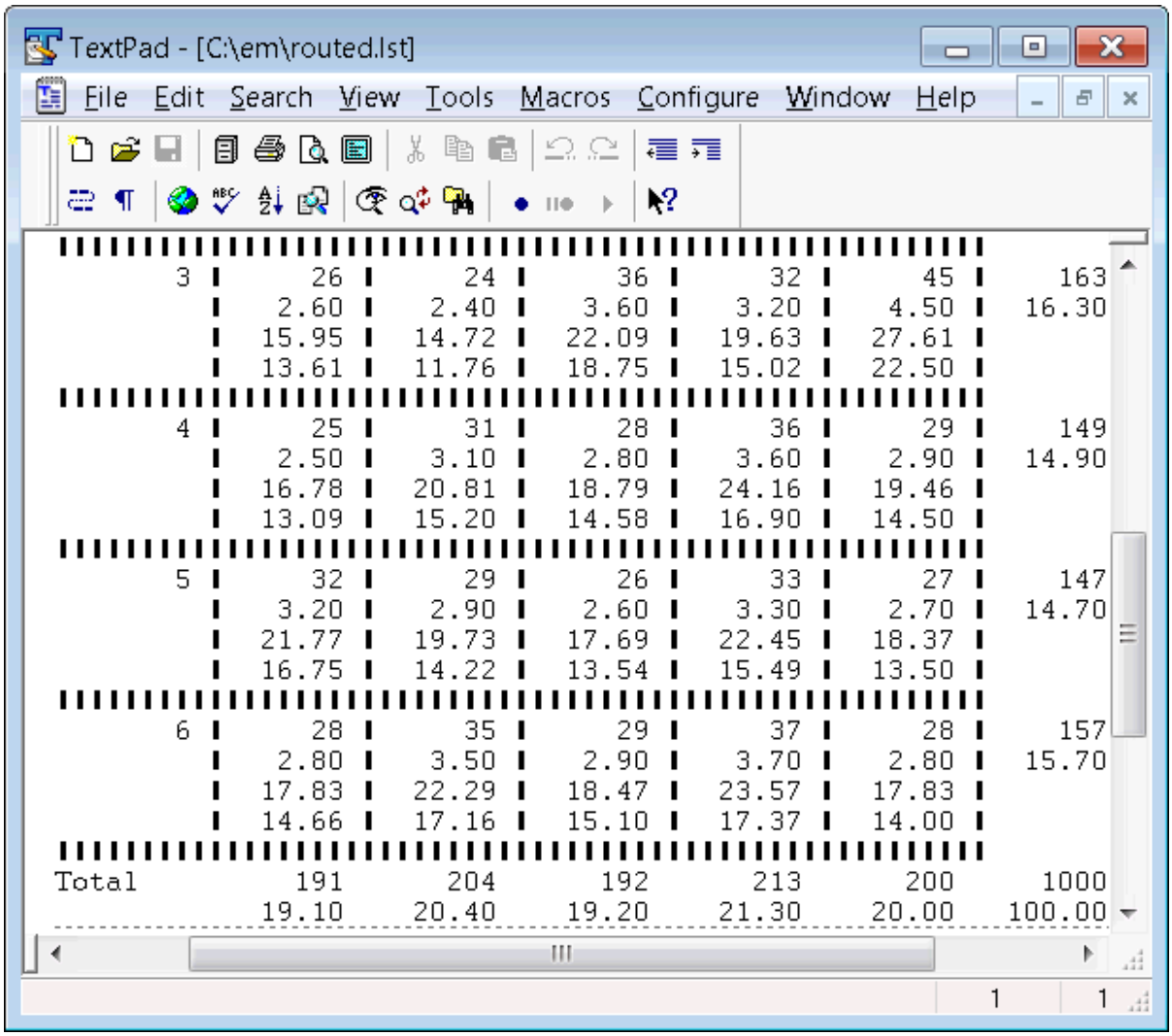
Output 49.3 *PROC FREQ Output Routed to the External File Referenced as ROUTED*

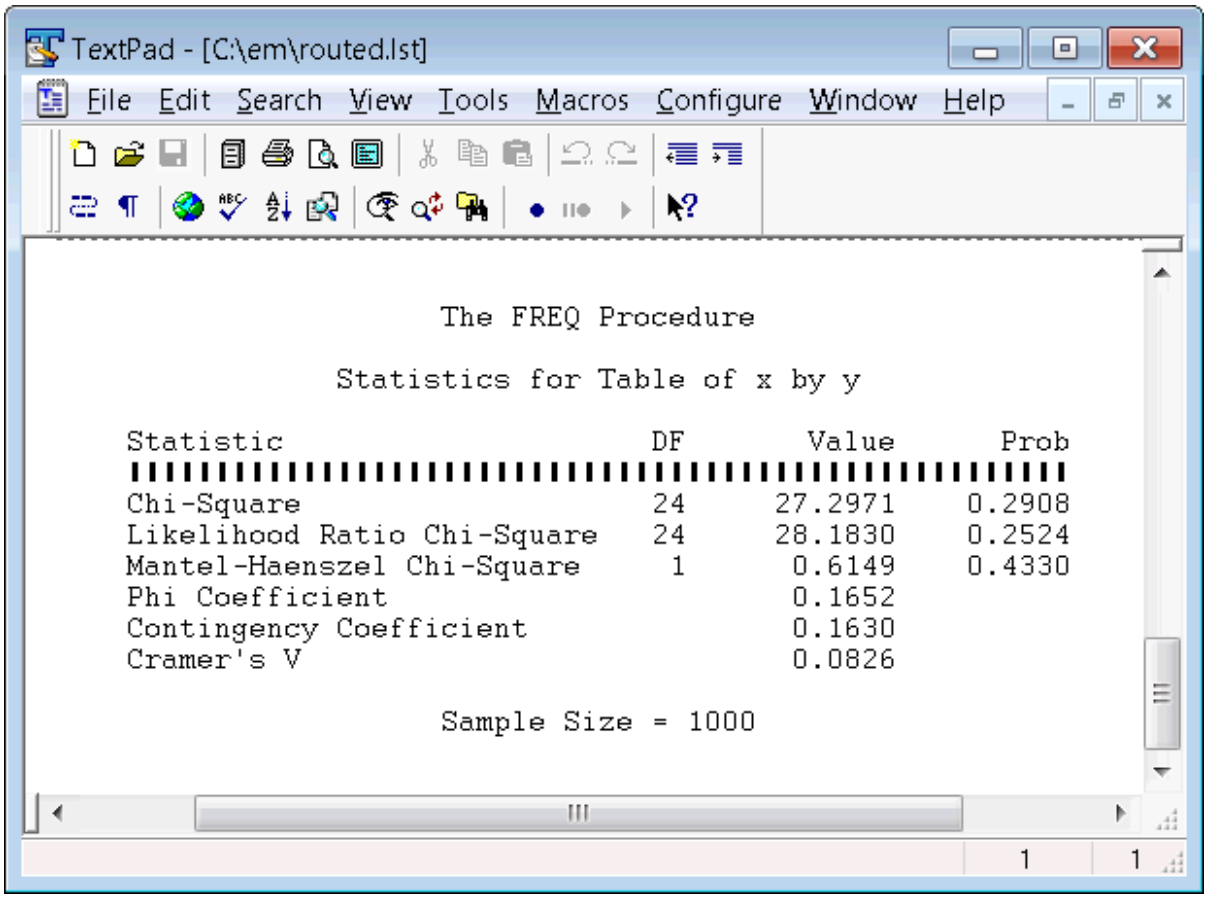


The FREQ Procedure

Table of x by y

x / y	0	1	2	3	4	Total
0 Frequency	29	33	12	25	27	126
Percent	2.90	3.30	1.20	2.50	2.70	12.60
Row Pct	23.02	26.19	9.52	19.84	21.43	
Col Pct	15.18	16.18	6.25	11.74	13.50	
1 Frequency	23	26	29	20	19	117
Percent	2.30	2.60	2.90	2.00	1.90	11.70
Row Pct	19.66	22.22	24.79	17.09	16.24	
Col Pct	12.04	12.75	15.10	9.39	9.50	
2 Frequency	28	26	32	30	25	141
Percent	2.80	2.60	3.20	3.00	2.50	14.10
Row Pct	19.86	18.44	22.70	21.28	17.73	
Col Pct	14.66	12.75	16.67	14.08	12.50	


TextPad - [C:\em\routed.lst]
File Edit Search View Tools Macros Configure Window Help
3 | 26 | 24 | 36 | 32 | 45 | 163
| 2.60 | 2.40 | 3.60 | 3.20 | 4.50 | 16.30
| 15.95 | 14.72 | 22.09 | 19.63 | 27.61 |
| 13.61 | 11.76 | 18.75 | 15.02 | 22.50 |
4 | 25 | 31 | 28 | 36 | 29 | 149
| 2.50 | 3.10 | 2.80 | 3.60 | 2.90 | 14.90
| 16.78 | 20.81 | 18.79 | 24.16 | 19.46 |
| 13.09 | 15.20 | 14.58 | 16.90 | 14.50 |
5 | 32 | 29 | 26 | 33 | 27 | 147
| 3.20 | 2.90 | 2.60 | 3.30 | 2.70 | 14.70
| 21.77 | 19.73 | 17.69 | 22.45 | 18.37 |
| 16.75 | 14.22 | 13.54 | 15.49 | 13.50 |
6 | 28 | 35 | 29 | 37 | 28 | 157
| 2.80 | 3.50 | 2.90 | 3.70 | 2.80 | 15.70
| 17.83 | 22.29 | 18.47 | 23.57 | 17.83 |
| 14.66 | 17.16 | 15.10 | 17.37 | 14.00 |
Total 191 204 192 213 200 1000
19.10 20.40 19.20 21.30 20.00 100.00
1 1



Output 49.4 *PROC PRINT Output of Data Set PROBTEST, Routed to the Default Destination*

Chi-Square Analysis for Table of X by Y

Obs	chisq	prob
1	27.2971	0.2908

Example 4: Routing to a Printer

Features: PRINTTO statement option
PRINT=

Details

This example uses PROC PRINTTO to route procedure output directly to a printer.

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

filename your_fileref printer
'printer-name';

proc printto print=your_fileref;
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Associate a fileref with the printer name. The FILENAME statement associates a fileref with the printer name that you specify. If you want to associate a fileref with the default printer, omit '*printer-name*'.

```
filename your_fileref printer
'printer-name';
```

Specify the file to route to the printer. The PRINT= option specifies the file that PROC PRINTTO routes to the printer.

```
proc printto print=your_fileref;
run;
```

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PRODUCT_STATUS Procedure

Overview: PRODUCT_STATUS Procedure

What Does the PRODUCT_STATUS Procedure Do?

PROC PRODUCT_STATUS returns a list of the SAS Foundation products that are installed on your system, along with the version numbers of those products. It provides a quick method to determine whether a SAS product is available for your use. The results from PROC PRODUCT_STATUS are returned to the SAS log.

Special Considerations

PROC PRODUCT_STATUS does not return information about web applications or other Java-based products.

If your site has installed a SAS Metadata Server, then you should use the SAS ViewRegistry utility instead of PROC PRODUCT_STATUS.

The SYSVLONG and SYSVLONG4 automatic macro variables return only the version information for the SAS host image that is installed at your site. They do not return information for all of the SAS Foundation products that are installed at your site. For more information, see "SYSVLONG Automatic Macro Variable" in *SAS Macro Language: Reference* and "SYSVLONG4 Automatic Macro Variable" in *SAS Macro Language: Reference*.

Syntax: PRODUCT_STATUS Procedure

PROC PRODUCT_STATUS;

Statement	Task
"Example: Results from PROC PRODUCT_STATUS"	Specify the names and versions of the SAS Foundation products that are installed on your operating system.

PROC PRODUCT_STATUS Statement

Returns the names and versions of the SAS Foundation products that are installed on your operating system.

Restriction: PROC PRODUCT_STATUS is deprecated for SAS Viya 3.5 and will not be available in future SAS Viya releases. PROC PRODUCT_STATUS is available to SAS 9.4 users.

Syntax

PROC PRODUCT_STATUS;

Details

The PROC PRODUCT STATUS statement does not have any arguments.

Example: Results from PROC PRODUCT_STATUS

```
proc product_status;
run;
```

Here is a partial output that contains an example of the results that are produced by PROC PRODUCT_STATUS.

```
For Base SAS Software ...
   Custom version information: 9.4_M3
   Image version information: 9.04.01M3D041815
For SAS/STAT ...
   Custom version information: 14.1
For SAS/GRAPH ...
   Custom version information: 9.4_M3
For SAS/ETS ...
   Custom version information: 14.1
For SAS/FSP ...
   Custom version information: 9.4_M3
For SAS/OR ...
   Custom version information: 14.1
For SAS/AF ...
   Custom version information: 9.4_M3
For SAS/IML ...
   Custom version information: 14.1
For SAS/QC ...
   Custom version information: 14.1
For SAS/ASSIST ...
   Custom version information: 9.4
For SAS/CONNECT ...
   Custom version information: 9.4_M3
For SAS/TOOLKIT ...
   Custom version information: 9.4
For SAS/GIS ...
   Custom version information: 9.4_M3
For SAS Table Server ...
   Custom version information: 9.4
For SAS/ACCESS Interface to Netezza ...
   Custom version information: 9.4_M3
```

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PROTO Procedure

Overview: PROTO Procedure

What Does the PROTO Procedure Do?

The PROTO procedure enables you to register, in batch mode, external functions that are written in the C or C++ programming languages. You can use these functions in SAS as well as in C-language structures and types. After the C-language functions are registered in PROC PROTO, they can be called from any SAS function or subroutine that is declared in the FCMP procedure.

Concepts: PROTO Procedure

Registering Function Prototypes

Function prototypes are registered (declared) in the PROTO procedure. For more information, see "FUNCTION-PROTOTYPE-N Statement" on page 1898.

Supported C Return Types

The following C return types are supported in the PROTO procedure.

Table 51.1 *Supported C Return Types*

Function Prototype	SAS Variable Type	C Variable Type
short	numeric	short, short *, short **
short *	numeric, array	short, short *, short **
int	numeric	int, int *, int **

Function Prototype	SAS Variable Type	C Variable Type
int *	numeric, array	int, int *, int **
long	numeric	long, long *, long **
long *	numeric, array	long, long *, long **
double	numeric	double, double *, double **
double *	numeric, array	double, double *, double **
char *	character	char *, char **
struct *	struct	struct *, struct **
void		void

Supported C Argument Types

The following C argument types are supported in the PROTO procedure.

Table 51.2 *Supported C Argument Types*

Function Prototype	SAS Variable Type	C Variable Type
short	numeric	short, short *, short **
short *	numeric, array	short, short *, short **
short **	array	short *, short **
int	numeric	int, int *, int **
int *	numeric, array	int, int *, int **
int **	array	int *, int **
long	numeric	long, long *, long **
long *	numeric, array	long, long *, long **
long **	array	long *, long **

Function Prototype	SAS Variable Type	C Variable Type
double	numeric	double, double *, double **
double *	numeric, array	double, double *, double **
double **	array	double *, double **
char *	character	char *, char **
char **	character	char *, char **
struct *	structure	struct *, struct **
struct **	structure	struct *, struct **

C Structures in SAS

Basic Concepts

Many C language libraries contain functions that have structure pointers as arguments. In SAS, structures can be defined only in PROC PROTO. After being defined, they can be declared and instantiated within many PROC PROTO compatible procedures, such as PROC COMPILE.

A C structure is a template that is applied to a contiguous piece of memory. Each entry in the template is given a name and a type. The type of each element determines the number of bytes that are associated with each entry and how each entry is to be used. Because of various alignment rules and base type sizes, SAS relies on the current machine compiler to determine the location of each entry in the memory of the structure.

Declaring and Referencing Structures in SAS

The syntax of a structure declaration in SAS is the same as for C non-pointer structure declarations. A structure declaration has the following form:

struct *structure_name structure_instance*;

Each structure is set to zero values at declaration time. The structure retains the value from the previous pass through the data to start the next pass.

Structure elements are referenced by using the static period (.) notation of C. There is no pointer syntax for SAS. If a structure points to another structure, the only way to reference the structure that is pointed to is by assigning the pointer to a declared structure of the same type. You use that declared structure to access the elements.

If a structure entry is a short, int, or long type, and it is referenced in an expression, it is first cast to a double type and then used in the calculations. If a structure entry is a pointer to a base type, then the pointer is dereferenced and the value is returned. If the pointer is null, then a missing value is returned. The missing value assignments that are made in the PROC PROTO code are used when conversions fail or when missing values are assigned to non-double structure entities.

The length of arrays must be known to SAS so that an array entry in a structure can be used in the same way as an array in SAS, as long as its dimension is declared in the structure. This requirement includes arrays of short, int, and long types. If the entry is actually a pointer to an array of a double type, then the array elements can be accessed by assigning that pointer to a SAS array. Pointers to arrays of other types cannot be accessed by using the array syntax.

Structure Example

```
proc proto package =
sasuser.mylib.struct
   label = "package of structures";

   #define MAX_IN 20;

   typedef char * ptr;
   struct foo {
      double hi;
      int mid;
      ptr buf1;
      long * low;
      struct {
         short ans[MAX_IN + 1];
         struct {     /* inner */
            int inner;
         } n2;
         short outer;
      } n;
   };

   typedef struct foo *str;

   struct foo2 {
      str tom;
   };

   str get_record(char *name, int userid);
run;

proc fcmp library = sasuser.mylib;
   struct foo result;
```

```
   result = get_record("Mary", 32);
   put result=;
run;
```

Enumerations in SAS

Enumerations are mnemonics for integer numbers. Enumerations enable you to set a literal name as a specific number and aid in the readability and supportability of C programs. Enumerations are used in C language libraries to simplify the return codes. After a C program is compiled, you can no longer access enumeration names.

Enumerated Types Example

The following example shows how to set up two enumerated value types in PROC PROTO: YesNoMaybeType, and Tens. Both are referenced in the structure ESTRUCTURE:

```
proc proto package=sasuser.mylib.str2
   label="package of structures";

   #define E_ROW 52;
   #define L_ROW 124;
   #define S_ROW 15;

   typedef double ExerciseArray[S_ROW][2];
   typedef double LadderArray[L_ROW];
   typedef double SamplingArray[S_Row];

   typedef enum
   {
      True, False, Maybe
   }  YesNoMaybeType;

   typedef enum {
      Ten=10, Twenty=20, Thirty=30, Forty=40, Fifty=50
      } Tens;

   typedef struct {
      short           rows;
      short           cols;
      YesNoMaybeType  type;
      Tens            dollar;
      ExerciseArray   dates;
    } EStructure;
run;
```

The following PROC FCMP example shows how to access these enumerated types. In this example, the enumerated values that are set up in PROC PROTO are implemented in SAS as macro variables. Therefore, they must be accessed using the & symbol:

```
proc fcmp library=sasuser.mylib;
```

```
   struct EStructure mystruct;

   mystruct.type=&True;
   mystruct.dollar=&Twenty;
run;
```

C-Source Code in SAS

You can use PROC PROTO in a limited way to compile external C functions. The C source code can be specified in PROC PROTO in the following way:

```
C-function-prototype;
externc function-name;
   ... C-source-statements ...
externcend;
```

The function name tells PROC PROTO which function's source code is specified between the EXTERNC and EXTERNCEND statements. When PROC PROTO compiles source code, it includes any structure definitions and C function prototypes that are currently declared. However, typedef and #define are not included.

This functionality is provided to enable the creation of simple "helper" functions that facilitate the interface to preexisting external C libraries. Any valid C statement is permitted except for the #include statement. Only a limited subset of the C-stdlib functions is available. However, you can call any other C function that is already declared within the current PROC PROTO step.

The following C-stdlib functions are supported:

Table 51.3 *Supported stdlib Functions*

Function	Description
double sin(double x)	returns the sine of x (radians)
double cos(double x)	returns the cosine of x (radians)
double tan(double x)	returns the tangent of x (radians)
double asin(double x)	returns the arcsine of x (-pi/2 to pi/2 radians)
double acos(double x)	returns the arccosine of x (0 to pi radians)
double atan(double x)	returns the arctangent of x (-pi/2 to pi/2 radians)
double atan2(double x, double y)	returns the arctangent of y/x (-pi to pi radians)
double sinh(double x)	returns the hyperbolic sine of x (radians)

Function	Description
double cosh(double x)	returns the hyperbolic cosine of x (radians)
double tanh(double x)	returns the hyperbolic tangent of x (radians)
double exp(double x)	returns the exponential value of x
double log(double x)	returns the logarithm of x
double log2(double x)	returns the logarithm of x base-2
double log10(double x)	returns the logarithm of x base-10
double pow(double x, double y)	returns x raised to the y power of x**y
double sqrt(double x)	returns the square root of x
double ceil(double x)	returns the smallest integer not less than x
double fmod(double x, double y)	returns the remainder of (x/y)
double floor(double x)	returns the largest integer not greater than x
int abs(int x)	returns the absolute value of x
double fabs(double)	returns the absolute value of x
int min(int x, int y)	returns the minimum of x and y
double fmin(double x, double y)	returns the minimum of x and y
int max(int x, int y)	returns the maximum of x and y
double fmax(double x, double y)	returns the maximum of x and y
char* malloc(int x)	allocates memory of size x
void free(char*)	frees memory allocated with malloc

The following example shows a simple C function written directly in PROC PROTO:

```
proc proto
package=sasuser.mylib.foo;
   struct mystruct {
      short a;
      long b;
   };
   int fillMyStruct(short a, short b,
struct mystruct * s);
```

```
   externc  fillMyStruct;
      int fillMyStruct(short a, short b,
struct mystruct * s) {
         s ->a = a;
         s ->b = b;
         return(0);
      }
   externcend;
run;
```

Limitations for C Language Specifications

The limitations for the C language specifications in the PROTO procedure are as follows:

- #define statements must be followed by a semicolon (;) and must be numeric in value.
- The #define statement functionality is limited to simple replacement and unnested expressions. The only symbols that are affected are array dimension references.
- The C preprocessor statements #include and #if are not supported. The SAS macro %INC can be used in place of #include.
- A maximum of two levels of indirection are allowed for structure elements. Elements like "double ***" are not allowed. If these element types are needed in the structure, but are not accessed in SAS, you can use placeholders.
- The float type is not supported.
- Unsigned is the only type specifier that is currently supported.
- A specified bit size for structure variables is not supported.
- Function pointers and definitions of function pointers are not supported.
- The union type is not supported. However, if you plan to use only one element of the union, you can declare the variable for the union as the type for that element.
- All non-pointer references to other structures must be defined before they are used.
- You cannot use the ENUM key word in a structure. In order to specify ENUM in a structure, use the TYPEDEF key word.
- Structure elements with the same alphanumeric name but with different cases (for example, ALPHA, Alpha, and alpha) are not supported. SAS is not case-sensitive. Therefore, all structure elements must be unique when compared in a case-insensitive program.

Syntax: PROTO Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

PROC PROTO PACKAGE=*entry* <*options*>;

MAPMISS *type1=value1 type2=value2 ...*;

LINK *load-module* <NOUNLOAD>;

function–prototype–1 <*function-prototype-n* ...;>

Statement	Task	Example
PROC PROTO	Register, in batch mode, external functions that are written in the C or C++ programming languages	Ex. 1
LINK	Specify the name, path, and load module that contains your functions	
MAPMISS	Specify alternative values, by type, to pass to functions if values are missing	
FUNCTION-PROTOTYPE-N	Registers function prototypes in the PROTO procedure.	

PROC PROTO Statement

Register, in batch mode, external functions that are written in the C or C++ programming languages.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Example: "Example: Splitter Function Example" on page 1910

Syntax

PROC PROTO PACKAGE=*entry* <*options*>;

Summary of Optional Arguments

ENCRYPT

HIDE
: for XML databases only, enables the code to be encoded within a data set.

LABEL=*package-label*
: specifies a text string to describe or label a package.

NOSIGNALS
: specifies that none of the functions in a package will produce exceptions.

STDCALL
: for Windows PC platforms only, indicates that functions be called using the "_ stdcall" convention.

STRUCTPACK*n*

PACK*n*
: for 32 bit Windows PC platforms or Power Architecture platform running on Linux only, specifies that all structures in a package be compiled with a specific N-BYTE packing pragma.

Required Arguments

PACKAGE=*entry*
specifies the SAS entry where the prototype information is saved. *Entry* is a three-level name having the following form: `library.dataset.package`. *Package* enables you to specify grouping in the GUI. *Package* must be unique for the first 8 characters.

function-prototype-1
function-prototype-n
contains the C code of the function prototypes.

Optional Arguments

ENCRYPT | HIDE
specifies that encoding within a database is allowed.

Restriction This option is available for XML databases only.

LABEL=*package-label*
specifies a text string that is used to describe or label the package. The maximum length of the label is 256 characters.

NOSIGNALS
specifies that none of the functions in a package will produce exceptions or signals.

STDCALL
for Windows PC platforms only, indicates that all functions in the package are called using the "_stdcall" convention.

STRUCTPACK*n* | PACK*n*
for 32 bit Windows PC platforms or the Power Architecture platform running on Linux only, specifies that all structures in this package were compiled with the given N-BYTE packing pragma. That is, STRUCTURE4 specifies that all structures in the package were compiled with the “#pragma pack(4)” option.

LINK Statement

Specifies the name of the load module that contains your functions. Specifying the path is optional.

Restriction: The LINK statement is not supported for z/OS or MVS environments.

Windows specifics: The image specified in the LINK statement must not contain an extension for the image to load.

Note:

Syntax

LINK *load-module* <NOUNLOAD>;

Required Argument

load-module
specifies the load module that contains your functions. You can add more LINK statements to include as many libraries as you need for your prototypes. *Load-module* can have the following forms, depending on your operating environment:

```
'c:\mylibs\xxx.dll';
'c:\mylibs\xxx';
'/users/me/mylibs/xxx';
```

Tip If the full pathname for a module is larger than 32 bytes, use the PROTOLIBS system option to specify the path. Then use the LINK statement to specify the module name.

Optional Argument

NOUNLOAD

IMPORTANT Starting in SAS 9.4M7, you can use the NOUNLOAD option to prevent the PROTO procedure from crashing due to runtime incompatibilities in certain libraries..

specifies that selected libraries remain loaded when the SAS session ends.

Details

Specifying Extensions and Functions

You do not need to specify your module's extension. SAS loads your module with the extension that is specific to your operating environment.

All functions must be declared externally in your load module so that SAS can find them. For most platforms, external declaration is the default behavior for the compiler. However, many C compilers do not export function names by default. The following examples show how to declare your functions for external loading for most PC compilers:

```
_declspec(dllexport) int myfunc(int, double);
_declspec(dllexport) int price2(int a, double foo);
```

The PROTOLIBS System Option

CAUTION
Security Issue Calling a third-party library to a valid path for a load library that is set by the LINK statement can cause a security issue.

Beginning with SAS 9.4M6, the SAS administrator at your site can use the PROTOLIBS system option to control the function of the LINK statement. The administrator can use the PROTOLIBS option to specify a list of valid paths where modules that are specified by the LINK statement can be loaded. The administrator can also use the PROTOLIBS option to disable the LINK statement.

The PROTOLIBS option is a restricted option. Only the SAS administrator at your site can specify a value for it. The default value of the PROTOLIBS option is NONE, which means that the LINK statement is disabled.

You can use the VALUE argument of PROC OPTIONS to find where you can register load modules.

For more information, see PROTOLIBS System Option.

MAPMISS Statement

Specifies alternative values, by type, to pass to functions if values are missing.

Syntax

MAPMISS <POINTER=*pointer-value* > <INT=*integer-value* > <DOUBLE=*double-value*>
< LONG=*long-value* > <SHORT=*short-value*>;

Optional Arguments

POINTER=*pointer-value*
specifies the pointer value to pass to functions for pointer values that are missing.

Default null

INT=*integer-value*
specifies an integer value to pass to functions for integer values that are missing.

DOUBLE=*double-value*
specifies a double value to pass to functions for double values that are missing.

LONG=*long-value*
specifies a long value to pass to functions for long values that are missing.

SHORT=*short-value*
specifies a short value to pass to functions for short values that are missing.

Details

The MAPMISS statement is used to specify alternative values, by data type or pointer value. These values are passed to functions if values are missing. The values are specified as arguments in the MAPMISS statement.

If you set POINTER=NULL, a null value pointer is passed to the functions for pointer variables that are missing. If you do not specify a mapping for a type that is used as an argument to a function, the function is not called when an argument of that type is missing.

MAPMISS values have no affect on arrays because array elements are not checked for missing values when they are passed as parameters to C functions.

FUNCTION-PROTOTYPE-N Statement

Registers function prototypes in the PROTO procedure.

Syntax

function-prototype-1 <*function-prototype-n* ...> *return-type function-name*
(*argument-type* <*argument-name*> / <*iotype*>
<*argument-label*>, ...) <*options*>;

Required Arguments

return-type
specifies a C language type for the returned value.

Tip *Return-type* can be preceded by either the UNSIGNED or EXCELDATE modifiers. You need to use EXCELDATE if the return type is a Microsoft Excel date.

See "Supported C Return Types" on page 1886

function-name
specifies the name of the function to be registered.

Tip Function names within a given package must be unique in the first 32 characters.

argument-type
specifies the C language type for the function argument.

You must specify *argument-type* for each argument in the function's argument list. The argument list must be enclosed in parentheses. If the argument is an array, then you must specify the argument name prefixed to square brackets that contain the array size (for example, `double A[10]`). If the size is not known or if you want to disable verification of the length, then use type**name* instead (for example, `double*A`).

Tip *Argument-type* can be preceded by either the UNSIGNED, CONST, or EXCELDATE modifiers. You need to use EXCELDATE if the return type is a Microsoft Excel date.

See "Supported C Argument Types" on page 1887

argument-name
specifies the name of the argument.

iotype
specifies the I/O type of the argument. Use I for input, O for output, and U for update.

Alias IO

Tips In the program code, use IOTYPE=I | O | U.

By default, all parameters that are pointers are assumed to be input type U. All non-pointer values are assumed to be input type I. This behavior parallels the C language parameter passing scheme.

See "Example: Splitter Function Example" on page 1910 for an example of how *iotype* is used.

argument-label
specifies a description or label for the argument.

LABEL="*text-string*"
specifies a description or a label for the function. Enclose the text string in quotation marks.

Note The LABEL option can be used with the PROTO procedure.

KIND | GROUP=*group-type*
specifies the group that the function belongs to. The KIND= or GROUP= option allows for convenient grouping of functions in a package.

You can use any string (up to 40 characters) in quotation marks to group similar functions.

Note The KIND or GROUP option can be used with the PROTO procedure.

Tip The following special cases provided for Risk Dimensions do not require quotation marks: INPUT (Instrument Input), TRANS (Risk Factor Transformation), PRICING (Instrument Pricing), and PROJECT. The default is PRICING.

Usage: PROTO Procedure

Basic C Language Types

The SAS language supports two data types: character and numeric. These types correspond to an array of characters and a double (double-precision floating point) data type in the C programming language. When SAS variables are used as arguments to external C functions, they are converted (cast) into the proper types.

Working with Character Variables

You can use character variables for arguments that require a "char *" value only. The character string that is passed is a null string that is terminated at the current length of the string. The current length of the character string is the minimum of the allocated length of the string and the length of the last value that was stored in the string. The allocated length of the string (by default, 32 bytes) can be specified by using the LENGTH statement. Functions that return "char *" can return a null or zero-delimited string that is copied to the SAS variable. If the current length of the character string is less than the allocated length, the character string is padded with blanks.

In the following example, the allocated length of *str* is 10, but the current length is 5. When the string is null-terminated at the allocated length, "hello " is passed to the function xxx:

```
length str $ 10;
str = "hello";
call xxx(str);
```

To avoid the blank padding, use the SAS TRIM function on the parameter within the function call:

```
length str $ 10;
str = "hello";
call xxx(trim(str));
```

In this case, the value "hello" is passed to the function xxx.

Working with Numeric Variables

You can use numeric variables for an argument that requires a short, int, long, or double data type, as well as for pointers to those types. Numeric variables are converted to the required type automatically. If the conversion fails, then the function is not called and the output to the function is set to missing. If pointers to these types are requested, the address of the converted value is passed. On return from the call, the value is converted back to a double type and stored in the SAS variable. SAS scalar variables cannot be passed as arguments that require two or more levels of indirection. For example, a SAS variable cannot be passed as an argument that requires a cast to a "long **" type.

Working with Missing Values

SAS variables that contain missing values are converted according to how the function that is being called has mapped missing values when using the PROTO procedure. All variables that are returned from the function are checked for the mapped missing values and converted to SAS missing values.

For example, if an argument to a function is missing, and the argument is to be converted to an integer, and an integer was mapped to –99, then –99 is passed to the function. If the same function returns an integer with the value –99, then the variable that this value is returned to would have a value of missing.

Function Names

External functions and FCMP functions can have the same name as long as they are saved to different packages. When these packages are loaded, a warning message in the log identifies which package contains the default definition for a given

function. To use a function definition from a package other than the default, call the function using *package-name.function-name*.

When you load multiple packages of external functions, all function names must be unique. If two or more external functions of the same name are loaded, the first function that is loaded will be used. Duplicate external functions are ignored. A warning message in the log indicates which package contains the function that will be used, and which package contained the discarded definition.

Interfacing with External C Functions

To make it easier to interface with external C functions, many PROTO-compatible procedures have been enhanced to support most of these C types.

In working with arrays, it is important to note that SAS arrays are passed to EXTERNC routines as single dimensional arrays. They will be read as single dimensional arrays when returning to an FCMP function.

The following example shows log output that is generated when you use arrays and the double ** variable type.

```
proc proto package=work.proto_ds.test;
   void idmat(double** a,int m,int n);
   externc idmat;
   void idmat(double** a,int m,int n)
   {
      int i=0,j=0;
      for(i=0;i<m;i++)
      {
         for(j=0;j<n;j++)
         {
          if(i==j)
             a[0][i*m+j]=1;
          else
             a[0][i*m+j]=0;
       }
    }
};
externcend;
run;

proc fcmp outlib=work.proto_ds.test inlib=work.proto_ds;
   subroutine sas_idmat(b[*,*]);
      outargs b;
      m=dim(b,1);
      n=dim(b,2);
      call idmat(b,m,n);
      put b=;
      put ' ';
   endsub;
quit;
run;
```

```
options cmplib=work.proto_ds;

data cmat;
   array ctmp[3,3] _temporary_;
   array c[3,3];
   output;
   call sas_idmat(ctmp);
   do i=1 to dim(c,1);
      do j=1 to dim(c,2);
         c[i,j]=ctmp[i,j];
      end;
   end;
   output;
   drop i j;
run;
```

SAS writes the following results to the log:

```
b[1, 1]=1 b[1, 2]=0 b[1, 3]=0 b[2, 1]=0 b[2, 2]=1 b[2, 3]=0 b[3, 1]=0 b[3, 2]=0 b[3,
3]=1
```

There is no way to return and save a pointer to any type in a SAS variable. Pointers are always dereferenced, and their contents are converted and copied to SAS variables.

The EXTERNC statement is used to specify C variables in PROTO compatible procedures. The syntax of the EXTERNC statement has the following form:

EXTERNC DOUBLE | INT | LONG | SHORT | CHAR <[*][*]> *var-1* <*var-2 ... var-n*>;

The following table (Table 51.100 on page 1903) shows how these variables are treated when they are positioned on the left side of an expression. The table shows the automatic casting that is performed for a short type on the right side of an assignment. (Explicit type conversions can be forced in any expression, with a unary operator called a cast.) The table lists all the allowed combinations of short types that are associated with SAS variables.

Note: A table for int, long, and double types can be created by substituting any of these types for "short" in this table.

If any of the pointers are null and require dereferencing, then the result is set to missing if there is a missing value set for the result variable. For more information, see "MAPMISS Statement" on page 1897.

Table 51.4 *Automatic Type Casting for the short Data Type in an Assignment Statement*

Type for Left Side of Assignment	Type for Right Side of Assignment	Cast Performed
short	SAS numeric	y = (short) x
short	short	y = x

Type for Left Side of Assignment	Type for Right Side of Assignment	Cast Performed
short	short *	y = * x
short	short **	y = ** x
short *	SAS numeric	* y = (short) x
short *	short	y = & x
short *	short *	y = x
short *	short **	y = * x
short **	SAS numeric	**y = (short) x
short **	short *	y = & x
short **	short **	y = x
SAS numeric	short	y = (double) x
SAS numeric	short *	y = (double) * x
SAS numeric	short **	y = (double) ** x

The following table shows how these variables are treated when they are passed as arguments to an external C function.

Table 51.5 *Types That Are Allowed for External C Arguments*

Function Prototype	SAS Variable Type	C Variable Type
short	numeric	short, short *, short **
short *	numeric, array	short, short *, short **
short **	array	short *, short **
int	numeric	int, int *, int **
int *	numeric, array	int, int *, int **
int **	array	int *, int **

Function Prototype	SAS Variable Type	C Variable Type
long	numeric	long, long *, long **
long *	numeric, array	long, long *, long **
long **	array	long *, long **
double	numeric	double, double *, double **
double *	numeric, array	double, double *, double **
double **	array	double *, double **
char *	character	char *, char **
char **	character	char *, char **
struct *	structure	struct *, struct **
struct **	structure	struct *, struct **

Note: Automatic conversion between two different C types is never performed.

Scope of Packages in PROC PROTO

PROC PROTO packages are loaded in the order that is specified in the CMPLIB= system option, and the contents are used globally. Packages that are loaded through a PROC statement option are considered local in scope. Local definitions are loaded last, and in all cases, local scope overrides global scope.

Definitions are loaded regardless of whether they have unique names or duplicate names. Multiple definitions of certain PROC PROTO elements (for example, enumeration names and function prototypes) can cause name conflicts and generate errors. To prevent name conflicts between PROC PROTO packages, ensure that elements such as enumerated types and function definitions have unique names.

The following example loads three PROC PROTO packages, and shows how the order in which typedef and #define statements override one another.

This part of the example loads the first two PROC PROTO packages:

```
proc proto package = work.p1.test1;
```

```
    typedef struct { int a; int b; } AB_t;
    #define NUM 1;
    int p1(void);
    externc p1;
        int p1(void)
        {
            return NUM;
        }
    externcend;
run;

proc proto package = work.p2.test2;
    typedef struct { int a; int b; } AB_t;
    #define NUM 2;
    int p2(void);
    externc p2;
        int p2(void)
        {
            return NUM;
        }
    externcend;
run;

options CMPLIB = (work.p1 work.p2);

proc fcmp;
   x = p1();
   put "Should be 2: " x=;
run;
```

The result from executing the programs above is 2, because the packages are loaded in order.

In the following example, PROC PROTO adds a third package and includes it in PROC FCMP locally, keeping the CMPLIB= system option set as above:

```
proc proto package = work.p3.test3;
    typedef struct { int a; int b; } AB_t;
    #define NUM 3;
    int p3(void);
    externc p3;
        int p3(void)
        {
            return NUM;
        }
    externcend;
run;

proc fcmp libname = work.p3;
   x = p1();
   put "Should be 3: " x=;
run;
```

In this example, the local definition of NUM in *work.p3* is used instead of the global definitions that are loaded through *work.p1* and *work.p2*.

C Helper Functions and CALL Routines

What Are C Helper Functions and CALL Routines?

Several helper functions and CALL routines are provided with the package to handle C-language constructs in PROC FCMP. Most C-language constructs must be defined in a catalog package that is created by PROC PROTO before the constructs can be referenced or used by PROC FCMP. The ISNULL function and the STRUCTINDEX and SETNULL CALL routines have been added to extend the SAS language to handle C-language constructs that do not naturally fit into the SAS language.

The following C helper functions and CALL routines are available:

Table 51.6 *C Helper Functions and CALL Routines*

C Helper Function or CALL Routine	Description
"ISNULL C Helper Function" on page 1907	Determines whether a pointer element of a structure is null
"SETNULL C Helper CALL Routine" on page 1908	Sets a pointer element of a structure to null
"STRUCTINDEX C Helper CALL Routine" on page 1908	Enables you to access each structure element in an array of structures

ISNULL C Helper Function

The ISNULL function determines whether a pointer element of a structure is NULL. The function has the following form:

double **ISNULL** (*pointer-element*);

Pointer-element refers to the pointer element.

In the following example, the LINKLIST structure and the GET_LIST function are defined by using PROC PROTO. The GET_LIST function is an external C routine that generates a linked list with as many elements as requested:

```
struct linklist{
   double value;
   struct linklist * next;
```

```
};

struct linklist * get_list(int);
```

The following example shows how to use the ISNULL helper function to loop over the linked list that is created by the GET_LIST function:

```
struct linklist list;

list = get_list(3);
put list.value=;

do while (^isnull(list.next));
   list = list.next;
   put list.value=;
end;
```

Example Code 51.1 *Looping over a Linked List*

```
LIST.value=0
LIST.value=1
LIST.value=2
```

SETNULL C Helper CALL Routine

The SETNULL CALL routine sets a pointer element of a structure to null. It has the following form:

CALL SETNULL(*pointer-element*);

Pointer-element is a pointer to a structure.

If you specify a variable that has a pointer value (a structure entry), then SETNULL sets the pointer to null:

```
call setnull(12.next);
```

The following example assumes that the same LINKLIST structure that is described in "ISNULL C Helper Function" on page 1907 is defined using PROC PROTO. The SETNULL CALL routine can be used to set the next element to null:

```
proc proto;
   struct linklist list;
   call setnull(list.next);
run;
```

STRUCTINDEX C Helper CALL Routine

The STRUCTINDEX CALL routine enables you to access each structure element in an array of structures. When a structure contains an array of structures, you can access each structure element of the array by using the STRUCTINDEX CALL routine. The STRUCTINDEX CALL routine has the following form:

CALL STRUCTINDEX(*struct_array*, *index*, *struct_element*);

Struct_array specifies an array; *index* is a 1–based index as used in SAS arrays; and *struct_element* points to an element in the array.

The following example consists of two parts. Copy and paste the two parts of the example into your SAS editor, and run them as one SAS program.

In the first part of this example, the following structures and function are defined using PROC PROTO:

```
options cmplib=(work.proto_ds work.fcmp_ds);
proc proto package=work.proto_ds.cfcns;
     struct POINT {
           short s;
           int i;
           long l;
           double d;
     };
     struct POINT_ARRAY {
           int length;
           struct POINT * p;
           char name[32];
     };
     struct POINT * struct_array( int );

     externc struct_array;
         struct POINT * struct_array( int num ) {
              return(malloc(sizeof(struct POINT) * num));
         }
     externcend;
run;
```

In the second part of this example, the PROC FCMP code segment shows how to use the STRUCTINDEX CALL routine to get and set each POINT structure element of an array called P in the POINT_ARRAY structure:

```
proc fcmp;
struct point_array pntarray;
struct point pnt;

   /* Call struct_array to allocate an array of 2 POINT structures. */
pntarray.p = struct_array(2);
pntarray.plen = 2;
pntarray.name = "My funny structure";

   /* Get each element using the STRUCTINDEX CALL routine and set
values. */
do i = 1 to 2;
   call structindex(pntarray.p, i, pnt);
   put "Before setting the" i "element: " pnt=;
   pnt.s = 1;
   pnt.i = 2;
   pnt.l = 3;
   pnt.d = 4.5;
   put "After setting the" i "element: " pnt=;
end;
```

```
run;
```

Example Code 51.2 *Results from the STRUCTINDEX CALL Routine*

```
Before setting the 1 element: PNT {s=0, i=0, l=0, d=0}
After setting the 1 element: PNT {s=1, i=2, l=3, d=4.5}
Before setting the 2 element: PNT {s=0, i=0, l=0, d=0}
After setting the 2 element: PNT {s=1, i=2, l=3, d=4.5}
```

Example: Splitter Function Example

Features: INT statements
KIND= prototype argument
PROC FCMP

Details

This example shows how to use PROC PROTO to prototype two external C language functions called SPLIT and CASHFLOW. These functions are contained in the two shared libraries that are specified by the LINK statements.

Program

```
options nodate pageno=1 linesize=80 pagesize=40;

proc proto package =
sasuser.myfuncs.mathfun
           label = "package of math functions";


           link "link-library";
           link "link-library";

   int split(int x "number to split")
       label = "splitter function" kind=PRICING;

   int cashflow(double amt, double rate, int periods,
                double * flows / iotype=0)
       label = "cash flow function" kind=PRICING;

run;

proc fcmp libname=sasuser.myfuncs;
   array flows[20];
   a = split(32);
   put a;
```

```
   b = cashflow(1000, .07, 20, flows);
   put b;
   put flows;
run;

run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGNO= specifies the starting page number. LINESIZE= specifies the output line length. PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Specify the catalog entry where the function package information is saved. The catalog entry is a three-level name.

```
proc proto package =
sasuser.myfuncs.mathfun
           label = "package of math functions";
```

Specify the libraries that contain the SPLIT and CASHFLOW functions. You can add more LINK statements to include as many libraries as you need for your prototypes.

```
           link "link-library";
           link "link-library";
```

Prototype the SPLIT function. The INT statement prototypes the SPLIT function and assigns a label to the function.

```
int split(int x "number to split")
    label = "splitter function" kind=PRICING;
```

Prototype the CASHFLOW function. The INT statement prototypes the CASHFLOW function and assigns a label to the function.

```
int cashflow(double amt, double rate, int periods,
             double * flows / iotype=O)
    label = "cash flow function" kind=PRICING;
```

Execute the PROTO procedure. The RUN statement executes the PROTO procedure.

```
run;
```

Call the SPLIT and CASHFLOW functions. PROC FCMP calls the SPLIT and CASHFLOW functions. Output from PROC FCMP is created.

```
proc fcmp libname=sasuser.myfuncs;
   array flows[20];
   a = split(32);
   put a;
   b = cashflow(1000, .07, 20, flows);
   put b;
   put flows;
```

```
run;
```

Execute the FCMP procedure. The RUN statement executes the FCMP procedure.

```
run;
```

Output: Prototyping Functions

Output 51.1 *Results from Prototyping the SPLIT and CASHFLOW Functions*

```
                                        The SAS System                      1


                                     The FCMP Procedure

16
12
70 105 128.33333333 145.83333333 159.83333333 171.5 181.5 190.25 198.02777778
205.02777778
211.39141414 217.22474747 222.60936286 227.60936286 232.27602953 236.65102953
240.76867658
244.65756547 248.341776 251.841776
```

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PRTDEF Procedure

Overview: PRTDEF Procedure

What Does the PRTDEF Procedure Do?

The PRTDEF procedure creates printer definitions in batch mode either for an individual user or for all SAS users at your site. Your system administrator can create printer definitions in the SAS registry and make these printers available to all SAS users at your site by using PROC PRTDEF with the USESASHELP option. An individual user can create personal printer definitions in the SAS registry by using PROC PRTDEF.

See Also

Chapter 53, “PRTEXP Procedure,” on page 1933

Syntax: PRTDEF Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

PROC PRTDEF <*options*>;

Statement	Task	Example
PROC PRTDEF	Create printer definitions in batch mode either for an individual user or for all SAS users at your site	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5

PROC PRTDEF Statement

Creates printer definitions in batch mode.

Examples:
“Example 1: Defining Multiple Printer Definitions” on page 1922
“Example 2: Creating a Ghostview Printer in SASUSER to Preview PostScript Printer Output in SASUSER” on page 1923
“Example 3: Creating a Single Printer Definition That Is Available to All Users” on page 1925
“Example 4: Adding, Modifying, and Deleting Printer Definitions” on page 1927
“Example 5: Deleting a Single Printer Definition” on page 1929

Syntax

PROC PRTDEF <*options*>;

Optional Arguments

DATA=*SAS-data-set*
specifies the SAS data set that contains the printer attributes.

Requirement Printer attributes variables that must be specified are DEST, DEVICE, MODEL, and NAME, except when the value of the

variable OPCODE is DELETE. In that case, only the NAME variable is required.

See "Input Data Set Variables That Are Used To Create Printer Definitions" on page 1916

DELETE
specifies that the default operation is to delete the printer definitions from the registry.

Interaction If both DELETE and REPLACE are specified, then DELETE is the default operation.

Tip If the user-defined printer definition is deleted, then the administrator-defined printer can still appear if it exists in the Sashelp catalog.

Example "Example 5: Deleting a Single Printer Definition" on page 1929

FOREIGN
specifies that the registry entries are being created for export to a different host. As a consequence, tests of any host-dependent items, such as the TRANTAB, are skipped.

LIST
specifies that a list of printers that is created or replaced is written to the log.

Examples "Example 2: Creating a Ghostview Printer in SASUSER to Preview PostScript Printer Output in SASUSER" on page 1923

"Example 4: Adding, Modifying, and Deleting Printer Definitions" on page 1927

REPLACE
specifies that the default operation is to modify existing printer definitions. Any printer name that already exists is modified by using the information in the printer attributes data set. Any printer name that does not exist is added.

Interaction If both REPLACE and DELETE are specified, then a DELETE is performed.

Example "Example 2: Creating a Ghostview Printer in SASUSER to Preview PostScript Printer Output in SASUSER" on page 1923

USESASHELP
specifies that the printer definitions are to be placed in the Sashelp library, where they are available to all users. If the USESASHELP option is not specified, then the printer definitions are placed in the current Sasuser library, where they are available to the local user only.

Windows Specifics: You can create printer definitions with PROC PRTDEF in the Windows operating environment. However, because Universal Printing is turned off by default in Windows, these printer definitions do not appear in the Print window. If you want to use your printer definitions when Universal Printing is turned off, then either specify the printer definition as part of the

PRINTERPATH system option or, from the Output Delivery System (ODS), issue the following code:

```
ODS PRINTER SAS PRINTER=myprinter;
```

where *myprinter* is the name of your printer definition.

Restriction To use the USESASHELP option, you must have permission to write to the Sashelp catalog.

Example "Example 3: Creating a Single Printer Definition That Is Available to All Users" on page 1925

Usage: PRTDEF Procedure

Input Data Set Variables That Are Used To Create Printer Definitions

Summary of Valid Variables

To create your printer definitions, you must create a SAS data set whose variables contain the appropriate printer attributes. The following table lists and describes both the required and optional variables for this data set.

Table 52.1 *Required and Optional Variable for Creating Printer Definition Records*

Variable Name	Variable Description
Required	
DEST	Destination
DEVICE	Device
MODEL	Prototype
NAME	Printer name
Optional	

Variable Name	Variable Description
BOTTOM	Default bottom margin
CHARSET	Default font character set
DESC	Description
FONTSIZE	Point size of the default font
HOSTOPT	Host options
LEFT	Default left margin
LRECL	Output buffer size
OPCODE	Operation code
PAPERIN	Paper source or input tray
PAPEROUT	Paper destination or output tray
PAPERSIZ	Paper size
PAPERTYP	Paper type
PREVIEW	Preview
PROTOCOL	Protocol
RES	Default printer resolution
RIGHT	Default right margin
STYLE	Default font style
TOP	Default top margin
TRANTAB	Translation table
TYPEFACE	Default font
UNITS	CM or IN units
VIEWER	Viewer
WEIGHT	Default font weight

Required Variables

To create or modify a printer, you must supply the NAME, MODEL, DEVICE, and DEST variables. All the other variables use default values from the printer prototype that is specified by the MODEL variable.

To delete a printer, specify only the required NAME variable.

The following variables are required in the input data set:

DEST
specifies the output destination for the printer.

Operating Environment Information: DEST is case sensitive for some devices.

Restriction DEST is limited to 1023 characters.

DEVICE
specifies the type of I/O device to use when sending output to the printer. Valid devices are listed in the Printer Definition wizard and in the SAS Registry Editor.

Restriction DEVICE is limited to 31 characters.

MODEL
specifies the printer prototype to use when defining the printer.

For a valid list of prototypes or model descriptions, you can look in the SAS Registry Editor under CORE\PRINTING\PROTOTYPES.

Restriction MODEL is limited to 127 characters.

Tip While in interactive mode, you can invoke the registry with the REGEDIT command.

NAME
specifies the printer definition name that is associated with the rest of the attributes in the printer definition.

The name is unique within a given registry. If a new printer definition contains a name that already exists, then the record is not processed unless the REPLACE option has been specified or unless the value of the OPCODE variable is **`Modify`**.

Restriction NAME is limited to 127 characters, must have at least one nonblank character, and cannot contain a backslash. Leading and trailing blanks are stripped from the name.

Optional Variables

The following variables are optional in the input data set:

BOTTOM
specifies the default bottom margin in the units that are specified by the UNITS variable.

CHARSET
specifies the default font character set.

Restriction The value must be one of the character set names in the typeface that is specified by the TYPEFACE variable.

DESC
specifies the description of the printer.

Default DESC defaults to the prototype that is used to create the printer.

Restriction The description can have a maximum of 1023 characters.

FONTSIZE
specifies the point size of the default font.

HOSTOPT
specifies any host options for the output destination. The host options are not case sensitive.

Restriction The host options can have a maximum of 1023 characters.

LEFT
specifies the default left margin in the units that are specified by the UNITS variable.

LRECL
specifies the buffer size or record length to use when sending output to the printer.

Default If LRECL is less than zero when modifying an existing printer, the printer's buffer size is reset to the size that is specified by the printer prototype.

OPCODE
is a character variable that specifies what action (Add, Delete, or Modify) to perform on the printer definition.

Add
creates a new printer definition in the registry. If the REPLACE option has been specified, then this operation will also modify an existing printer definition.

Delete
removes an existing printer definition from the registry.

Restriction This operation requires only the NAME variable to be defined. The other variables are ignored.

Modify
changes an existing printer definition in the registry or adds a new one.

Restriction OPTCODE is limited to eight characters.

Tip If a user modifies and saves new attributes on a printer in the SASHELP library, then these modifications are stored in the SASUSER library. Values that are specified by the user will override values that are set by the administrator, but they will not replace them.

PAPERIN
specifies the default paper source or input tray.

Restriction The value of PAPERIN must be one of the paper source names in the printer prototype that is specified by the MODEL variable.

PAPEROUT
specifies the default paper destination or output tray.

Restriction The value of PAPEROUT must be one of the paper destination names in the printer prototype that is specified by the MODEL variable.

PAPERSIZ
specifies the default paper source or input tray.

Restriction The value of PAPERSIZ must be one of the paper size names listed in the printer prototype that is specified by the MODEL variable.

PAPERTYP
specifies the default paper type.

Restriction The value of PAPERTYP must be one of the paper source names listed in the printer prototype that is specified by the MODEL variable.

PREVIEW
specifies the printer application to use for print preview.

Restriction PREVIEW is limited to 127 characters.

PROTOCOL
specifies the I/O protocol to use when sending output to the printer.

Operating Environment Information: On mainframe systems, the protocol describes how to convert the output to a format that can be processed by a protocol converter that connects the mainframe to an ASCII device.

Restriction PROTOCOL is limited to 31 characters.

RES
specifies the default printer resolution.

Restriction The value of RES must be one of the resolution values available to the printer prototype that is specified by the MODEL variable.

RIGHT
specifies the default right margin in the units that are specified by the UNITS variable.

STYLE
specifies the default font style.

Restriction The value of STYLE must be one of the styles available to the typeface that is specified by the TYPEFACE variable.

TOP
specifies the default top margin in the units that are specified by the UNITS variable.

TRANTAB
specifies which translation table to use when sending output to the printer.

Operating Environment Information: The translation table is needed when an EBCDIC host sends data to an ASCII device.

Restriction TRANTAB is limited to eight characters.

TYPEFACE
specifies the typeface of the default font.

Restriction The typeface must be one of the typeface names available to the printer prototype that is specified by the MODEL variable.

UNITS
specifies the units CM or IN that are used by margin variables.

VIEWER
specifies the host system command that is to be used during print previews. As a result, PROC PRTDEF causes a preview printer to be created.

Preview printers are specialized printers that are used to display printer output on the screen before printing.

Restriction VIEWER is limited to 127 characters.

Tip The values of the PREVIEW, PROTOCOL, DEST, and HOSTOPT variables are ignored when a value for VIEWER has been specified. Place *%s* where the input filename would normally be in the viewer command. *%s* can be used as many times as needed.

WEIGHT
specifies the default font weight.

Restriction The value must be one of the valid weights for the typeface that is specified by the TYPEFACE variable.

Examples: PRTDEF Procedure

Example 1: Defining Multiple Printer Definitions

Features: PROC PRTDEF statement options
DATA=

Details

This example shows you how to set up various printers.

Program

```
data printers;
input name $ 1-14 model $ 16-42 device $ 46-53 dest $ 57-70;
datalines;
Myprinter      PostScript Level 1 (Color)    PRINTER   printer1
Laserjet       PCL 5 (DeltaRow)              PIPE      lp -dprinter5
Color LaserJet PostScript Level 2 (Color)    PIPE      lp -dprinter2
;

proc prtdef data=printers;
run;
```

Program Description

Create the PRINTERS data set. The INPUT statement contains the names of the four required variables. Each data line contains the information that is needed to produce a single printer definition.


```
data printers;
input name $ 1-14 model $ 16-42 device $ 46-53 dest $ 57-70;
datalines;
Myprinter      PostScript Level 1 (Color)    PRINTER   printer1
Laserjet       PCL 5 (DeltaRow)              PIPE      lp -dprinter5
Color LaserJet PostScript Level 2 (Color)    PIPE      lp -dprinter2
;
```

Specify the input data set that contains the printer attributes and create the printer definitions. PROC PRTDEF creates the printer definitions for the SAS registry, and the DATA= option specifies PRINTERS as the input data set that contains the printer attributes.

```
proc prtdef data=printers;
run;
```

Log

Example Code 52.1 *The SAS Log After Defining Printers*

```
1    data printers;
2    input name $ 1-14 model $ 16-42 device $ 46-53 dest $ 57-70;
3    datalines;

NOTE: The data set WORK.PRINTERS has 3 observations and 4 variables.
NOTE: DATA statement used (Total process time):
      real time           0.03 seconds
      cpu time            0.03 seconds


7    ;
8    proc prtdef data=printers;
9    run;

NOTE: 3 printer definitions added to the registry.
NOTE: 0 printer definitions modified in the registry.
NOTE: 0 printer definitions deleted from the registry.
NOTE: PROCEDURE PRTDEF used (Total process time):
      real time           0.15 seconds
      cpu time            0.01 seconds
```

Example 2: Creating a Ghostview Printer in SASUSER to Preview PostScript Printer Output in SASUSER

Features: PROC PRTDEF statement options
- DATA=
- LIST
- REPLACE

Details

This example creates a Ghostview printer definition in the Sasuser library for previewing PostScript output.

Program

```
data gsview;
   name = "Ghostview";
   desc = "Print Preview with Ghostview";
   model= "PostScript Level 2 (Color)";
   viewer = 'ghostview %s';
   device = "Dummy";
   dest = " ";
run;

proc prtdef data=gsview list replace;
run;
```

Program Description

Create the GSVIEW data set, and specify the printer name, printer description, printer prototype, and commands to be used for print preview. The GSVIEW data set contains the variables whose values contain the information that is needed to produce the printer definitions. The NAME variable specifies the printer name that will be associated with the rest of the attributes in the printer definition data record. The DESC variable specifies the description of the printer. The MODEL variable specifies the printer prototype to use when defining this printer. The VIEWER variable specifies the host system commands to be used for print preview. GSVIEW must be installed on your system and the value for VIEWER must include the path to find it. You must enclose the value in single quotation marks because of the `%s`. If you use double quotation marks, SAS will assume that `%s` is a macro variable. DEVICE and DEST are required variables, but no value is needed in this example. Therefore, a “dummy” or blank value should be assigned.

```
data gsview;
   name = "Ghostview";
   desc = "Print Preview with Ghostview";
   model= "PostScript Level 2 (Color)";
   viewer = 'ghostview %s';
   device = "Dummy";
   dest = " ";
run;
```

Specify the input data set that contains the printer attributes, create the printer definitions, write the printer definitions to the SAS log, and replace a printer definition in the SAS registry. The DATA= option specifies GSVIEW as the input

data set that contains the printer attributes. PROC PRTDEF creates the printer definitions. The LIST option specifies that a list of printers that are created or replaced will be written to the SAS log. The REPLACE option specifies that a printer definition will replace a printer definition in the registry if the name of the printer definition matches a name already in the registry. If the printer definition names do not match, then the new printer definition is added to the registry.

```
proc prtdef data=gsview list replace;
run;
```

Log

Example Code 52.2 *The SAS Log After Defining a GhostView Printer*

```
10   data gsview;
11   name = "Ghostview";
12   desc = "Print Preview with Ghostview";
13   model= "PostScript Level 2 (Color)";
14   viewer = 'ghostview %s';
15   device = "Dummy";
16   dest = " ";

NOTE: The data set WORK.GSVIEW has 1 observations and 6 variables.
NOTE: DATA statement used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds


17   proc prtdef data=gsview list replace;
18   run;

NOTE: Printer Ghostview created.
NOTE: 1 printer definitions added to the registry.
NOTE: 0 printer definitions modified in the registry.
NOTE: 0 printer definitions deleted from the registry.
NOTE: PROCEDURE PRTDEF used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

Example 3: Creating a Single Printer Definition That Is Available to All Users

Features: PROC PRTDEF statement options
- DATA=
- USESASHELP

Restriction: To use the USESASHELP option, you must have permission to write to the Sashelp catalog.

Details

This example creates a definition for a Tektronix Phaser 780 printer with a Ghostview print previewer with the following specifications:

- bottom margin set to 1 inch
- font size set to 14 point
- paper size set to A4

Program

```
data tek780;
   name = "Tek780";
   desc = "Test Lab Phaser 780P";
   model = "Tek Phaser 780 Plus";
   device = "PRINTER";
   dest = "testlab3";
   preview = "Ghostview";
   units = "cm";
   bottom = 2.5;
   fontsize = 14;
   papersiz = "ISO A4";
run;

proc prtdef data=tek780 usesashelp;
run;
```

Program Description

Create the TEK780 data set and supply appropriate information for the printer destination. The TEK780 data set contains the variables whose values contain the information that is needed to produce the printer definitions. In the example, assignment statements are used to assign these variables. The NAME variable specifies the printer name that is associated with the rest of the attributes in the printer definition data record. The DESC variable specifies the description of the printer. The MODEL variable specifies the printer prototype to use when defining this printer. The DEVICE variable specifies the type of I/O device to use when sending output to the printer. The DEST variable specifies the output destination for the printer. The PREVIEW variable specifies which printer is used for print preview. The UNITS variable specifies whether the margin variables are measured in centimeters or inches. The BOTTOM variable specifies the default bottom margin in the units that are specified by the UNITS variable. The FONTSIZE variable specifies the point size of the default font. The PAPERSIZ variable specifies the default paper size.

```
data tek780;
```

```
   name = "Tek780";
   desc = "Test Lab Phaser 780P";
   model = "Tek Phaser 780 Plus";
   device = "PRINTER";
   dest = "testlab3";
   preview = "Ghostview";
   units = "cm";
   bottom = 2.5;
   fontsize = 14;
   papersiz = "ISO A4";
run;
```

Create the TEK780 printer definition and make the definition available to all users. The DATA= option specifies TEK780 as the input data set. The USESASHELP option specifies that the printer definition will be available to all users.

```
proc prtdef data=tek780 usesashelp;
run;
```

Example 4: Adding, Modifying, and Deleting Printer Definitions

Features: PROC PRTDEF statement options
DATA=
LIST

Details

This example does the following:

- adds two printer definitions
- modifies a printer definition
- deletes two printer definitions

Program

```
data printers;
length name   $ 80
   model  $ 80
   device $ 8
   dest   $ 80
   opcode $ 3
   ;
input opcode $& name $& model $& device $& dest $&;
```

```
datalines;
add  Color PostScript   PostScript Level 2 (Color)       DISK
sasprt.ps
mod  LaserJet 5         PCL 5 (DeltaRow)                 DISK
sasprt.pcl
del  Gray Postscript    PostScript Level 1 (Gray Scale)  DISK
sasprt.ps
del  test               PostScript Level 2 (Color)       DISK
sasprt.ps
add  ColorPS            PostScript Level 2 (Color)       DISK
sasprt.ps
;

proc prtdef data=printers replace list;
run;
```

Program Description

Create the PRINTERS data set and specify which actions to perform on the printer definitions. The PRINTERS data set contains the variables whose values contain the information that is needed to produce the printer definitions. The MODEL variable specifies the printer prototype to use when defining this printer. The DEVICE variable specifies the type of I/O device to use when sending output to the printer. The DEST variable specifies the output destination for the printer. The OPCODE variable specifies which action (add, delete, or modify) to perform on the printer definition. The first Add operation creates a new printer definition for Color PostScript in the SAS registry. The second Add operation creates a new printer definition for ColorPS in the SAS registry. The Mod operation modifies the existing printer definition for LaserJet 5 in the registry. The Del operation deletes the printer definitions for test from the registry. The **&** specifies that two or more blanks separate character values. This allows the name and model value to contain blanks.

```
data printers;
length name   $ 80
   model  $ 80
   device $ 8
   dest   $ 80
   opcode $ 3
   ;
input opcode $& name $& model $& device $& dest $&;
datalines;
add  Color PostScript   PostScript Level 2 (Color)       DISK
sasprt.ps
mod  LaserJet 5         PCL 5 (DeltaRow)                 DISK
sasprt.pcl
del  Gray Postscript    PostScript Level 1 (Gray Scale)  DISK
sasprt.ps
del  test               PostScript Level 2 (Color)       DISK
sasprt.ps
add  ColorPS            PostScript Level 2 (Color)       DISK
sasprt.ps
;
```

Create multiple printer definitions and write them to the SAS log. The DATA= option specifies the input data set PRINTERS that contains the printer attributes. PROC PRTDEF creates five printer definitions, two of which have been deleted. The LIST option specifies that a list of printers that are created or replaced will be written to the log.

```
proc prtdef data=printers replace list;
run;
```

Log

Example Code 52.3 *The SAS Log After Modifying and Deleting Printers*

```
15   data printers;
16   length name   $ 80
17      model  $ 80
18      device $ 8
19      dest   $ 80
20      opcode $ 3
21      ;
22   input opcode $& name $& model $& device $& dest $&;
23   datalines;

NOTE: The data set WORK.PRINTERS has 5 observations and 5 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds


29   ;
30   proc prtdef data=printers list replace;
31   run;

NOTE: Printer Color PostScript modified.
NOTE: Printer LaserJet 5 modified.
NOTE: Printer Gray Postscript deleted.
NOTE: Printer test deleted.
NOTE: Printer ColorPS modified.
NOTE: PROCEDURE PRTDEF used (Total process time):
      real time           0.04 seconds
      cpu time            0.03 seconds
```

Example 5: Deleting a Single Printer Definition

Features: PROC PRTDEF statement option
DELETE

Details

This example shows you how to delete a printer from the registry.

Program

```
data deleteprt;
name='printer1';
run;

proc prtdef data=deleteprt delete list;
run;
```

Program Description

Create the DELETEPRT data set. The NAME variable contains the name of the printer to delete.

```
data deleteprt;
name='printer1';
run;
```

Delete the printer definition from the registry and write the deleted printer to the log. The DATA= option specifies DELETEPRT as the input data set. PROC PRTDEF creates printer definitions for the SAS registry. DELETE specifies that the printer is to be deleted. LIST specifies to write the deleted printer to the log.

```
proc prtdef data=deleteprt delete list;
run;
```

Log

Example Code 52.4 *The SAS Log After Deleting a Single Printer*

```
45   data deleteprt;
46      name='printer1';
47      run;

NOTE: The data set WORK.DELETEPRT has 1 observations and 1 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.00 seconds


48      proc prtdef data=deleteprt delete list;
49      run;

NOTE: Printer printer1 deleted.
NOTE: 0 printer definitions added to the registry.
NOTE: 0 printer definitions modified in the registry.
NOTE: 1 printer definitions deleted from the registry.
NOTE: PROCEDURE PRTDEF used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds
```

53

PRTEXP Procedure

Overview: PRTEXP Procedure

What Does the PRTEXP Procedure Do?

The PRTEXP procedure enables you to replicate, modify, and create printer definitions from the SAS registry, either for an individual user or for all SAS users at your site. PROC PRTEXP then writes these attributes to the SAS log or to a SAS data set. You can specify that PROC PRTEXP search for these attributes in the SASHELP portion of the registry or the entire SAS registry.

If you write printer definitions to a SAS data set, you can later replicate and modify them. You can then use PROC PRTDEF to create the printer definitions in the SAS registry from your input data set. For a complete discussion of PROC PRTDEF and the variables and attributes that are used to create the printer definitions, see "Input Data Set Variables That Are Used To Create Printer Definitions" on page 1916.

See Also

Chapter 52, "PRTDEF Procedure," on page 1913

Syntax: PRTEXP Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Tip: If neither the SELECT nor the EXCLUDE statement is used, then all of the printers will be included in the output.

PROC PRTEXP <*options*>;

SELECT *printer(s)*;

EXCLUDE *printer(s)*

Statement	Task	Example
PROC PRTEXP	Obtain printer attributes from the SAS registry	Ex. 1, Ex. 2
EXCLUDE	Obtain printer attributes for all printers except for the specified printers	
SELECT	Obtain printer attributes for the specified printers	Ex. 1, Ex. 2

PROC PRTEXP Statement

Replicates, modifies, and creates printer definitions.

Examples: "Example 1: Writing Attributes to the SAS Log" on page 1936
"Example 2: Writing Attributes to a SAS Data Set" on page 1937

Syntax

PROC PRTEXP <*options*>;

Optional Arguments

USESASHELP
specifies that SAS search only the SASHELP portion of the registry for printer definitions.

Default The default is to search both the SASUSER and SASHELP portions of the registry for printer definitions.

OUT=*SAS-data-set*
specifies the SAS data set that contains the printer definitions.

The data set that is specified by the OUT=*SAS-data-set* option is the same type of data set that is specified by the DATA=*SAS-data-set* option in PROC PRTDEF to define each printer.

Default If OUT=*SAS-data-set* is not specified, then the data that is needed to define each printer is written to the SAS log.

EXCLUDE Statement

Names the printers whose information does not appear in output.

Syntax

EXCLUDE *printer(s)*;

Required Argument

printer(s)
specifies one or more printers that you do not want the output to contain information about.

SELECT Statement

Names the printers whose information is contained in the output.

Examples: "Example 1: Writing Attributes to the SAS Log" on page 1936
"Example 2: Writing Attributes to a SAS Data Set" on page 1937

Syntax

SELECT *printer(s)*;

Required Argument

printer(s)
specifies one or more printers that you would like the output to contain information about.

Examples: PRTEXP Procedure

Example 1: Writing Attributes to the SAS Log

Features: PROC PRTEXP statement option
USESASHELP
SELECT statement

Details

This example shows you how to write the attributes that are used to define a printer to the SAS log.

Program

Specify the printer that you want information about, specify that only the SASHELP portion of the registry be searched, and write the information to the SAS log. The SELECT statement specifies that you want the attribute information that is used to define the printer PostScript to be included in the output. The USESASHELP option specifies that only the SASHELP registry is to be searched for PostScript's printer definitions. The data that is needed to define each printer is written to the SAS log because the OUT= option was not used to specify a SAS data set.

```
proc prtexp usesashelp;
select postscript;
run;
```

Log

Example Code 53.1 *The SAS Log After Extracting Printer Information from the SASHELP Portion of the Registry*

```
379  proc prtexp usesashelp;
380  select postscript;
381  run;

NAME:     PostScript
MODEL:    PostScript Level 1 (Color)
DEVICE:   DISK
DEST:     sasprt.ps
HOSTOPT:
PROTOCOL:
TRANTAB:
DESC:     Generic PostScript Level 1 Printer
PREVIEW:  Adobe Reader
VIEWER:
PAPERSIZ:
PAPERTYP:
PAPERIN:
PAPEROUT:
RES:      300 DPI
TOP:      0.50
LEFT:     0.50
RIGHT:    0.50
BOTTOM:   0.50
UNITS:    IN
TYPEFACE: <MTmonospace>
WEIGHT:   Normal
STYLE:    Regular
CHARSET:  Western
FONTSIZE: 8.00
LRECL:    .
```

Example 2: Writing Attributes to a SAS Data Set

Features: PROC PRTEXP statement option
OUT=
SELECT statement

Details

This example shows you how to create a SAS data set that contains the data that PROC PRTDEF would use to define the printers PCL4, PCL5, PCL5E, and PCLC.

Program

Specify the printers that you want information about and create the PRDVTER data set. The SELECT statement specifies the printers PCL4, PCL5, PCL5E, and PCLC. The OUT= option creates the SAS data set PRDVTER, which contains the same attributes that are used by PROC PRTDEF to define the printers PCL4, PCL5, PCL5E, and PCLC. SAS will search both the SASUSER and SASHELP registries, because USESASHELP was not specified.

```
proc prtexp out=PRDVTER;
   select pcl4 pcl5 pcl5e pcl5c;
run;

proc print data=prdvter;
run;
```

Output

The following data set is a partial view of the Prdvter data set that contains 26 variables and four observations.

Output 53.1 *The Output Data Set for Prdvter*

The SAS System

Obs	DEST	HOSTOPT	DESC	VIEWER	NAME	MODEL	PREVIEW	TYPEFACE
1	sasprt.pcl		Generic PCL 4 Printer		PCL4	PCL 4	Adobe Reader	
2	sasprt.pcl		Generic PCL 5 Printer		PCL5	PCL 5 (DeltaRow)	Adobe Reader	
3	sasprt.pcl		Generic PCL 5 RGB Color Printer with Alpha Blending		PCL5c	PCL 5rgba (DeltaRow)	Adobe Reader	
4	sasprt.pcl		Generic PCL 5e Printer		PCL5e	PCL 5e (DeltaRow)	Adobe Reader	

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PWENCODE Procedure

Overview: PWENCODE Procedure

What Does the PWENCODE Procedure Do?

The PWENCODE procedure enables you to encode passwords. Encoding obfuscates the data. Unlike encryption, encoding is a reversible permutation of the data and uses no keys.

Encoded passwords can be used in place of plaintext passwords in SAS programs that access relational database management systems (RDBMSs) and various servers. Examples are SAS/CONNECT servers, SAS/SHARE servers, SAS Integrated Object Model (IOM) servers, SAS Metadata Servers, and more.

Concepts: PWENCODE Procedure

Using Encoded Passwords in SAS Programs

When a password is encoded with PROC PWENCODE, the output string includes a tag that identifies the string as having been encoded. An example of a tag is `{sas001}`. The tag indicates the encoding method. SAS servers and SAS/ACCESS engines recognize the tag and decode the string before using it. Encoding a password enables you to write SAS programs without having to specify a password in plaintext.

Note: PROC PWENCODE passwords can contain up to a maximum of 512 characters, which include alphanumeric characters, spaces, and special characters. Data set passwords, however, must follow SAS naming rules. For information about SAS naming rules, see "Rules for Most SAS Names" in *SAS Language Reference: Concepts*.

The encoded password is never written to the SAS log in plain text. Instead, each character of the password is replaced by an X in the SAS log.

Encoding versus Encryption

Encoding techniques disguise passwords and the approach is intended to prevent casual, non-malicious viewing of passwords. With encoding, one character set is translated to another character set through some form of table lookup.

Encryption, by contrast, involves the transformation of data from one form to another through the use of mathematical operations and, usually, a "key" value. Encryption is generally more difficult to break than encoding. Several options for PROC PWENCODE designate encryption techniques that align with industry standards. These options support longer encryption keys (for example, 256-bit). Salting and multiple iterations are provided to the AES encryption algorithm to create passwords that are harder to break.

Encoding methods for PROC PWENCODE are now SAS001 – SAS005. Starting in SAS 9.4M5, PROC PWENCODE provides stronger password protection using the SAS005 method of encoding.

Password protection is an important part of your security strategy, but you should not rely only on password protection for all your data security needs; a determined

and knowledgeable attacker can break passwords. Data should also be protected by other security controls such as file system permissions, other access control mechanisms, and encryption of data at rest and in transit.

Encoding Methods

Starting in SAS 9.4M5,the SAS005 method for encoding passwords is added. When SAS005 is specified for PROC PWENCODE, a more secure 256-bit fixed key is generated. SAS005, like SAS004, uses a 256-bit fixed key plus a 64-bit random salt. However, it is hashed for additional iterations.

Table 54.1 *Supported Encoding Methods*

Encoding Method	Uses Data Encryption Algorithm	Encoded Password/key Description
`sas001`	None	Uses base64 to encode passwords.
`sas002`, which can also be specified as `sasenc`	SASProprietary, which is included in SAS software.	Uses a 32-bit fixed key.
`sas003`	AES (Advanced Encryption Standard).	Uses a 256-bit fixed key plus a 16-bit random salt value.
`sas004`	AES (Advanced Encryption Standard).	Uses a 256-bit fixed key and a 64-bit random salt value.
`sas005`	AES (Advanced Encryption Standard).	Uses a 256-bit fixed key, a 64-bit random salt value, and is hashed for additional iterations.

IMPORTANT Starting with SAS 9.4M8, SAS Foundation servers use the cryptographic libraries provided and installed on the operating system to provide encryption for data at rest and data in motion. With this change, SAS no longer provides the cryptographic libraries for SAS Foundation servers as part of the SAS Installation. AES encryption is supported using the operating system cryptographic libraries. Prior to SAS 9.4M8, AES encryption was supported as part of SAS/SECURE.

For more information, see "Cryptographic Library Support Starting with SAS 9.4M8" in *Encryption in SAS*.

Note: The METHOD= option supports the SAS003, SAS004, and SAS005 values. Prior to SAS 9.4M8, you needed SAS/SECURE to support SAS003–SAS005. With SAS 9.4M8, SAS003-SAS005 are supported using the operating system's cryptopgraphic libraries. SAS Proprietary encoding that supports SAS002 is available with all SAS software. For more information, see SAS/SECURE.

Syntax: PWENCODE Procedure

PROC PWENCODE IN='*password*' <OUT=*fileref*> <METHOD=*encoding-method*>;

Statement	Task	Example
PROC PWENCODE	Encode a password	Ex. 1, Ex. 2, Ex. 3, Ex. 4

PROC PWENCODE Statement

Encodes a password.

Examples:

"Example 1: Encoding a Password" on page 1944
"Example 2: Using an Encoded Password in a SAS Program" on page 1945
"Example 3: Saving an Encoded Password to the Paste Buffer" on page 1947
"Example 4: Specifying Method= SAS003 to Encode a Password" on page 1948
"Example 5: Specifying Method= SAS005 to Encode a Password" on page 1949

Syntax

PROC PWENCODE IN='*password*' <OUT=*fileref*> <METHOD=*encoding-method*>;

Required Argument

IN='*password*'
specifies the password to encode. The password can contain up to a maximum of 512 characters, which include alphanumeric characters, spaces, and special characters.

Note: Data set passwords must follow SAS naming rules. If the IN=*password* follows SAS naming rules, it can also be used for SAS data sets. For information

about SAS naming rules, see "Rules for Most SAS Names" in *SAS Language Reference: Concepts*.

If the password contains embedded single or double quotation marks, use the standard SAS rules for quoting character constants. These rules can be found in the SAS Constants in Expressions chapter of *SAS Language Reference: Concepts*.

Note: Each character of the encoded password is replaced by an X when written to the SAS log.

See "Example 1: Encoding a Password" on page 1944

"Example 2: Using an Encoded Password in a SAS Program" on page 1945

"Example 3: Saving an Encoded Password to the Paste Buffer" on page 1947

Optional Arguments

OUT=*fileref*

specifies a fileref to which the output string is to be written. If the OUT= option is not specified, the output string is written to the SAS log.

Note: The global macro variable

```
_PWENCODE
```

is set to the value that is written to the OUT= fileref or to the value that is displayed in the SAS log.

See "Example 2: Using an Encoded Password in a SAS Program" on page 1945

METHOD=*encoding-method*

specifies the encoding method. Here are the supported values for *encoding-method*.

- *SAS001*
- *SAS002*
- *SAS003*
- *SAS004*
- *SAS005*

The SAS003, SAS004, and SAS005 encoded passwords use a 256-bit fixed key plus a random salt value that is applied to the encoding method. Therefore, each time you use PROC PWENCODE to encode the same password, you get a different encoded password, because the salt values are random.

For more information about each of these encoding methods, see "Encoding Methods " on page 1941.

Note: The METHOD= option supports the SAS003, SAS004, and SAS005 values. Prior to SAS 9.4M8, you needed SAS/SECURE to provide support of SAS003-SAS005 encoding methogs. With SAS 9.4M8, SAS003-SAS005 are supported using the operating system's cryptopgraphic libraries. SAS Proprietary encoding that supports SAS002 is available with all SAS software. For more information, see SAS/SECURE.

If the METHOD= option is omitted, the default encoding method is used. The default method is **sas002** in most cases. **SAS002** is also the default method used if you specify an invalid method.

When the FIPS 140-2 compliance option, -encryptfips, is specified, the encoding method defaults to **sas003**. For more information about FIPS, see "FIPS 140-2 Standards Compliance" in *Encryption in SAS*.

Examples: PWENCODE Procedure

Example 1: Encoding a Password

Features: IN= argument

Details

This example shows a simple case of encoding a password and writing the encoded password to the SAS log.

Program

Encode the password.

```
proc pwencode in='my password';
run;
```

Log

Note that each character of the password is replaced by an X in the SAS log.

```
19   proc pwencode in=XXXXXXXXXXXXX;
20   run;


{SAS002}DBCC571245AD0B31433834F80BD2B99E16B3C969

NOTE: PROCEDURE PWENCODE used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

Example 2: Using an Encoded Password in a SAS Program

Features: IN= argument
OUT= option

Details

This example illustrates the following:

- encoding a password and saving it to an external file
- reading the encoded password with a DATA step, storing it in a macro variable, and using it in a SAS/ACCESS LIBNAME statement

Program 1: Encoding the Password

```
filename pwfile
'external-filename';

proc pwencode in='mypass1' out=pwfile;
run;
```

Program Description

Declare a fileref.

```
filename pwfile
'external-filename';
```

Encode the password and write it to the external file. The OUT= option specifies which external fileref the encoded password is written to.

```
proc pwencode in='mypass1' out=pwfile;
run;
```

Program 2: Using the Encoded Password

```
filename pwfile
'external-filename';

options symbolgen;

data _null_;
infile pwfile truncover;
input line :$50.;
call symputx('dbpass',line);
run;

libname x odbc dsn=SQLServer user=testuser password="&dbpass";
```

Program Description

Declare a fileref for the encoded-password file.

```
filename pwfile
'external-filename';
```

Set the SYMBOLGEN SAS system option. This step shows that the actual password cannot be revealed, even when the macro variable that contains the encoded password is resolved in the SAS log. This step is not required in order for the program to work properly.

```
options symbolgen;
```

Read the file and store the encoded password in a macro variable. The DATA step stores the encoded password in the macro variable DBPASS.

```
data _null_;
infile pwfile truncover;
input line :$50.;
call symputx('dbpass',line);
run;
```

Use the encoded password to access a DBMS. You must use double quotation marks (“ ”) so that the macro variable resolves properly.

```
libname x odbc dsn=SQLServer user=testuser password="&dbpass";
```

Log

```
1    filename pwfile 'external-filename';
2    options symbolgen;
3    data _null_;
4    infile pwfile truncover;
5    input line :$50.;
6    call symputx('dbpass',line);
7    run;

NOTE: The infile PWFILE is:
      Filename=external-filename
      RECFM=V,LRECL=256,File Size (bytes)=4,
      Last Modified=12Apr2012:13:23:49,
      Create Time=12Apr2012:13:23:39

NOTE: 1 record was read from the infile PWFILE.
      The minimum record length was 4.
      The maximum record length was 4.
NOTE: DATA statement used (Total process time):
      real time           0.57 seconds
      cpu time            0.04 seconds
8
9   libname x odbc
SYMBOLGEN:  Macro variable DBPASS resolves to {sas002}bXlwYXNzMQ==
9 !               dsn=SQLServer user=testuser password="&dbpass";
NOTE: Libref X was successfully assigned as follows:
      Engine:        ODBC
      Physical Name: SQLServer
```

Example 3: Saving an Encoded Password to the Paste Buffer

Features:

IN= argument

OUT= option

FILENAME statement with CLIPBRD access method

DETAILS

This example saves an encoded password to the paste buffer. You can then paste the encoded password into another SAS program or into the password field of an authentication dialog box.

Program

```
filename clip clipbrd;

proc pwencode in='my password' out=clip;
run;
```

Program Description

Declare a fileref with the CLIPBRD access method.

```
filename clip clipbrd;
```

Encode the password and save it to the paste buffer. The OUT= option saves the encoded password to the fileref that was declared in the previous statement.

```
proc pwencode in='my password' out=clip;
run;
```

Log

Note that each character of the password is replaced by an X in the SAS log.

```
24
25   filename clip clipbrd;
26     proc pwencode in=XXXXXXXXXXXXX out=clip;
27   run;

NOTE: PROCEDURE PWENCODE used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds
```

Example 4: Specifying Method= SAS003 to Encode a Password

Features: METHOD= argument

Details

This example shows a simple case of encoding a password using the **sas003** encoding method and writing the encoded password to the SAS log. SAS003 uses a 16-bit salt to encode a password.

Program

Encode the password using SAS003. The encoded password is a 256-bit key with a 16 bit random salt.

```
proc pwencode in='mypassword' method=sas003;
run;
```

Log

Note that each character of the password is replaced by an X in the SAS log. SAS003 encoding uses AES encryption plus a 16-bit salt. Because SAS003 uses random salting, each time you run the following code, a different password is generated.

```
8   proc pwencode in=XXXXXXXXXXXXX method=sas003;
29   run;

{SAS003}4837B146585CED2C9FED14A3C946D68E4389

NOTE: PROCEDURE PWENCODE used (Total process time):
      real time           0.00 seconds
      cpu time            0.00 seconds
```

Example 5: Specifying Method= SAS005 to Encode a Password

Features: METHOD= argument

Details

This example shows a simple case of encoding a password using the **sas005** encoding method and writing the encoded password to the SAS log. SAS005 uses a 256-bit fixed key that uses a 64-bit random salt to encode the password.

Program

Encode the password using SAS005.

```
proc pwencode in='mypassword' method=sas005;
run;
```

Log

Note that each character of the password is replaced by an X in the SAS log. SAS005 encoding uses AES encryption with a 256-bit fixed key and a 64-bit random salt value. SAS005 increases security for stored passwords by using the SHA-256 hashing algorithm and is hashed for additional iterations. Because SAS005 uses random salting, each time you run the following code, a different password is generated.

```
230  proc pwencode in=XXXXXXXXXXXX method=sas005;
231  run;


{SAS005}ADD8AB7108595A7D1A69190D78CDFE6145C1EB849CC7A43D

NOTE: PROCEDURE PWENCODE used (Total process time):
      real time           0.01 seconds
      cpu time            0.01 seconds
```

55

QDEVICE Procedure

Overview: QDEVICE Procedure

What Does the QDEVICE Procedure Do?

The QDEVICE procedure produces reports about graphics devices and universal printers. You can use the information in these reports to determine the best device or printer to use for a specific application.

Six different reports are available. These reports summarize information such as color support, default output sizes, margin sizes, resolution, supported fonts, hardware symbols, hardware fill types, hardware line styles, and device options.

You can send the output of this procedure to the SAS log or to an output SAS data set.

Concepts: QDEVICE Procedure

Reports for Windows Operating Environments

By default, SAS starts on Windows using the NOUNIVERSALPRINT (NOUPRINT) system option in order to use Windows printing. The SYSPRINT= system option determines the default Windows printer. Because printers on Windows are associated with a SAS printer interface device, reports that you create for the default Windows printer have a device name of one of the following SAS printer interface devices:

- WINPRTC (color)
- WINPRTG (gray scale)
- WINPRTM (monochrome)

If SAS starts with Universal Printing active on Windows, the default printer report is for the default SAS universal printer and not a Windows printer.

See "Example 4: Generate a Report for the Default Printer" on page 1989 for example reports.

Syntax: QDEVICE Procedure

Default: If you do not specify a report to create, a printer, or a device, the procedure generates a GENERAL report for the default display device if you are running SAS using the windowing environment, or the default universal printer in other modes.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Note: You can specify more than one DEVICE, PRINTER, or VAR statement. Statements are processed in the order in which they are specified.

PROC QDEVICE
<REPORT=GENERAL | FONT | DEVOPTION | LINESTYLE | RECTANGLE | SYMBOL>
<OUT=*SAS-data-set*>
<CATALOG=*catalog-name*>
<DEVLOC=GDEVICE*n* | SASHELP | _ALL_ | *libref*>
<REGISTRY=SASHELP | SASUSER>
<SUPPORT=YES | NO | ALL>
<UNITS=IN | CM;>

DEVICE <*device-name(s)*> <_ALL_> <_HTML_> <_LISTING_> <_RTF_>;

PRINTER <*printer-name(s)*> <_ALL_> <_PCL_> <_PDF_> <_PRINTER_> <_PS_>;

VAR *variable-1* <*variable-2* ...>;

Statement	Task	Example
PROC QDEVICE	Specify an (optional) output data set, which report to generate, which locations to search, whether to list supported or non-supported features, and sizing information	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7
DEVICE	Specify which SAS/GRAPH devices to generate a report for	Ex. 2, Ex. 7
PRINTER	Specify which universal printers to generate a report for	Ex. 6, Ex. 3
VAR	Specify the information (variables) to include in the generated reports	Ex. 5

PROC QDEVICE Statement

Controls the input data that is examined, the contents of a report, and the type of output to create.

Syntax

PROC QDEVICE
<REPORT=GENERAL | FONT | DEVOPTION | LINESTYLE | RECTANGLE | SYMBOL>
<OUT=*SAS-data-set*>
<CATALOG=*catalog-name*>
<DEVLOC=GDEVICE*n* | SASHELP | _ALL_ | *libref*>
<REGISTRY=SASHELP | SASUSER>
<SUPPORT=YES | NO | ALL>
<UNITS=IN | CM>;

Summary of Optional Arguments

CATALOG=*catalog-name*
: specifies the name of a SAS device catalog to search for a device.

DEVLOC=GDEVICE*n* | SASHELP | _ALL_ | *libref*
: specifies the library or libraries where the device catalog is located.

OUT=*SAS-data-set*
: specifies an output SAS data set for the report.

REGISTRY=SASHELP | SASUSER
: specifies which section of the SAS registry to search when querying a universal printer.

REPORT=DEVOPTION | FONT | GENERAL | LINESTYLE | RECTANGLE | SYMBOL
: specifies the type of report that you want to generate.

SUPPORT=YES | NO | ALL
: specifies whether to report only supported features, only unsupported features, or all features.

UNITS=IN | CM
: specifies whether the values for the certain variables are reported in inches (IN) or centimeters (CM) in the GENERAL report.

Optional Arguments

CATALOG=*catalog-name*
specifies the name of a SAS device catalog to search for a device.

Aliases
: C=
: CAT=

Default
: DEVICES

Interaction
: The CATALOG= option works with the DEVLOC= option. When you specify the CATALOG= option, SAS looks in the library that is specified by the DEVLOC= option (for example, sashelp.mycatalog).

Example "Example 7: Specify a User Library and Catalog for a Report" on page 1997

DEVLOC=GDEVICE*n* | SASHELP | _ALL_ | *libref*
specifies the library or libraries where the device catalog is located. You can specify these libraries:

GDEVICE*n*
specifies to search one of the SAS/GRAPH device libraries for a device. *n* can be 0–9.

SASHELP
specifies to search the Sashelp library for a device.

ALL
specifies to search the libraries Gdevice0 – Gdevice9 and the Sashelp library, in this order, for a device. All occurrences of a device from any of these libraries are reported.

libref
specifies a valid SAS library to search.

Defaults If you do not specify the DEVLOC= option, libraries are searched in the following order:

1. Gdevice0–Gdevice9
2. Sashelp

The first occurrence of the specified device is reported unless you specify DEVLOC=_ALL_.

Interaction The DEVLOC= option works with the CATALOG= option. When you specify the CATALOG= option, SAS looks in the library that is specified by the DEVLOC= option (for example, sashelp.mycatalog).

Example "Example 7: Specify a User Library and Catalog for a Report" on page 1997

OUT=*SAS-data-set*
specifies an output SAS data set for the report.

Default SAS Log

REGISTRY=SASHELP | SASUSER
specifies which section of the SAS registry to search when querying a universal printer.

SASHELP
search the SASHELP section of the registry.

SASUSER
search the SASUSER section of the registry.

Alias REG

Default SASHELP and SASUSER

REPORT=DEVOPTION | FONT | GENERAL | LINESTYLE | RECTANGLE | SYMBOL
specifies the type of report that you want to generate. You can request only one type of report. See "Valid Variables for All Reports" on page 1960 for the descriptions of the variables that are included in each report.

DEVOPTION
produces a report of the hardware device options supported by the specified device.

Restriction This report is unavailable for universal printers.

FONT
produces a report of all system and device-resident fonts supported by the specified device or printer.

See See "SAS/GRAPH, System, and Device-Resident Fonts" in *SAS/GRAPH: Reference* for a description of font categories.

GENERAL
produces a report of general information about the specified device or printer. This report includes information such as destination, margin sizes, default font information, resolution, color information, and size by pixels. This is the default report.

LINESTYLE
produces a report of the hardware line styles supported by the specified device.

Restriction This report is unavailable for universal printers.

RECTANGLE
produces a report of the hardware fill types supported by the specified device.

Restriction This report is unavailable for universal printers.

SYMBOL
produces a report of the hardware symbols supported by the specified device.

Restriction This report is unavailable for universal printers.

Default GENERAL

See See "Valid Variables for All Reports" on page 1960 for the descriptions of the variables that are included in each report.

SUPPORT=YES | NO | ALL
specifies whether to report only supported features, only unsupported features, or all features.

YES
reports only hardware features and options that are supported.

NO
reports only the hardware features and options that are not supported.

ALL
reports both supported and unsupported hardware features and options.

Default YES

Restriction This option applies only to devices when producing a DEVOPTION, LINESTYLE, RECTANGLE, or SYMBOL report.

UNITS=IN | CM
specifies whether the values for the certain variables are reported in inches (IN) or centimeters (CM) in the GENERAL report.

The HEIGHT, WIDTH, LEFT, LMIN, RIGHT, RMIN, BOTTOM, BMIN, TOP, TMIN, HRES, and VRES variables are reported in inches or centimeters. HRES and VRES values are reported as pixels-per-inch or pixels-per-centimeter.

Default IN

Restriction This option applies only when producing a GENERAL report.

DEVICE Statement

Specifies which SAS/GRAPH devices to generate a report for.

Requirement: You must specify at least one device name, _ALL_, _HTML_, _LISTING_, or _RTF_.

Syntax

DEVICE *<device-name(s)>* <_ALL_> <_HTML_> <_LISTING_> <_RTF_>;

Optional Arguments

device-name(s)
specifies the device for which you want to generate a report. Separate device names with a blank space. Enclose device names that contain spaces in quotation marks. You can use the wildcard characters * and ? to report all devices with similar names.

*
* represents any number of characters in that position of the device name.

Requirement Device names that contain wildcard characters must be enclosed in quotation marks.

Note You can specify the * and ? wildcard characters in the same device name.

Example 'svg*'

Example "Example 3: Generate a Report for SAS/GRAPH Device Drivers and Universal Printers" on page 1988

?

? represents one character in the device name. You can specify multiple consecutive ? characters in the device name.

Requirement Device names that contain wildcard characters must be enclosed in quotation marks.

Note You can specify the * and ? wildcard characters in the same device name.

Example 'tiff?300'

ALL
generates reports for all devices.

HTML
determines the default device that is used by the ODS HTML destination and generates a report for that device. The device is based on the default HTML version that is assigned in the ODS key of the SAS registry.

LISTING
determines the default device that is used by the ODS Listing destination and generates a report for that device. The default value is a host–specific display device.

RTF
determines the default device that is used by the ODS RTF destination and generates a report for that device.

PRINTER Statement

Specifies which universal printers to generate a report for.

Requirement: You must specify at least one printer name, _ALL_, _PCL_, _PDF_, _PRINTER_, or _PS_.

Syntax

PRINTER <*printer-name(s)*> <_ALL_> <_PCL_> <_PDF_> <_PRINTER_> <_PS_>;

Optional Arguments

printer-name(s)
specifies the universal printers for which you want to generate a report. If the printer name contains spaces, enclose the printer name in quotation marks.

Separate printer names with a blank space. You can use the wildcard characters * and ? to report all printers with similar names.

*
indicates to report all printers that match any number of characters in the position of the * in the printer name.

Requirement Printer names that contain wildcard characters must be enclosed in quotation marks.

Note You can specify the * and ? wildcard characters in the same printer name.

Example 'pcl*' reports on the printers pcl4, pcl5, pcl5c, and pcl5e

?
indicates to report all printers that match the printer name, where the character in the ? position can be any character. You can use multiple ? characters in *printer-name* to represent the same number of characters in the same position in the printer name.

Requirement Printer names that contain wildcard characters must be enclosed in quotation marks.

Note You can specify the * and ? wildcard characters in the same printer name.

Example 'tiff?' reports on the printers tiffa and tiffk. It does not report on the printer tiff because the tiff printer is only four characters.

Example "Example 3: Generate a Report for SAS/GRAPH Device Drivers and Universal Printers" on page 1988

ALL
generates reports for all universal printers.

PCL
determines the default printer that is used by the ODS PCL destination and generates a report for that printer.

PDF
determines the default printer that is used by the ODS PDF destination and generates a report for that printer.

PRINTER
determines the default printer that is used by the ODS PRINTER destination and generates a report for that printer.

Windows specifics By default, SAS uses Windows printing and not Universal Printing. When SAS uses Windows printing, the report that is generated when you specify the _PRINTER_ argument has information for the SAS printer interface device that is associated with the default Windows printer. The default Windows printer is specified by the SYSPRINT= system option. The SAS printer interface devices are WINPRTC (color), WINPRTG (gray scale), or WINPRTM (monochrome). The

report displays the printer interface device in the **Name** field and the printer name in the **Description** field.

_PS_
determines the default printer that is used by the ODS PS destination and generates a report for that printer.

VAR Statement

Specifies which variables to include in a report. The order of the variables in the report is determined by the order in which they are specified in the VAR statement.

Default: If you do not specify a VAR statement, all of the variables for the report are included in a default order.

Tip: If you specify the VAR statement, you must specify at least one variable. Otherwise, the statement is ignored.

Syntax

VAR *variable-1* <*variable-2* ...>;

Valid Variables for All Reports

DESC
displays the default description of the device or printer.

LOCATION
for the device entry that was found, displays the physical location of the Gdevice0-Gdevice9 library, the Sashelp library, or the library that is specified by the DEVLOC= option. For universal printers, this variable displays the SAS registry (SASHELP or SASUSER) where the printer was found.

NAME
displays the name of the device or printer.

TYPE
displays the type of device or printer. Here are the types of devices and printers:

- Graph Device
- Printer Interface Device
- Shortcut Device
- System Display
- System Metafile
- Universal Previewer
- Universal Printer

See "Device Categories and Modifying Default Output Attributes" in *SAS/GRAPH: Reference*

DEVOPTION Report Variables

For more information, see "Create a DEVOPTION Report" on page 1977.

BIT
displays the bit position in the DEVOPTS string for the corresponding device option.

See "DEVOPTS Device Parameter" in *SAS/GRAPH: Reference*

BITSTRING
displays the bit pattern of the corresponding device option.

See "DEVOPTS Device Parameter" in *SAS/GRAPH: Reference*

DESC
displays the default description of the device or printer.

LOCATION
for the device entry that was found, displays the physical location of the Gdevice0-Gdevice9 library, the Sashelp library, or the library that is specified by the DEVLOC= option.

NAME
displays the name of the device or printer.

ODESC
displays the descriptions of the hardware options in effect for the device.

OPTION
displays the names of the hardware options in effect for the device.

SUPPORT
displays the device options.

Interaction The value of the SUPPORT variable is affected by the SUPPORT= option in the PROC QDEVICE statement. If SUPPORT=YES, the report shows the supported device options. If SUPPORT=NO, the report shows device options that are not supported. If SUPPORT=ALL, the report shows all supported and non-supported device options.

TYPE
displays the type of device or printer.

Here are the types of devices and printers:

- Graph Device
- Printer Interface Device
- Shortcut Device
- System Display

- System Metafile

See "Device Categories and Modifying Default Output Attributes" in *SAS/GRAPH: Reference*

FONT Report Variables

For more information, see "Create a FONT Report" on page 1975.

ALIAS
reports an alternate name for a font that is registered by the FONTREG procedure.

DESC
displays the default description of the device or printer.

FONT
displays the name of the default font.

See "Default Fonts" in *SAS/GRAPH: Reference*

"Variable Labels in a FONT Report" on page 1976

FSTYLE
displays the font style, such as Roman or Italic, for each font and font weight, in an output data set.

Restriction When the report output is directed to the SAS log, the FONT report displays only font family names, such as Courier, Helvetica, Times, and so on. The specific font style is not reported.

Note If the font name is acquired from a CHARREC list in a device entry, the style is not available. See "CHARREC Device Parameter" in *SAS/GRAPH: Reference* for more information.

See "Variable Labels in a FONT Report" on page 1976

FTYPE
displays the type of font, such as Printer Resident, System, or Software.

Note The values for the FTYPE variable in the output data set are Printer Resident, System, or Software. The value Software appears only in a FONT report for a SAS/GRAPH device that has hardware font support disabled.

FWEIGHT
displays the font weight, such as Normal or Bold, for each font and font style, in an output data set.

Restriction When the report output is directed to the SAS log, the FONT report displays only font family names, such as Courier, Helvetica, Times, and so on. The specific font weight is not reported.

Note If the font name is acquired from a CHARREC list in a device entry, the weight is not available. See "CHARREC Device Parameter" in *SAS/GRAPH: Reference* for more information.

FVERSION
specifies the font version.

Restriction When the report output is directed to the SAS log, the FONT report displays only font family names, such as Courier, Helvetica, Times, and so on. The specific font version is not reported.

LOCATION
for the device entry that was found, displays the physical location of the Gdevice0-Gdevice9 library, the Sashelp library, or the library that is specified by the DEVLOC= option. For universal printers, this variable displays the SAS registry (SASHELP or SASUSER) where the printer was found.

NAME
displays the name of the device or printer.

TYPE
displays the type of device or printer. Here are the types of devices and printers:

- Graph Device
- Printer Interface Device
- Shortcut Device
- System Display
- System Metafile
- Universal Previewer
- Universal Printer

See "Device Categories and Modifying Default Output Attributes" in *SAS/GRAPH: Reference*

GENERAL Report Variables

For more information, see "Create a GENERAL Report" on page 1972.

ALIAS
reports an alternate name for a font that is registered by the FONTREG procedure.

ANIMATION
specifies whether animation is active, enabled, disabled, or unsupported for a Universal Printer:

Active indicates that the graphs in the ODS HTML output are grouped together in the animation. Animate=Start and Animate=Stop are ignored.

Enabled	indicates that animation is supported. Animate=Start and Animate=Stop must be specified to start and stop the animation.
Disabled	indicates that animation is supported but has been disabled for the device or printer.
Unsupported	indicates that animation is not supported for the device or printer.

BMIN
displays the minimum size of the bottom margin.

BOTTOM
displays the current size of bottom margin.

CLRSPACE
displays the type of color support (color space) such as RGB, RGBA, CMYK, HLS, and so on.

See "Color-Naming Schemes" in *SAS/GRAPH: Reference*

COLS
displays the number of horizontal columns in the output.

See "Cells" in *SAS/GRAPH: Reference*

COMPRESSION
indicates the condition under which compression is used. Compression can always be in effect, in effect only when specified by a compression option, or never used by the device or printer.

Here are the compression values on the report:

Always	indicates that compression is always in effect.
Option	indicates that compression is specified by the UPRINTCOMPRESSION system option or the COMPRESS= option in the ODS PRINTER statement.
Never	specifies that compression is never used by the device or printer.

COMPMETHOD
indicates the compression method that is used if compression is supported by device or printer.

Note When Compression is Never and no compression is available, the Compression Method value does not appear in the SAS log.

DESC
displays the default description of the device or printer.

DEST
displays the default destination of the device or universal printer if the device or printer does not send output directly to a printer or a display device. If the device sends output directly to a printer or a display device, the value of DEST is blank.

A destination can have a blank value when output is going to a monitor, or on Windows, the output is going to a printer.

EMBEDDING
indicates whether font embedding is supported.

ALWAYS Font embedding is always in effect for the device or printer.

OPTION The FONTEMBEDDING system option controls whether font embedding is supported.

NEVER Font embedding is not supported.

FHEIGHT
displays the height, in the respective units, of the default font.

Note If the font name is acquired from a CHARREC list in a device entry, the height is not available. See "CHARREC Device Parameter" in *SAS/GRAPH: Reference* for more information.

FONT
displays the name of the default font.

See "Default Fonts" in *SAS/GRAPH: Reference*

FORMAT
displays the output format type (for example, EMF, EMF Plus, EMF Dual, PostScript, GIF, Host Display, and so on).

See "Commonly Used Devices" in *SAS/GRAPH: Reference*

FSTYLE
displays the style of the default font (for example, Roman, Regular, and so on).

Interaction The results of specifying the FSTYLE variable in a GENERAL report where the output is directed to the SAS log differs from the results that you get when you specify the FSTYLE variable for a FONTS report. In a GENERAL report, the font style is reported to the SAS log. In a FONT report, the SAS log report displays only the font family names. The specific font style is not reported.

Note If the font name is acquired from a CHARREC list in a device entry, the style is not available. See "CHARREC Device Parameter" in *SAS/GRAPH: Reference* for more information.

FWEIGHT
displays the weight of the default font (for example, Normal, Medium, and so on).

Interaction The results of specifying the FWEIGHT variable in a GENERAL report where the output is directed to the SAS log differs from the results that you get when you specify the FWEIGHT variable for a FONTS report. In a GENERAL report, the font weight is reported to the SAS log. In a FONT report, the SAS log report displays only the font family names. The specific font weights are not reported.

Note If the font name is acquired from a CHARREC list in a device entry, the weight is not available. See "CHARREC Device Parameter" in *SAS/GRAPH: Reference* for more information.

FVERSION
specifies the version of the font.

HEIGHT
displays the default vertical height of output (in UNITS) sent to the device or printer.

HRES
displays the horizontal resolution (pixels per UNIT) of output sent to the device or printer. Horizontal resolution is calculated by the formula `HRES=XPIXELS/WIDTH`.

Interaction If either the HRES or VRES variables are specified in the VAR statement, the horizontal and vertical resolutions are displayed together in the SAS log using the label XxY Resolution. In an output data set, HRES and VRES are reported separately.

See "Using the XPIXELS=, XMAX=, YPIXELS=, and YMAX= Graphics Options to Set the Resolution for the Traditional Devices" in *SAS/GRAPH: Reference*

IOTYPE
displays the type of input/output used by the device or printer (for example, DISK, PRINTER, PIPE, GTERM, and so on).

See "FILENAME Statement" in *SAS Global Statements: Reference* and "DEVTYPE Device Parameter" in *SAS/GRAPH: Reference*

LEFT
displays the size of the left margin of output.

LMIN
displays the minimum left margin.

LOCATION
for the device entry that was found, displays the physical location of the Gdevice0-Gdevice9 library, the Sashelp library, or the library that is specified by the DEVLOC= option. For universal printers, this variable displays the SAS registry (SASHELP or SASUSER) where the printer was found.

MAXCOLORS
displays the maximum number of colors that are supported by the device or printer.

See "Maximum Number of Colors Displayed on a Device" in *SAS/GRAPH: Reference*

MODULE
specifies the name of the device driver module.

NAME
displays the name of the device or printer.

PROTOTYPE
displays the prototype (model) that was used to define the universal printer.

See "What Is Universal Printing?" in *SAS 9.4 Universal Printing*

RIGHT
displays the size of the right margin.

RMIN
displays the minimum size of the right margin.

ROWS
displays the number of vertical rows in the output.

See "Cells" in *SAS/GRAPH: Reference*

TMIN
displays the minimum top margin of output.

TOP
displays the size of the top margin.

TYPE
displays the type of device or printer. Here are the types of devices and printers:

- Graph Device
- Printer Interface Device
- Shortcut Device
- System Display
- System Metafile
- Universal Previewer
- Universal Printer

See "Device Categories and Modifying Default Output Attributes" in *SAS/GRAPH: Reference*

UNITS
displays the units (IN for inches or CM for centimeters) in which sizes are displayed. In the SAS log, the value of UNITS appears respectively, as inches or centimeters. In an output data set, the value of UNITS appears as IN or CM.

Interaction If the VAR statement does not specify any variables for size, margins, or resolution, the SAS log shows the units that are used to measure size, margins or resolution. Here is an example:

```
 Name: EMF
Units: inches
```

If the VAR statement specifies any variables for size, margins, or resolution, the SAS log shows the units with the value. Here is an example:

```
XxY Resolution: 96x96 pixels per inch
```

VISUAL
displays the visual color type (for example, Indexed Color, Direct Color, True Color, Monochrome, or Gray Scale).

VRES
displays the vertical resolution (pixels per UNIT) of output sent to the device or printer.

Vertical resolution is calculated by the formula `VRES=YPIXELS/HEIGHT`.

Interaction If either the HRES or VRES variables are specified in the VAR statement, the horizontal and vertical resolutions are displayed together in the SAS log using the label XxY Resolution. In an output data set, HRES and VRES are reported separately.

See "Using the XPIXELS=, XMAX=, YPIXELS=, and YMAX= Graphics Options to Set the Resolution for the Traditional Devices" in *SAS/GRAPH: Reference*

WIDTH
displays the width of output (in UNITS) sent to device or printer.

XPIXELS
displays the width of the output in pixels.

See "XPIXELS Device Parameter and Graphics Option" in *SAS/GRAPH: Reference* and "Using the XPIXELS=, XMAX=, YPIXELS=, and YMAX= Graphics Options to Set the Resolution for the Traditional Devices" in *SAS/GRAPH: Reference*

YPIXELS
displays the height of the output in pixels.

See "YPIXELS Device Parameter and Graphics Option" in *SAS/GRAPH: Reference* and "Using the XPIXELS=, XMAX=, YPIXELS=, and YMAX= Graphics Options to Set the Resolution for the Traditional Devices" in *SAS/GRAPH: Reference*

LINESTYLE Report Variables

For more information, see "Create a LINESTYLE Report" on page 1981.

DESC
displays the default description of the device or printer.

LINE
displays the line styles supported by the device or printer.

Interaction In a SAS log LINESTYLE report, the LINE and SUPPORT variables are reported together. If either the LINE variable or the SUPPORT variable is specified in the VAR statement, the line styles are reported using the Supported Line Styles or Unsupported Line Styles variable labels.

See "Line Types" in *SAS/GRAPH: Reference*

LOCATION
displays the physical location of the Gdevice0-Device9 or Sashelp library that contains the Devices catalog where the device entry was found or the library that is specified by the DEVLOC= option.

NAME
displays the name of the device.

SUPPORT
displays the device lines styles.

Interaction The value of the SUPPORT variable is affected by the SUPPORT= option in the PROC QDEVICE statement. If SUPPORT=YES, the report shows the supported line styles. If SUPPORT=NO, the report shows line styles that are not supported. If SUPPORT=ALL, the report shows all supported and non-supported line styles.

TYPE
displays the type of device or printer:

- Graph Device
- Printer Interface Device
- Shortcut Device
- System Display
- System Metafile

See "Device Categories and Modifying Default Output Attributes" in *SAS/GRAPH: Reference*

RECTANGLE Report Variables

For more information, see "Create a RECTANGLE Report" on page 1982.

DESC
displays the default description of the device or printer.

FILL
displays the hardware fill types that are supported by the device.

Interaction In a SAS log RECTANGLE report, the FILL and SUPPORT variables are reported together. If either the FILL variable or the SUPPORT variable is specified in the VAR statement, the fill names are reported using either the label Supported Hardware Fills or the label Unsupported Hardware Fills.

See "PATTERN Statement" in *SAS/GRAPH: Reference*

LOCATION
displays the physical location of the Gdevice0-Device9 or Sashelp library that contains the Devices catalog where the device entry was found or the library that is specified by the DEVLOC= option.

NAME
displays the name of the device.

SUPPORT
displays the hardware fills.

Interaction The value of the SUPPORT variable is affected by the SUPPORT= option in the PROC QDEVICE statement. If SUPPORT=YES, the report shows the supported hardware fills. If SUPPORT=NO, the report shows hardware fills that are not supported. If SUPPORT=ALL, the report shows all supported and non-supported hardware fills.

TYPE
displays the type of device or printer.

Here is a list of types:

- Graph Device
- Printer Interface Device
- Shortcut Device
- System Display
- System Metafile

See "Device Categories and Modifying Default Output Attributes" in *SAS/GRAPH: Reference*

SYMBOL Report Variables

For more information, see "Create a SYMBOL Report" on page 1984.

DESC
displays the default description of the device or printer.

LOCATION
displays the physical location of the Gdevice0-Device9 or Sashelp library that contains the Devices catalog where the device entry was found or the library that is specified by the DEVLOC= option.

NAME
displays the name of the device.

SUPPORT
displays the device or printer symbols.

Interaction The value of the SUPPORT variable is affected by the SUPPORT= option in the PROC QDEVICE statement. If SUPPORT=YES, the report shows the supported symbols. If SUPPORT=NO, the report shows symbols that are not supported. If SUPPORT=ALL, the report shows all supported and non-supported symbols.

SYMBOL
specifies the name of hardware symbols.

Interaction In a SAS log SYMBOL report, if either the SYMBOL or SUPPORT variable is specified in the VAR statement, symbol names are

reported using the Supported Hardware Symbols label or Unsupported Hardware Symbols label.

See "SYMBOL, NOSYMBOL Device Parameters and Graphics Options" in *SAS/GRAPH: Reference* and "SYMBOLS Device Parameter" in *SAS/GRAPH: Reference*

TYPE
displays the type of device or printer.

Here is a list of types:

- Graph Device
- Printer Interface Device
- Shortcut Device
- System Display
- System Metafile

See "Device Categories and Modifying Default Output Attributes" in *SAS/GRAPH: Reference*

Usage: QDEVICE Procedure

Variables Common to All Reports

You can use the following variables in any of the reports:

- NAME
- DESC
- TYPE
- LOCATION

For a description of the variables, see "Valid Variables for All Reports" on page 1960.

Create a GENERAL Report

The GENERAL report produces a report of general information about the specified device or printer. This information includes margin sizes, default font information, resolution, and color information.

About GENERAL Report Variables

For a description of the variables, see "GENERAL Report Variables" on page 1963.

The following table lists the variables that you can use in a GENERAL report as well as the labels for the variables that are used either in the SAS log or the output data set. If you do not specify the VAR statement, the variables appear in the order in which they appear in the table.

Variable	SAS Log Label	Output Data Set Label
NAME	Name	NAME OF DEVICE OR PRINTER
DESC	Description	DESCRIPTION OF DEVICE OR PRINTER
MODULE	Module	DRIVER MODULE
TYPE	Type	TYPE OF DEVICE OR PRINTER
LOCATION	"Device Catalog" for a device "Registry" for a printer	LOCATION OF DEVICE OR PRINTER DEFINITION
PROTOTYPE	Prototype	PRINTER PROTOTYPE
FONT	Default Typeface	FONT TYPEFACE DEFAULT
ALIAS	Typeface Alias	FONT TYPEFACE ALIAS
FSTYLE	Font Style	FONT STYLE DEFAULT
FWEIGHT	Font Weight	FONT WEIGHT DEFAULT
FHEIGHT	Font Height	FONT HEIGHT DEFAULT

Variable	SAS Log Label	Output Data Set Label
FVERSION	Font Version	FONT VERSION
MAXCOLORS	Maximum Colors	MAXIMUM NUMBER OF SUPPORTED COLORS
VISUAL	Visual Color	TYPE OF VISUAL COLOR
CLRSPACE	Color Support	TYPE OF COLOR SUPPORT
DEST	Destination	OUTPUT DESTINATION DEFAULT
IOTYPE	I/O Type	TYPE OF I/O DEFAULT
FORMAT	Data Format	OUTPUT DATA FORMAT
HEIGHT	Height	HEIGHT OF OUTPUT
WIDTH	Width	WIDTH OF OUTPUT
UNITS	Units [1]	UNITS FOR SIZE, MARGINS AND RESOLUTION
YPIXELS	Ypixels	VERTICAL PIXELS
XPIXELS	Xpixels	HORIZONTAL PIXELS
ROWS	Rows (vpos)	ROWS
COLS	Columns (hpos)	COLUMNS
LEFT	Left Margin	LEFT MARGIN
LMIN	Minimum Left Margin	MINIMUM LEFT MARGIN
RIGHT	Right Margin	RIGHT MARGIN
RMIN	Minimum Right Margin	MINIMUM RIGHT MARGIN
BOTTOM	Bottom Margin	BOTTOM MARGIN
BMIN	Minimum Bottom Margin	MINIMUM BOTTOM MARGIN
TOP	Top Margin	TOP MARGIN

Variable	SAS Log Label	Output Data Set Label
TMIN	Minimum Top Margin	MINIMUM TOP MARGIN
HRES	XxY Resolution	HORIZONTAL PIXELS PER UNIT
VRES	XxY Resolution	VERTICAL PIXELS PER UNIT
COMPRESSION	Compression Enabled	COMPRESSION ENABLED
COMPMETHOD	Compression Method	COMPRESSION METHOD
EMBEDDING	Font Embedding	FONT EMBEDDING SUPPORT
ANIMATION	Animation	ANIMATION SUPPORT

1 If the type of units is displayed with the value of a variable, such as 0 inches for the left margin, the Units label is not displayed in the output to the SAS log.

System Options That Affect the Value of Size Variables

For universal printers, the values of the HEIGHT, WIDTH, LEFT, RIGHT, BOTTOM, TOP, LMIN, RMIN, BMIN, and TMIN variables are affected by the settings of the PAPERSIZE, LEFTMARGIN, RIGHTMARGIN, BOTTOMMARGIN, and TOPMARGIN SAS system options. The default paper size is determined by the SAS locale (which affects the default size for universal printers). For SAS/GRAPH devices, these variable values are not affected by the system option settings.

For more information, see *SAS System Options: Reference*.

Example: GENERAL Report

The following QDEVICE procedure creates a GENERAL report for the SVG universal printer:

```
proc qdevice;
   printer svg;
run;
```

Here is the GENERAL report in the SAS log:

```
16   proc qdevice;
17   printer svg;
18    run;

                Name: SVG
         Description: Scalable Vector Graphics 1.1
              Module: SASPDSVG
                Type: Universal Printer
            Registry: SASHELP
           Prototype: SVG 1.1
    Default Typeface: Cumberland AMT
      Typeface Alias: Courier
          Font Style: Regular
         Font Weight: Normal
         Font Height: 8 points
        Font Version: Version 1.03
      Maximum Colors: 16777216
        Visual Color: Direct Color
       Color Support: RGBA
         Destination: sasprt.svg
            I/O Type: DISK
         Data Format: SVG
              Height: 6.25 inches
               Width: 8.33 inches
             Ypixels: 600
             Xpixels: 800
          Rows(vpos): 50
       Columns(hpos): 114
         Left Margin: 0 inches
  Minimum Left Margin: 0 inches
        Right Margin: 0 inches
 Minimum Right Margin: 0 inches
       Bottom Margin: 0 inches
Minimum Bottom Margin: 0 inches
          Top Margin: 0 inches
   Minimum Top Margin: 0 inches
      XxY Resolution: 96x96 pixels per inch
  Compression Enabled: Never
   Compression Method: Deflate
      Font Embedding: Option
           Animation: Enabled
```

Create a FONT Report

The FONT report produces a report of all system and device-resident fonts that are supported by the specified device or printer.

About FONT Report Variables

For a description of the variables, see “FONT Report Variables” on page 1962.

The following table lists the variables that you can use in a FONT report as well as the labels for the variables that are used either in the SAS log or the output data

set. If you do not specify the VAR statement, the variables appear in the order in which they appear in the table.

Variable	SAS Log Label	Output Data Set Label
NAME	Name	NAME OF DEVICE OR PRINTER
DESC	Description	DESCRIPTION OF DEVICE OR PRINTER
TYPE	Type	TYPE OF DEVICE OR PRINTER
LOCATION	"Device Catalog" for a device "Registry" for a printer	LOCATION OF DEVICE OR PRINTER DEFINITION
FONT	Depends on the font or type	FONT TYPEFACE
ALIAS	(alias: *alias*) to the right of the font name	FONT TYPEFACE ALIAS
FTYPE	Depends on the type of font	FONT TYPE
FSTYLE	None	FONT STYLE
FWEIGHT	None	FONT WEIGHT
FVERSION	None	FONT VERSION

Variable Labels in a FONT Report

When you specify the FONT, FTYPE, FSTYLE, or the FWEIGHT variables in a FONT report, the variable labels that appear in the SAS log vary. The variable labels in the output data set are always the same: FONT TYPEFACE DEFAULT, FONT TYPE, FONT STYLE DEFAULT, and FONT WEIGHT DEFAULT, respectively.

If the VAR statement specifies one or more of the variables FONT, FTYPE, FSTYLE, FWEIGHT, or FVERSION, the SAS log reports only the font type labels and the font family names. The font styles, weights, and versions are not reported to the SAS log. The font type label that appears is dependent on the font type. Some example labels are Supported Font Typefaces, Supported Resident Typefaces, Supported TrueType Typefaces, and Supported Type1 Typefaces.

Example: FONT Report

The following QDEVICE procedure creates a FONT report for the ACTIVEX graphics device:

```
proc qdevice report=font;
   device activex;
run;
```

Here is a partial FONT report in the SAS log:

```
41   proc qdevice report=font;
42   device activex;
43   run;

                    Name: ACTIVEX
             Description: ActiveX enabled GIF Driver
                    Type: Graph Device
          Device Catalog: your-font-catalog-path
Supported Font Typefaces: System (7x16) 8pt
                          System (9x20) 10pt
                          Terminal (8x12) 7pt
                          Terminal (4x6) 4pt
                          Terminal (5x12) 7pt
                          Terminal (6x8) 5pt
                          Terminal (7x12) 7pt
                          Terminal (10x18) 11pt
                          Terminal (12x16) 10pt
                          Fixedsys (8x15) 7pt
                          Fixedsys (10x20) 11pt
                          Modern
                          Roman
                          Script
                          Courier (8x13) 8pt
```

Create a DEVOPTION Report

The DEVOPTION report produces a report of the hardware device options that are supported by the specified device. This report is unavailable for universal printers.

About DEVOPTION Report Variables

For a description of the variables, see "DEVOPTION Report Variables" on page 1961.

The following table lists the variables that you can use in a DEVOPTION report as well as the labels for the variables that are used either in the SAS log or the output data set. If you do not specify the VAR statement, the variables appear in the order in which they appear in the table.

Variable	SAS Log Label	Output Data Set Label
NAME	Name	NAME OF DEVICE OR PRINTER
DESC	Description	DESCRIPTION OF DEVICE OR PRINTER
TYPE	Type	TYPE OF DEVICE OR PRINTER
LOCATION	Device Catalog	LOCATION OF DEVICE OR PRINTER DEFINTION
BIT	Bit Position	DEVICE OPTION BIT POSITON
BITSTRING	Bit Pattern	DEVICE OPTION BIT PATTERN
OPTION	Device Option	DEVICE OPTION NAME
ODESC	Option Description	DEVICE OPTION DESCRIPTION
SUPPORT	Support	DEVICE OPTION SUPPORT

Example: DEVOPTION Report

The following QDEVICE procedure creates a DEVOPTION report for the SASEMF graphics device, reporting supported options because the default for SUPPORT is YES:

```
proc qdevice report=devoption;
   device sasemf;
run;
```

Here is the report in the SAS log:

```
104  proc qdevice report=devoption;
105     device sasemf;
106  run;

NOTE: Writing HTML Body file: sashtml.htm
              Name: SASEMF
       Description: Enhanced Metafile Driver
              Type: Shortcut Device
    Device Catalog: your-sas-path\sashelp
       Bit Pattern: 8000000000000000
     Device Option: GDCIRCLEARC
Option Description: Hardware is capable of drawing circles
           Support: Yes

      Bit Position: 1
       Bit Pattern: 4000000000000000
     Device Option: GDPIEFILL
Option Description: Device has hardware pie-fill capability
           Support: Yes

      Bit Position: 3
       Bit Pattern: 1000000000000000
     Device Option: GDCRT
Option Description: Hardware is a CRT or the device acts like a CRT
           Support: Yes

      Bit Position: 5
       Bit Pattern: 0400000000000000
     Device Option: GDPOLYGONFILL
Option Description: Device has polygonfill capability
           Support: Yes

      Bit Position: 7
       Bit Pattern: 0100000000000000
     Device Option: GDRGB
Option Description: Hardware is capable of defining colors in one or more color
spaces
           Support: Yes

      Bit Position: 8
       Bit Pattern: 0080000000000000
     Device Option: GDMBPOLY
Option Description: Hardware can draw polygons with multiple boundaries
           Support: Yes

      Bit Position: 9
       Bit Pattern: 0040000000000000
     Device Option: GDOPACITY
Option Description: Hardware is capable of supporting opacity
           Support: Yes

      Bit Position: 11
       Bit Pattern: 0010000000000000
     Device Option: GDLWIDTH
Option Description: Hardware can draw lines of varying widths
           Support: Yes

      Bit Position: 14
       Bit Pattern: 0002000000000000
     Device Option: GDHRDCHR
Option Description: Hardware characters are supported by the device
           Support: Yes
```

```
      Bit Position: 15
       Bit Pattern: 0001000000000000
     Device Option: GDXLIMIT
Option Description: There is no limit on max value allowed for x coordinate
           Support: Yes

      Bit Position: 16
       Bit Pattern: 0000800000000000
     Device Option: GDYLIMIT
Option Description: There is no limit on max value allowed for y coordinate
           Support: Yes

      Bit Position: 18
       Bit Pattern: 0000200000000000
     Device Option: GDTXJUSTIFY
Option Description: Hardware is capable of justifying proportional text
           Support: Yes

      Bit Position: 24
       Bit Pattern: 0000008000000000
     Device Option: GDUNICODE
Option Description: Device supports the use of the Unicode font attribute
           Support: Yes

      Bit Position: 25
       Bit Pattern: 0000004000000000
     Device Option: GDPOLYLINE
Option Description: Hardware is capable of supporting polylines
           Support: Yes

      Bit Position: 28
       Bit Pattern: 0000000800000000
     Device Option: GDTRUETYPE
Option Description: Device supports the use of TrueType fonts
           Support: Yes

      Bit Position: 36
       Bit Pattern: 0000000008000000
     Device Option: GDIMAGE
Option Description: Device is capable of drawing images
           Support: Yes

      Bit Position: 39
       Bit Pattern: 0000000001000000
     Device Option: GDIMGROTATE
Option Description: Device is incapable of doing image rotation
           Support: Yes
```

```
      Bit Position: 40
       Bit Pattern: 0000000000800000
     Device Option: GDTRUECOLOR
Option Description: Hardware is a 24-bit true color device
           Support: Yes

      Bit Position: 44
       Bit Pattern: 0000000000080000
     Device Option: GDTEXTCLIP
Option Description: Hardware will clip text at the device limits
           Support: Yes

      Bit Position: 50
       Bit Pattern: 0000000000002000
     Device Option: GDAUTOSIZE
Option Description: Autosize text to fit rows and columns
           Support: Yes

      Bit Position: 54
       Bit Pattern: 0000000000000200
     Device Option: GDPOLYOUTLINE
Option Description: Device draws polygon outlines
           Support: Yes

      Bit Position: 55
       Bit Pattern: 0000000000000100
     Device Option: GDPRINTERPATH
Option Description: Device temporarily sets printerpath to that of the device name
           Support: Yes

      Bit Position: 56
       Bit Pattern: 0000000000000080
     Device Option: GDOPTPASSTHRU
Option Description: PAPERSIZE option sets default value of PAPERSIZE goption
           Support: Yes

      Bit Position: 57
       Bit Pattern: 0000000000000040
     Device Option: GDPIEOUTLINE
Option Description: Driver draws pie slice outlines (empty pies)
           Support: Yes
```

Create a LINESTYLE Report

The LINESTYLE report produces a report of the hardware (dashed) line styles that are supported by the specified device.

About LINESTYLE Report Variables

For a description of the variables, see “LINESTYLE Report Variables” on page 1968.

The following table lists the variables that you can use in a LINESTYLE report as well as the labels for the variables that are used either in the SAS log or the output data set. If you do not specify the VAR statement, the variables appear in the order in which they appear in the table.

Variable	SAS Log Label	Output Data Set Label
NAME	Name	NAME OF DEVICE OR PRINTER
DESC	Description	DESCRIPTION OF DEVICE OR PRINTER
TYPE	Type	TYPE OF DEVICE OR PRINTER
LOCATION	Device Catalog	LOCATION OF DEVICE OR PRINTER DEFINTION
LINE	Supported Line Styles Unsupported Line Styles	HARDWARE DASHED LINE NUMBER
SUPPORT	Supported Line Styles Unsupported Line Styles	HARDWARE DASHED LINE SUPPORT

Example: LINESTYLE Report

The following QDEVICE procedure creates a LINESTYLE report of the LJ5PS device, reporting the supported line styles because the default for SUPPORT is YES:

```
proc qdevice report=linestyle;
   device lj5ps;
run;
```

Here is the LINESTYLE report in the SAS log:

```
202  proc qdevice report=linestyle;
203     device lj5ps;
204  run;

                 Name: LJ5PS
          Description: LaserJet 5P -- 600 dpi -- PostScript
                 Type: Graph Device
       Device Catalog: your-sas-path\sashelp
Supported Line Styles: 1-44
```

Create a RECTANGLE Report

A RECTANGLE report produces a report of the hardware fill types that are supported by the specified device.

About RECTANGLE Report Variables

For a description of the variables, see "RECTANGLE Report Variables" on page 1969.

The following table lists the variables that you can use in a RECTANGLE report as well as the labels for the variables that are used either in the SAS log or the output data set. If you do not specify the VAR statement, the variables appear in the order in which they appear in the table.

Variable	SAS Log Label	Output Data Set Label
NAME	Name	NAME OF DEVICE OR PRINTER
DESC	Description	DESCRIPTION OF DEVICE or PRINTER
TYPE	Type	TYPE OF DEVICE OR PRINTER
LOCATION	Device Catalog	LOCATION OF DEVICE OR PRINTER DEFINTION
FILL	Supported Hardware Fills	HARDWARE RECTANGLE FILL NAME
SUPPORT	Supported Hardware Fills Unsupported Hardware Fills	HARDWARE RECTANGLE FILL SUPPORT

Example: RECTANGLE Report

The following QDEVICE procedure creates a RECTANGLE report for the SASPRTG universal printer, reporting the supported hardware fills because the default for SUPPORT is YES.

```
proc qdevice report=rectangle;
   device sasprtg;
run;
```

Here is the RECTANGLE report in the SAS log:

```
205  proc qdevice report=rectangle;
206     device sasprtg;
207  run;

                    Name: SASPRTG
             Description: POSTSCRIPT LEVEL 1
                    Type: Printer Interface Device
          Device Catalog: your-sas-path\sashelp
Supported Hardware Fills: Empty,Solid
```

SASPRTG is a printer interface device. Because Universal Printing is active, SASPRTG interfaces with the default universal printer. For this reason, the report shows information about the PostScript Level 1 printer as a universal printer.

Create a SYMBOL Report

A SYMBOL report produces a report of the hardware symbols that are supported by the specified device.

About SYMBOL Report Variables

For a description of the variables, see "SYMBOL Report Variables" on page 1970.

The following table lists the variables that you can use in a SYMBOL report as well as the labels for the variables that are used either in the SAS log or the output data set. If you do not specify the VAR statement, the variables appear in the order in which they appear in the table.

Variable	SAS Log Label	Output Data Set Label
NAME	Name	NAME OF DEVICE OR PRINTER
DESC	Description	DESCRIPTION OF DEVICE OR PRINTER
TYPE	Type	TYPE OF DEVICE OR PRINTER
LOCATION	Device Catalog	LOCATION OF DEVICE OR PRINTER DEFINTION
SYMBOL	Supported Hardware Symbols Unsupported Hardware Symbols	HARDWARE SYMBOL NAME
SUPPORT	Support	DEVICE OPTION SUPPORT

Example: SYMBOL Report

The following QDEVICE procedure creates a SYMBOL report for the CGM device, reporting the supported hardware symbols because the default for SUPPORT is YES:

```
proc qdevice report=symbol;
   device cgm;
run;
```

Here is the SYMBOL report in the SAS log:

```
235  proc qdevice report=symbol;
236     device cgm;
237  run;

                     Name: CGM
              Description: CGM generator--binary output
                     Type: Graph Device
            Device Catalog: your-sas-path\sashelp
Supported Hardware Symbols: Plus,X,Star
```

Examples: QDEVICE Procedure

Example 1: Generate a Report for the Default Display Device

Features: PROC QDEVICE

Details

The following example creates a General report for the default display device. This example assumes that you are running in an interactive mode on Windows.

For the WIN device, the number of colors is controlled by your Windows display settings. The size is controlled by your monitor and resolution settings.

Program

```
proc qdevice;
run;
```

Log

If you do not specify the OUT= option, the QDEVICE procedure sends its output to the SAS log. The output for the Windows operating environment is shown below as it appears in the SAS log.

Example Code 55.1 *The SAS Log After Running PROC QDEVICE*

```
                Name: WIN
         Description: Microsoft Windows Display
                Type: System Display
      Device Catalog: your-device-catalog
    Default Typeface: Sasfont
          Font Style: Roman
         Font Weight: Normal
         Font Height: 7 points
       Maximum Colors: 2147483647
        Visual Color: True Color
       Color Support: RGB
            I/O Type: GTERM
         Data Format: Host Display
              Height: 5.75 inches
               Width: 9.25 inches
             Ypixels: 690
             Xpixels: 1110
          Rows(vpos): 46
       Columns(hpos): 111
         Left Margin: 0 inches
  Minimum Left Margin: 0 inches
        Right Margin: 0 inches
 Minimum Right Margin: 0 inches
       Bottom Margin: 0 inches
Minimum Bottom Margin: 0 inches
           Top Margin: 0 inches
   Minimum Top Margin: 0 inches
      XxY Resolution: 120x120 pixels per inch
  Compression Enabled: Never
      Font Embedding: Never
           Animation: Unsupported
```

Example 2: Generate a General Report for All Devices

Features: PROC QDEVICE statement option: OUT=
DEVICE statement

Details

The following example creates a General report for all devices and writes the results to WORK.ALLDEVICES.

You can use the _ALL_ keyword to generate a report for all devices.

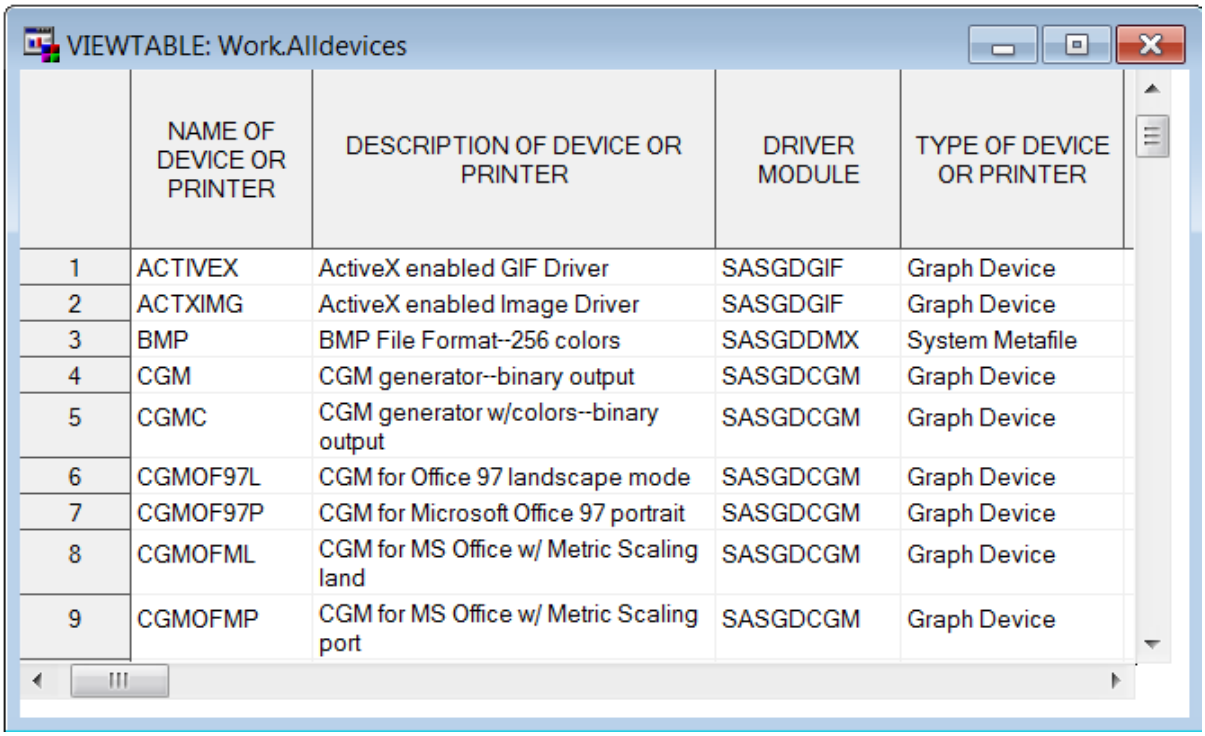
Program

```
proc qdevice out=allDevices;
   device _all_;
run;
```

Output

The following image shows a portion of the report as it appears in the Viewtable window.

Output 55.1 *The Output Data Set Report for All Devices*



	NAME OF DEVICE OR PRINTER	DESCRIPTION OF DEVICE OR PRINTER	DRIVER MODULE	TYPE OF DEVICE OR PRINTER
1	ACTIVEX	ActiveX enabled GIF Driver	SASGDGIF	Graph Device
2	ACTXIMG	ActiveX enabled Image Driver	SASGDGIF	Graph Device
3	BMP	BMP File Format--256 colors	SASGDDMX	System Metafile
4	CGM	CGM generator--binary output	SASGDCGM	Graph Device
5	CGMC	CGM generator w/colors--binary output	SASGDCGM	Graph Device
6	CGMOF97L	CGM for Office 97 landscape mode	SASGDCGM	Graph Device
7	CGMOF97P	CGM for Microsoft Office 97 portrait	SASGDCGM	Graph Device
8	CGMOFML	CGM for MS Office w/ Metric Scaling land	SASGDCGM	Graph Device
9	CGMOFMP	CGM for MS Office w/ Metric Scaling port	SASGDCGM	Graph Device

Example 3: Generate a Report for SAS/GRAPH Device Drivers and Universal Printers

Features: PROC QDEVICE statement option: OUT=
DEVICE statement
PRINTER statement

Details

The following example creates a General report for all devices that end in EMF and the PDF and SVG? universal printers. The results are written to the WORK.MYREPORT data set. If you do not specify the REPORT= option, the QDEVICE procedure generates a General report.

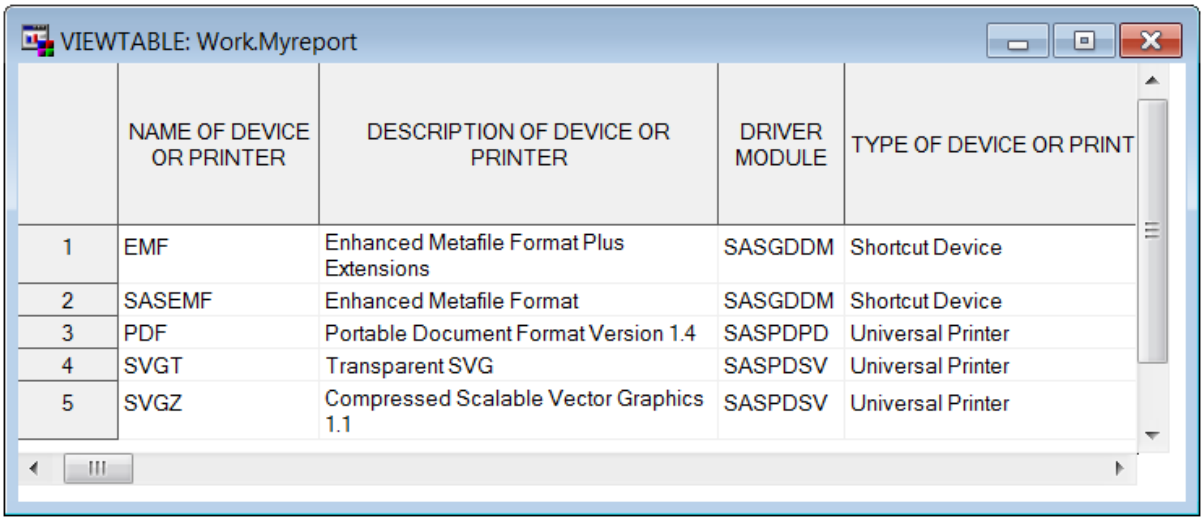
Program

```
proc qdevice out=myreport;
  device '*emf';
  printer pdf 'svg?';
run;
```

Output

The following image shows a portion of the report as it appears in the Viewtable window.

Output 55.2 *The Output Data Set Report for the EMF Device, and PDF and SVG Printers*



VIEWTABLE: Work.Myreport

	NAME OF DEVICE OR PRINTER	DESCRIPTION OF DEVICE OR PRINTER	DRIVER MODULE	TYPE OF DEVICE OR PRINT
1	EMF	Enhanced Metafile Format Plus Extensions	SASGDDM	Shortcut Device
2	SASEMF	Enhanced Metafile Format	SASGDDM	Shortcut Device
3	PDF	Portable Document Format Version 1.4	SASPDPD	Universal Printer
4	SVGT	Transparent SVG	SASPDSV	Universal Printer
5	SVGZ	Compressed Scalable Vector Graphics 1.1	SASPDSV	Universal Printer

Example 4: Generate a Report for the Default Printer

Features: PROC QDEVICE statement
PRINTER statement

Details

By default, printing in SAS under Windows is done by the default Windows printer and not by Universal Printing. Therefore, the results that you see for the QDEVICE procedure when you use the `printer _PRINTER_` statement differ. Under Windows, where the NOUPRINT system option is the default, the report is based on the printer interface device that interfaces with the default Windows printer. Under UNIX, where the UPRINT system option is set, the report is based on the default SAS universal printer.

Because the REPORT= option is not specified, the QDEVICE procedure generates a General report. The OUT= option is not specified and the results are written to the SAS log. The _PRINTER_ keyword determines the default printer to report on and generates a report for that printer.

For more information, see these topics:

- "Printing" in *SAS Companion for Windows*
- "UNIVERSALPRINT" in *SAS Companion for Windows*
- "What Is Universal Printing?" in *SAS 9.4 Universal Printing*

Program: Windows

```
proc qdevice;
  printer _PRINTER_;
run;
```

Log: Default Windows Printer Report

Example Code 55.2 *The SAS Log Output Report for the Default Windows Printer*

```
1    proc qdevice;
2       printer _PRINTER_;
3       run;

NOTE: The "\\wprt02nc0\clxmfpj21" printer will be used by default with the ODS
PRINTER destination.

                 Name: WINPRTC
          Description: \\WPRT02NC0\CLXMFPJ21
               Module: SASGDDMX
                 Type: Printer Interface Device
       Device Catalog: your-sas-path\sashelp
     Default Typeface: SAS Monospace
           Font Style: Roman
          Font Weight: Normal
          Font Height: 10 points
         Font Version: mfgpctt-v4.4 Thu Sep 16 14:30:47 EDT 1999
       Maximum Colors: 2097152
         Visual Color: True Color
        Color Support: RGB
              I/O Type: PRINTER
          Data Format: Host Printer
               Height: 10.67 inches
                Width: 8.15 inches
              Ypixels: 6392
              Xpixels: 4892
           Rows(vpos): 55
        Columns(hpos): 97
          Left Margin: 0.18 inches
  Minimum Left Margin: 0.18 inches
         Right Margin: 0.17 inches
 Minimum Right Margin: 0.17 inches
        Bottom Margin: 0.18 inches
Minimum Bottom Margin: 0.18 inches
            Top Margin: 0.17 inches
   Minimum Top Margin: 0.17 inches
       XxY Resolution: 600x600 pixels per inch
  Compression Enabled: Never
       Font Embedding: Never
            Animation: Unsupported
```

Program: UNIX

```
proc qdevice;
   printer _PRINTER_;
run;
```

Log: Default Universal Printer Report under UNIX

Example Code 55.3 *The SAS Log Output Report for the Default Universal Printer under UNIX*

```
1    proc qdevice;
2     printer _PRINTER_;
3     run;

NOTE: The "PostScript Level 1" printer will be used by default with the ODS PRINTER
destination.

                 Name: PostScript Level 1
          Description: Generic PostScript Level 1 Printer
               Module: SASPDPSL
                 Type: Universal Printer
             Registry: SASHELP
            Prototype: PostScript Level 1 (Color)
     Default Typeface: Cumberland AMT
       Typeface Alias: Courier
           Font Style: Regular
          Font Weight: Normal
          Font Height: 8 points
         Font Version: Version 1.03
       Maximum Colors: 16777216
         Visual Color: Direct Color
        Color Support: CMYK
          Destination: sasprt.ps
             I/O Type: DISK
          Data Format: PostScript
               Height: 10 inches
                Width: 7.5 inches
              Ypixels: 3000
              Xpixels: 2250
           Rows(vpos): 81
        Columns(hpos): 112
          Left Margin: 0.5 inches
  Minimum Left Margin: 0 inches
         Right Margin: 0.5 inches
 Minimum Right Margin: 0 inches
        Bottom Margin: 0.5 inches
Minimum Bottom Margin: 0 inches
           Top Margin: 0.5 inches
   Minimum Top Margin: 0 inches
       XxY Resolution: 300x300 pixels per inch
  Compression Enabled: Never
       Font Embedding: Option
            Animation: Unsupported
```

Example 5: Generate a Font Report

Features:

PROC QDEVICE statement options
- REPORT=
- OUT=

PRINTER statement

Details

The first example generates a report of all the printer-resident and system fonts available for the printer. The results are written to the Work.Myfonts data set.

The second example is a SAS program that uses a macro, the DATA step, and the PRINT procedure to create a list of fonts for devices.

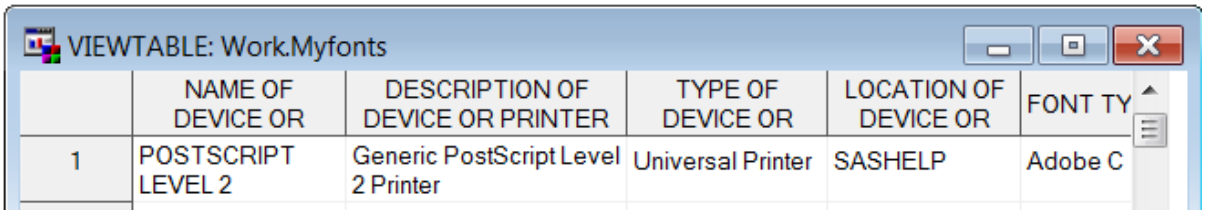
Program

```
proc qdevice report=font out=myfonts;
  printer 'postscript level 2';
run;
```

Output

The following output shows the report as it appears in the Viewtable window.

Output 55.3 *The Output Data Set for a Font Report*



	NAME OF DEVICE OR	DESCRIPTION OF DEVICE OR PRINTER	TYPE OF DEVICE OR	LOCATION OF DEVICE OR	FONT TY
1	POSTSCRIPT LEVEL 2	Generic PostScript Level 2 Printer	Universal Printer	SASHELP	Adobe C

Program

```
/* Macro FONTLIST - Report fonts supported by a device */

%macro fontlist(type, name);

proc qdevice report=font out=fonts;
   &type &name;
   var font ftype fstyle fweight;
run;

data;
   set fonts;
   drop ftype;
   length type $16;
   if ftype = "System"
     then do;
        if substr(font,2,3) = "ttf" then type = "TrueType";
```

```
          else if substr(font,2,3) = "at1" then type = "Adobe Type1";
          else if substr(font,2,3) = "cff" then type = "Adobe CFF/
Type2";
          else if substr(font,2,3) = "pfr" then type = "Bitstream PFR";
          else type = "System";
        if type ^= "System" then font = substr(font,7,length(font)-6);
          else if substr(font,1,1) = "@"
               then font = substr(font, 2,length(font)-1);
       end;
       else type = "Printer Resident";
run;

proc sort;
   by font;
run;

title "Fonts Supported by the %upcase(&name) &type";

proc print label;
   label fstyle="Style" fweight="Weight" font="Font" type="Type";
run;


%mend fontlist;



%fontlist(device, pcl5c)
```

Program Description

Create the macro fontlist. The %macro statement begins the macro. The input to the macro is the type, whether it is a device or printer, and the name of the device or printer.

```
/* Macro FONTLIST - Report fonts supported by a device */

%macro fontlist(type, name);
```

Create a data set, fonts, for the device. The macro input variables, type and name, are used to create a Font report using the QDEVICE procedure. The output is written to the data set fonts.

```
proc qdevice report=font out=fonts;
   &type &name;
   var font ftype fstyle fweight;
run;
```

Categorize the font type. Fonts can be a type System, TrueType, Adobe Type1, Adobe CFF/Type2, Bitstream PFR, or Printer Resident.

```
data;
   set fonts;
   drop ftype;
   length type $16;
   if ftype = "System"
     then do;
        if substr(font,2,3) = "ttf" then type = "TrueType";
```

```
          else if substr(font,2,3) = "at1" then type = "Adobe Type1";
          else if substr(font,2,3) = "cff" then type = "Adobe CFF/
Type2";
          else if substr(font,2,3) = "pfr" then type = "Bitstream PFR";
          else type = "System";
        if type ^= "System" then font = substr(font,7,length(font)-6);
          else if substr(font,1,1) = "@"
               then font = substr(font, 2,length(font)-1);
       end;
       else type = "Printer Resident";
run;
```

Sort the font data set by the font name.

```
proc sort;
   by font;
run;
```

Print the fonts for a device or printer.

```
title "Fonts Supported by the %upcase(&name) &type";

proc print label;
   label fstyle="Style" fweight="Weight" font="Font" type="Type";
run;
```

End the macro.

```
%mend fontlist;
```

Use the macro &fontlist to create and output data set for the PCL5c device.

```
%fontlist(device, pcl5c)
```

Output

Output 55.4 *A Partial View of the Fonts Supported by the PCL5c Device*

Fonts Supported by the PCL5C device

Obs	Font	Style	Weight	Type
1	CG Courier	Italic	Bold	Printer Resident
2	CG Courier	Italic	Normal	Printer Resident
3	CG Courier	Roman	Bold	Printer Resident
4	CG Courier	Roman	Normal	Printer Resident
5	CG Letter Gothic	Italic	Bold	Printer Resident
6	CG Letter Gothic	Italic	Normal	Printer Resident
7	CG Letter Gothic	Roman	Bold	Printer Resident
8	CG Letter Gothic	Roman	Normal	Printer Resident
9	CG Marigold	Roman	Normal	Printer Resident
10	CG Times	Italic	Bold	Printer Resident
11	CG Times	Italic	Normal	Printer Resident
12	CG Times	Roman	Bold	Printer Resident
13	CG Times	Roman	Normal	Printer Resident
14	EW Arial	Italic	Bold	Printer Resident
15	EW Arial	Italic	Normal	Printer Resident
16	EW Arial	Roman	Bold	Printer Resident
17	EW Arial	Roman	Normal	Printer Resident
18	EW CG Times	Italic	Bold	Printer Resident
19	EW CG Times	Italic	Normal	Printer Resident
20	EW CG Times	Roman	Bold	Printer Resident

Example 6: Generate a Device Option Report

Features:

PROC QDEVICE statement options
- REPORT=
- SUPPORT=
- OUT=

DEVICE statement

Details

The following example creates a Device Options (DEVOPTIONS) report for the PNG device. The report is written to an output data set.

Program

```
proc qdevice report=devoption support=all out=devop;
  device png;
run;

proc print data=devop;
   var bit bitstring option odesc;
   where Support="Yes";
   title "Supported PNG Device Options";
run;
```

Program Description

Report the options for the PNG device. The REPORT=DEVOPTION option specifies to create a device options report. SUPPORT=ALL specifies to report all device features. The option OUT=DEVOP creates the data set WORK.DEVOP. The DEVICE PNG statement specifies to report on the PNG device.

```
proc qdevice report=devoption support=all out=devop;
  device png;
run;
```

Print the device options report. Printing the WORK.DEVOP data set, the printed report shows the BIT, BITSTRING, OPTION, and ODESC variables for the device options where Support="Yes".

```
proc print data=devop;
   var bit bitstring option odesc;
   where Support="Yes";
   title "Supported PNG Device Options";
run;
```

Output

Output 55.5 *The Output Data Set for the PNG Device*

Supported PNG Device Options

Obs	BIT	BITSTRING	OPTION	ODESC
1	0	8000000000000000	GDCIRCLEARC	Hardware is capable of drawing circles
2	1	4000000000000000	GDPIEFILL	Device has hardware pie-fill capability
4	3	1000000000000000	GDCRT	Hardware is a CRT or the device acts like a CRT
5	4	0800000000000000	GDTRANSPARENCY	Device supports transparency
6	5	0400000000000000	GDPOLYGONFILL	Device has polygonfill capability
8	7	0100000000000000	GDRGB	Hardware is capable of defining colors in one or more color spaces
9	8	0080000000000000	GDMBPOLY	Hardware can draw polygons with multiple boundaries
10	9	0040000000000000	GDOPACITY	Hardware is capable of supporting opacity
13	14	0002000000000000	GDHRDCHR	Hardware characters are supported by the device
14	15	0001000000000000	GDXLIMIT	There is no limit on max value allowed for x coordinate
15	16	0000800000000000	GDYLIMIT	There is no limit on max value allowed for y coordinate
17	18	0000200000000000	GDTXJUSTIFY	Hardware is capable of justifying proportional text
20	24	0000008000000000	GDUNICODE	Device supports the use of the Unicode font attribute
21	25	0000004000000000	GDPOLYLINE	Hardware is capable of supporting polylines
24	28	0000000800000000	GDTRUETYPE	Device supports the use of TrueType fonts
32	36	0000000008000000	GDIMAGE	Device is capable of drawing images
35	39	0000000001000000	GDIMGROTATE	Device is incapable of doing image rotation
36	40	0000000000800000	GDTRUECOLOR	Hardware is a 24-bit true color device
37	41	0000000000400000	GDFONTATTR	Device supports setting font attributes
38	42	0000000000200000	GDSCANLNFNT	Device will use scan line font rendering
40	44	0000000000080000	GDTEXTCLIP	Hardware will clip text at the device limits
46	50	0000000000002000	GDAUTOSIZE	Autosize text to fit rows and columns
50	54	0000000000000200	GDPOLYOUTLINE	Device draws polygon outlines
51	55	0000000000000100	GDPRINTERPATH	Device temporarily sets printerpath to that of the device name
52	56	0000000000000080	GDOPTPASSTHRU	PAPERSIZE option sets default value of PAPERSIZE goption
53	57	0000000000000040	GDPIEOUTLINE	Driver draws pie slice outlines (empty pies)
54	60	0000000000000008	GDNOROTATE	Force the graphics sublib not to rotate the graph

Example 7: Specify a User Library and Catalog for a Report

Features: PROC QDEVICE statement options
CATALOG=

DEVLOC=
PRINTER statement

Details

This example creates a general report for a GIF printer in a user-specified library and catalog using the DEVLOC= and CATALOG= options in the PROC QDEVICES statement. The results are written to the SAS log.

Program

Assign the device library and catalog

```
libname devlib 'c:\em';
proc qdevice report=general devloc=devlib cat=mydevices;
   device gif;
run;
```

Log

Example Code 55.4 *The SAS Log Report for a Specific Device Library and Catalog*

```
144  libname devlib 'c:\em';
NOTE: Libref DEVLIB was successfully assigned as follows:
      Engine:        V9
      Physical Name: C:\em
145  proc qdevice report=general devloc=devlib cat=mydevices;
146     device gif;
147  run;

                 Name: GIF
          Description: Graphics Interchange Format RGB Color/Alpha Blending
               Module: SASGDDMX
                 Type: Shortcut Device
       Device Catalog: C:\em
            Prototype: GIF
     Default Typeface: Cumberland AMT
       Typeface Alias: Courier
           Font Style: Regular
          Font Weight: Normal
          Font Height: 8 points
         Font Version: Version 1.03
       Maximum Colors: 16777216
         Visual Color: True Color
        Color Support: RGBA
          Destination: sasprt.gif
             I/O Type: DISK
          Data Format: GIF
               Height: 6.25 inches
                Width: 8.33 inches
              Ypixels: 600
              Xpixels: 800
           Rows(vpos): 50
        Columns(hpos): 114
          Left Margin: 0 inches
  Minimum Left Margin: 0 inches
         Right Margin: 0 inches
 Minimum Right Margin: 0 inches
        Bottom Margin: 0 inches
Minimum Bottom Margin: 0 inches
           Top Margin: 0 inches
   Minimum Top Margin: 0 inches
       XxY Resolution: 96x96 pixels per inch
  Compression Enabled: Always
   Compression Method: LZW
       Font Embedding: Never
            Animation: Enabled
```

56

RANK Procedure

Overview: RANK Procedure

What Does the RANK Procedure Do?

The RANK procedure computes ranks for one or more numeric variables across the observations of a SAS data set and writes the ranks to a new SAS data set. PROC RANK by itself produces no printed output.

Ranking Data

The following output shows the results of ranking the values of one variable with a simple PROC RANK step. In this example, the new ranking variable shows the order of finish of five golfers over a four-day competition. The player with the lowest number of strokes finishes in first place. The following statements produce the output:

```
proc rank data=golf out=rankings;
   var strokes;
   ranks Finish;
run;

proc print data=rankings;
run;
```

Output 56.1 *Assignment of the Lowest Rank Value to the Lowest Variable Value*

The SAS System 1

Obs	Player	Strokes	Finish
1	Jack	279	2
2	Jerry	283	3
3	Mike	274	1
4	Randy	296	4
5	Tito	302	5

In the following output, the candidates for city council are ranked by district according to the number of votes that they received in the election. They are also ranked according to the number of years that they have served in office.

This example shows how PROC RANK can do the following tasks:

- reverse the order of the rankings so that the highest value receives the rank of 1, the next highest value receives the rank of 2, and so on
- rank the observations separately by values of multiple variables
- rank the observations within BY groups
- handle tied values

For an explanation of the program that produces this report, see "Example 2: Ranking Values within BY Groups" on page 2019.

Output 56.2 *Assignment of the Lowest Rank Value to the Highest Variable Value within Each BY Group*

```
                    Results of City Council Election                    1

---------------------------------- District=1 ----------------------------------

                                                    Vote    Years
              Obs    Candidate    Vote    Years    Rank     Rank

               1     Cardella     1689      8        1       1
               2     Latham       1005      2        3       2
               3     Smith        1406      0        2       3
               4     Walker        846      0        4       3

                              N = 4


---------------------------------- District=2 ----------------------------------

                                                    Vote    Years
             Obs    Candidate      Vote    Years    Rank     Rank

              5     Hinkley         912      0        3       3
              6     Kreitemeyer    1198      0        2       3
              7     Lundell        2447      6        1       1
              8     Thrash          912      2        3       2

                              N = 4
```

Concepts: RANK Procedure

Computer Resources

For any variable that is being ranked, PROC RANK stores in memory the value of that variable for every observation.

Statistical Applications

Ranks are useful for investigating the distribution of values for a variable. The ranks divided by *n* or *n*+1 form values in the range 0 to 1, and these values estimate the cumulative distribution function. You can apply inverse cumulative distribution functions to these fractional ranks to obtain probability quantile scores. You can compare these scores to the original values to judge the fit to the distribution. For example, if a set of data has a normal distribution, the normal scores should be a linear function of the original values, and a plot of scores versus original values should be a straight line.

Many nonparametric methods are based on analyzing ranks of a variable:

- A two-sample *t* test applied to the ranks is equivalent to a Wilcoxon rank sum test using the *t* approximation for the significance level. If you apply the *t* test to the normal scores rather than to the ranks, the test is equivalent to the van der Waerden test. If you apply the *t* test to median scores (GROUPS=2), the test is equivalent to the median test.
- A one-way analysis of variance applied to ranks is equivalent to the Kruskal-Wallis *k*-sample test; the F test generated by the parametric procedure applied to the ranks is often better than the X^2 approximation used by Kruskal-Wallis. This test can be extended to other rank scores (Quade 1966).
- You can obtain a Friedman's two-way analysis for block designs by ranking within BY groups and then performing a main-effects analysis of variance on these ranks (Conover 1998).
- You can investigate regression relationships by using rank transformations with a method described by Iman and Conover (1979).

Treatment of Tied Values

When PROC RANK ranks values, if two or more values of an analysis variable that are within a BY group are equal, then tied values are present in the data. Because the values are indistinguishable and there is usually no further obvious information about which the ranks can reasonably be based, PROC RANK does not assign different ranks to the values. Tied values could be arbitrarily assigned different ranks. But in statistical applications such as nonparametric statistical tests using ranks, it is conventional to assign the same rank to tied values.

These statistical tests commonly assume that the data is from a continuous distribution, in which the probability of a tie is theoretically zero. In practice, whether because of inaccuracies in measurement, the finite accuracy of representation within a digital computer, or other reasons, tied values often occur. It is also conventional in these statistical tests to assign the average rank to a group of tied values. Assignment of the average rank is preferred because it

preserves the sum of the ranks and therefore does not distort the estimate of the cumulative distribution function.

For applications within and outside of statistics, the RANK procedure provides the TIES= option to control the treatment of tied values. The default value for this option depends on the specified ranking or scoring method, which you can specify with the options of the PROC RANK statement. For ranking and scoring methods, when TIES=LOW, TIES=HIGH, or TIES=MEAN, tied values are initially treated as if they are distinguishable. These methods all begin by sorting the values of the analysis variable within a BY group, and then assigning to each nonmissing value an ordinal number that indicates its position in the sequence.

Subsequently, for non-scoring methods, PROC RANK resolves tied values by selecting the minimum with TIES=LOW, selecting the maximum with TIES=HIGH, or calculating the average of the ordinals in a group of tied values with TIES=MEAN. PROC RANK then obtains the rank from this value through one or more further transformations such as scaling, translation, and truncation.

Scoring methods include normal and Savage scoring, which are requested by the NORMAL= and SAVAGE options. Non-scoring methods include ordinal ranking, the default, and those methods that are requested by the FRACTION, NPLUS1, GROUPS=, and PERCENT options. For the scoring methods NORMAL= and SAVAGE, PROC RANK obtains the probability quantile scores with the appropriate formulas as if no tied values were present within the data. PROC RANK then resolves tied values by selecting the minimum, selecting the maximum, or calculating the average of all scores within a tied group.

For all ranking and scoring methods, when TIES=DENSE, tied values are treated as indistinguishable, and each value within a tied group is assigned the same ordinal. As with the other TIES= resolution methods, all ranking and scoring methods begin by sorting the values of the analysis variable and then assigning ordinals. However, a group of tied values is treated as a single value. The ordinal assigned to the group differs by only +1 from the ordinal that is assigned to the value just prior to the group, if there is one. The ordinal differs by only -1 from the ordinal assigned to the value just after the group, if there is one. Therefore, the smallest ordinal within a BY group is 1, and the largest ordinal is the number of unique, nonmissing values in the BY group.

After the ordinals are assigned, PROC RANK calculates ranks and scores using the number of unique, nonmissing values instead of the number of nonmissing values for scaling. Because of its tendency to distort the cumulative distribution function estimate, dense ranking is not generally acceptable for use in nonparametric statistical tests.

Note that PROC RANK bases its computations on the internal numeric values of the analysis variables. The procedure does not format or round these values before analysis. When values differ in their internal representation, even slightly, PROC RANK does not treat them as tied values. If this is a concern for your data, then round the analysis variables by an appropriate amount before invoking PROC RANK. For information about the ROUND function, see “ROUND Function” in *SAS Functions and CALL Routines: Reference*.

In-Database Processing for PROC RANK

In-database processing has several advantages over processing within SAS. These advantages include increased security, reduced network traffic, and the potential for faster processing. Increased security is possible because sensitive data does not have to be extracted from the DBMS.

Faster processing is possible for the following reasons:

- Data is manipulated locally, on the DBMS, using high-speed secondary storage devices instead of being transported across a relatively slow network connection.
- The DBMS might have more processing resources at its disposal.
- The DBMS might be capable of optimizing a query for execution in a highly parallel and scalable fashion.

In-database processing for PROC RANK supports the following database management systems:

- Amazon Redshift
- Aster
- DB2
- Google BigQuery
- Greenplum
- Hadoop
- HAWQ
- Impala
- Microsoft SQL Server
- Netezza
- Oracle
- PostgreSQL
- SAP HANA
- Snowflake
- Teradata
- Vertica
- Yellowbrick

Note: When using the Google BigQuery data source, columns in the BY statement in PROC RANK cannot be of data type FLOAT64 for in-database processing.

The presence of table statistics might affect the performance of the RANK procedure's in-database processing. If your DBMS is not configured to automatically generate table statistics, then manual generation of table statistics might be necessary to achieve acceptable in-database performance.

Note: For DB2, generation of table statistics (either automatic or manual) is highly recommended for all but the smallest input tables.

If the RANK procedure's input data set is a table or view that resides within a database from which rows would normally be retrieved with the SAS/ACCESS interface to a supported DBMS, then PROC RANK can perform much or all of its work within the DBMS. There are several other factors that determine whether such in-database processing can occur. In-database processing will not occur in the following circumstances:

- if the RENAME= data set option is specified on the input data set.
- if a WHERE statement appears in the context of the RANK procedure or a WHERE= data set option is specified on the input data set, and the WHERE statement or option contains a reference to a SAS function that has no equivalent in the DBMS or a format that has not been installed for use by SAS within the DBMS.
- if any variable specified in a BY statement has an associated format. Formatted BY variables are not supported by PROC RANK for in-database processing.
- if a FORMAT statement appears within the procedure context and applies to a variable specified in a BY statement, then in-database processing cannot be performed. Formatted BY variables are not supported by RANK for in-database processing. With a DBMS, formats can be associated with variables only if a FORMAT or ATTRIB statement appears within the procedure context.
- The TIES=CONDENSE option is not supported for the RANK procedure's in-database processing in an Oracle DBMS. If you use this option, it will prevent SQL generation and execution of in-database processing.

When PROC RANK can process data within the DBMS, it generates an SQL query. The structure of the SQL query that is generated during an in-database invocation of PROC RANK depends on several factors, including these:

- the target DBMS
- the ranking methods that are used
- the number of variables that are ranked
- the inclusion of BY and WHERE statements
- the PROC RANK options that are used, such as TIES= and DESCENDING

The SQL query expresses the required calculations and is submitted to the DBMS. The results of this query will either remain as a new table within the DBMS if the output of the RANK procedure is directed there, or it will be returned to SAS. The settings for the MSGLEVEL option and the SQLGENERATION option determine whether messages will be printed to the SAS log, which indicates whether in-database processing was performed. Generated SQL can be examined by setting the SQL_IP_TRACE option or the SASTRACE= option. SQL_IP_TRACE shows the SQL that is generated by PROC RANK. For more information, see the SASTRACE=

option in *SAS/ACCESS for Relational Databases: Reference* or the SQL_IP_TRACE option in *SAS(R) Analytics Accelerator 1.3 for Teradata: Guide*.

For more information about the settings for system options, library options, data set options, and statement options that affect in-database performance for SAS procedures, see the SQLGENERATION= LIBNAME Option and the SQLGENERATION= option in *SAS/ACCESS for Relational Databases: Reference*.

Syntax: RANK Procedure

Tips:

You can use the ATTRIB, FORMAT, LABEL, and WHERE statements with the RANK procedure. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

You can also use any global statement. For a list, see "Global Statements" on page 25 and "Dictionary of SAS Global Statements" in *SAS Global Statements: Reference*.

For in-database processing to occur, your data must reside within a supported version of the DBMS that has been properly configured for SAS in-database processing. For more information, see "In-Database Processing for PROC RANK" on page 2006.

PROC RANK <*options*>;

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

VAR *data-set-variables(s)*;

RANKS *new-variables(s)*;

Statement	Task	Example
PROC RANK	Compute the ranks for one or more numeric variables in a SAS data set and writes the ranks to a new SAS data set	Ex. 1, Ex. 2, Ex. 3
BY	Calculate a separate set of ranks for each BY group	Ex. 2, Ex. 3
RANKS	Identify a variable to which the ranks are assigned	Ex. 1, Ex. 2
VAR	Specify the variables to rank	Ex. 1, Ex. 2, Ex. 3

PROC RANK Statement

Computes the ranks for one or more numeric variables.

Restrictions: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Only one ranking method can be specified in a single PROC RANK step.

Examples: "Example 1: Ranking Values of Multiple Variables" on page 2017

"Example 2: Ranking Values within BY Groups" on page 2019

"Example 3: Partitioning Observations into Groups Based on Ranks" on page 2022

Syntax

PROC RANK <*options*>;

Summary of Optional Arguments

Compute fractional ranks

NPLUS1
: computes fractional ranks by dividing each rank by the denominator *n*+1.

Create an output data set

OUT=*SAS-data-set*
: names the output data set.

Preserve values

PRESERVERAWBYVALUES
: preserves raw values of all BY variables.

Reverse the order of the rankings

DESCENDING
: reverses the direction of the ranks.

Specify how to rank tied values

TIES=HIGH | LOW | MEAN | DENSE
: specifies how to compute normal scores or ranks for tied data values.

Specify the input data set

DATA=*SAS-data-set*
: specifies the input SAS data set.

Specify the ranking method

FRACTION

computes fractional ranks by dividing each rank by the number of observations having nonmissing values of the ranking variable.

GROUPS=*number-of-groups*
assigns group values ranging from 0 to *number-of-groups* minus 1.

NORMAL=BLOM | TUKEY | VW
computes normal scores from the ranks.

PERCENT
calculates the percentage of observations with nonmissing values in the rank.

SAVAGE
computes Savage (or exponential) scores from the ranks.

Optional Arguments

DATA=*SAS-data-set*
specifies the input SAS data set.

Restrictions You cannot use PROC RANK with an engine that supports concurrent access if another user is updating the data set at the same time.

For in-database processing to occur, the data set specification must refer to a table that resides on a supported DBMS.

See "Input Data Sets" on page 26

DESCENDING
reverses the direction of the ranks. With DESCENDING, the largest value receives a rank of 1, the next largest value receives a rank of 2, and so on. Otherwise, values are ranked from smallest to largest.

See "Example 1: Ranking Values of Multiple Variables" on page 2017

"Example 2: Ranking Values within BY Groups" on page 2019

FRACTION
computes fractional ranks by dividing each rank by the number of observations having nonmissing values of the ranking variable.

Alias F

Interaction TIES=HIGH is the default with the FRACTION option. With TIES=HIGH, fractional ranks are considered values of a right-continuous, empirical cumulative distribution function.

See NPLUS1 option

GROUPS=*number-of-groups*
assigns group values ranging from 0 to *number-of-groups* minus 1. Common specifications are GROUPS=100 for percentiles, GROUPS=10 for deciles, and GROUPS=4 for quartiles. For example, GROUPS=4 partitions the original values into four groups. The smallest values receive, by default, a quartile value of 0 and the largest values receiving a quartile value of 3.

The formula for calculating group values is as follows:

$$\mathrm{FLOOR}(rank * k/(n+1))$$

FLOOR is the FLOOR function, *rank* is the value's order rank, *k* is the value of GROUPS=, and *n* is the number of observations having nonmissing values of the ranking variable for TIES=LOW, TIES=MEAN, and TIES=HIGH. For TIES=DENSE, *n* is the number of observations that have unique nonmissing values.

If the number of observations is evenly divisible by the number of groups, each group has the same number of observations, provided there are no tied values at the boundaries of the groups. Grouping observations by a variable that has many tied values can result in unbalanced groups because PROC RANK always assigns observations with the same value to the same group.

Tip Use DESCENDING to reverse the order of the group values.

See "Example 3: Partitioning Observations into Groups Based on Ranks" on page 2022

NORMAL=BLOM | TUKEY | VW

computes normal scores from the ranks. The resulting variables appear normally distributed. *n* is the number of observations that have nonmissing values of the ranking variable for TIES=LOW, TIES=MEAN, and TIES=HIGH. For TIES=DENSE, *n* is the number of observations that have unique nonmissing values. The formulas are as follows:

BLOM

$y_i=\Phi^{-1}((r_i-3/8)/(n+1/4))$

TUKEY

$y_i=\Phi^{-1}((r_i-1/3)/(n+1/3))$

VW

$y_i=\Phi^{-1}((r_i)/(n+1))$

In these formulas, Φ^{-1} is the inverse cumulative normal (PROBIT) function, r_i is the rank of the *i*th observation, and *n* is the number of nonmissing observations for the ranking variable.

VW stands for van der Waerden. With NORMAL=VW, you can use the scores for a nonparametric location test. All three normal scores are approximations to the exact expected order statistics for the normal distribution (also called *normal scores*). The BLOM version appears to fit slightly better than the others (Blom 1958; Tukey 1962).

Restriction Use of the NORMAL= option will prevent in-database processing.

Interaction If you specify the TIES= option, then PROC RANK computes the normal score from the ranks based on non-tied values and applies the TIES= specification to the resulting score.

NPLUS1

computes fractional ranks by dividing each rank by the denominator *n*+1, where *n* is the number of observations that have nonmissing values of the ranking

variable for TIES=LOW, TIES=MEAN, and TIES=HIGH. For TIES=DENSE, *n* is the number of observations that have unique nonmissing values.

Aliases FN1

N1

Interaction TIES=HIGH is the default with the NPLUS1 option.

See FRACTION option

OUT=*SAS-data-set*

names the output data set. If *SAS-data-set* does not exist, PROC RANK creates it. If you omit OUT=, the data set is named using the DATA*n* naming convention.

Interaction When in-database processing is being performed and OUT= also refers to a supported DBMS table, and if both IN= and OUT= reference the same library, then all processing can occur on the DBMS with results directly populating the output table. In this case, no results will be returned to SAS.

PRESERVERAWBYVALUES

preserves raw values of all BY variables. when those variables are propagated to the output data set. If the PRESERVERAWBYVALUES option is not specified, and one BY variable is specified, then a representative value for each BY group is written to the output data set. If multiple BY variables are specified, then a representative set of values for each BY group is written to the output data set.

PERCENT

divides each rank by the number of observations that have nonmissing values of the variable and multiplies the result by 100 to get a percentage. *n* is the number of observations that have nonmissing values of the ranking variable for TIES=LOW, TIES=MEAN, and TIES=HIGH. For TIES=DENSE, *n* is the number of observations that have unique nonmissing values.

Alias P

Interaction TIES=HIGH is the default with the PERCENT option.

Tip You can use PERCENT to calculate cumulative percentages, but you use GROUPS=100 to compute percentiles.

SAVAGE

computes Savage (or exponential) scores from the ranks by the following formula (Lehman 1998):

$$y_i = \left[\sum_{j=n-r_i+1} \left(\frac{1}{j}\right) \right] - 1$$

Interaction If you specify the TIES= option, then PROC RANK computes the Savage score from the ranks based on non-tied values and applies the TIES= specification to the resulting score.

TIES=HIGH | LOW | MEAN | DENSE

specifies how to compute normal scores or ranks for tied data values.

HIGH
assigns the largest of the corresponding ranks (or largest of the normal scores when NORMAL= is specified).

LOW
assigns the smallest of the corresponding ranks (or smallest of the normal scores when NORMAL= is specified).

MEAN
assigns the mean of the corresponding rank (or mean of the normal scores when NORMAL= is specified).

DENSE
computes scores and ranks by treating tied values as a single-order statistic. For the default method, ranks are consecutive integers that begin with the number one and end with the number of unique, nonmissing values of the variable that is being ranked. Tied values are assigned the same rank.

Note: CONDENSE is an alias for DENSE.

Default MEAN (unless the FRACTION option or PERCENT option is in effect).

Interaction If you specify the NORMAL= option, then the TIES= specification applies to the normal score, not to the rank that is used to compute the normal score.

See "Treatment of Tied Values" on page 2004

"Example 1: Ranking Values of Multiple Variables" on page 2017

"Example 2: Ranking Values within BY Groups" on page 2019

BY Statement

Produces a separate set of ranks for each BY group.

Interactions: If the NOTSORTED option is specified in a BY statement, then in-database processing cannot be performed.

Application of a format to any BY variable of the input data set, using a FORMAT statement for example, will prevent in-database processing.

See: "BY" on page 74

"Example 3: Partitioning Observations into Groups Based on Ranks" on page 2022

Examples: "Example 2: Ranking Values within BY Groups" on page 2019

"Example 3: Partitioning Observations into Groups Based on Ranks" on page 2022

Syntax

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, then the observations in the data set must either be sorted by all the variables that you specify or be indexed appropriately. Variables in a BY statement are called *BY variables*.

Note: When using the Google BigQuery data source, columns in the BY statement in PROC RANK cannot be of data type FLOAT64 for in-database processing.

Optional Arguments

DESCENDING
specifies that the observations are sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The observations are grouped in another way, such as chronological order.

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, the procedure treats each contiguous set as a separate BY group.

If you are using a SAS/ACCESS engine, and you specify a BY statement, then the data is always returned in sorted order. If you specify the NOTSORTED option, then it is ignored and in-database processing is performed.

RANKS Statement

Creates new variables for the rank values.

Default: If you omit the RANKS statement, the rank values replace the original variable values in the output data set.

Requirement: If you use the RANKS statement, you must also use the VAR statement.

Examples: "Example 1: Ranking Values of Multiple Variables" on page 2017
"Example 2: Ranking Values within BY Groups" on page 2019

Syntax

RANKS *new-variables(s)*;

Required Argument

new-variable(s)
specifies one or more new variables that contain the ranks for the variable(s) listed in the VAR statement. The first variable listed in the RANKS statement contains the ranks for the first variable listed in the VAR statement. The second variable listed in the RANKS statement contains the ranks for the second variable listed in the VAR statement, and so on.

VAR Statement

Specifies the input variables.

Default: If you omit the VAR statement, PROC RANK computes ranks for all numeric variables in the input data set.

Examples: "Example 1: Ranking Values of Multiple Variables" on page 2017
"Example 2: Ranking Values within BY Groups" on page 2019
"Example 3: Partitioning Observations into Groups Based on Ranks" on page 2022

Syntax

VAR *data-set-variables(s)*;

Required Argument

data-set-variable(s)
specifies one or more variables for which ranks are computed.

Details

Using the VAR Statement with the RANKS Statement

The VAR statement is required when you use the RANKS statement. Using these statements together creates the ranking variables named in the RANKS statement that corresponds to the input variables specified in the VAR statement. If you omit

the RANKS statement, the rank values replace the original values in the output data set.

Results: RANK Procedure

Missing Values

Missing values are not ranked and are left missing when ranks or rank scores replace the original values in the output data set.

Output Data Set

The RANK procedure creates a SAS data set containing the ranks or rank scores but does not create any printed output. You can use PROC PRINT, PROC REPORT, or another SAS reporting tool to print the output data set.

The output data set contains all the variables from the input data set plus the variables named in the RANKS statement. If you omit the RANKS statement, the rank values replace the original variable values in the output data set.

Numeric Precision

For in-database processing, the mathematical operations expressed by the RANK procedure in SQL, and the order in which they are performed, are essentially the same as those performed within SAS. However, in-database processing might result in small numerical differences when compared to results produced directly by SAS.

Examples: RANK Procedure

Example 1: Ranking Values of Multiple Variables

Features:

PROC RANK statement options
- DESCENDING
- TIES=

RANKS statement

VAR statement

PRINT procedure

Details

This example performs the following actions:

- reverses the order of the ranks so that the highest value receives the rank of 1
- assigns the best possible rank to tied values
- creates ranking variables and prints them with the original variables

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

data cake;
   input Name $ 1-10 Present 12-13 Taste 15-16;
   datalines;
Davis      77 84
Orlando    93 80
Ramey      68 72
Roe        68 75
Sanders    56 79
Simms      68 77
Strickland 82 79
;

proc rank data=cake out=order descending ties=low;

   var present taste;
```

```
   ranks PresentRank TasteRank;
run;

proc print data=order;
   title "Rankings of Participants' Scores";
run;
```

Program Description

Set the SAS system options. The NODATE option specifies to omit the date and time at which the SAS job begins. The PAGENO= option specifies the page number for the next page of output that SAS produces. The LINESIZE= option specifies the line size. The PAGESIZE= option specifies the number of lines for a page of SAS output.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Create the CAKE data set. This data set contains each participant's last name, score for presentation, and score for taste in a cake-baking contest.

```
data cake;
   input Name $ 1-10 Present 12-13 Taste 15-16;
   datalines;
Davis      77 84
Orlando    93 80
Ramey      68 72
Roe        68 75
Sanders    56 79
Simms      68 77
Strickland 82 79
;
```

Generate the ranks for the numeric variables in descending order and create the Order output data set. DESCENDING reverses the order of the ranks so that the high score receives the rank of 1. TIES=LOW gives tied values the best possible rank. OUT= creates the Order output data set.

```
proc rank data=cake out=order descending ties=low;
```

Create two new variables that contain ranks. The VAR statement specifies the variables to rank. The RANKS statement creates two new variables, PresentRank and TasteRank, that contain the ranks for the variables Present and Taste, respectively.

```
   var present taste;
   ranks PresentRank TasteRank;
run;
```

Print the data set. PROC PRINT prints the Order data set. The TITLE statement specifies a title.

```
proc print data=order;
   title "Rankings of Participants' Scores";
run;
```

Output: Listing

Output 56.3 *Rankings of Participants' Scores*

Rankings of Participants' Scores 1

Obs	Name	Present	Taste	Present Rank	Taste Rank
1	Davis	77	84	3	1
2	Orlando	93	80	1	2
3	Ramey	68	72	4	7
4	Roe	68	75	4	6
5	Sanders	56	79	7	3
6	Simms	68	77	4	5
7	Strickland	82	79	2	3

Example 2: Ranking Values within BY Groups

Features:

PROC RANK statement options
- DESCENDING
- TIES=

BY statement

RANKS statement

VAR statement

PRINT procedure

Details

This example performs the following actions:

- ranks observations separately within BY groups
- reverses the order of the ranks so that the highest value receives the rank of 1
- assigns the best possible rank to tied values
- creates ranking variables and prints them with the original variables

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

data elect;
   input Candidate $ 1-11 District 13 Vote 15-18 Years 20;
```

```
   datalines;
Cardella    1 1689 8
Latham      1 1005 2
Smith       1 1406 0
Walker      1  846 0
Hinkley     2  912 0
Kreitemeyer 2 1198 0
Lundell     2 2447 6
Thrash      2  912 2
;

proc rank data=elect out=results ties=low descending;

   by district;

   var vote years;
   ranks VoteRank YearsRank;
run;

proc print data=results n;
   by district;
   title 'Results of City Council Election';
run;
```

Program Description

Set the SAS system options. The NODATE option specifies to omit the date and time at which the SAS job begins. The PAGENO= option specifies the page number for the next page of output that SAS produces. The LINESIZE= option specifies the line size. The PAGESIZE= option specifies the number of lines for a page of SAS output.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Create the Elect data set. This data set contains each candidate's last name, district number, vote total, and number of years' experience on the city council.

```
data elect;
   input Candidate $ 1-11 District 13 Vote 15-18 Years 20;
   datalines;
Cardella    1 1689 8
Latham      1 1005 2
Smith       1 1406 0
Walker      1  846 0
Hinkley     2  912 0
Kreitemeyer 2 1198 0
Lundell     2 2447 6
Thrash      2  912 2
;
```

Generate the ranks for the numeric variables in descending order and create the Results output data set. DESCENDING reverses the order of the ranks so that the highest vote total receives the rank of 1. TIES=LOW gives tied values the best possible rank. OUT= creates the Results output data set.

```
proc rank data=elect out=results ties=low descending;
```

Create a separate set of ranks for each BY group. The BY statement separates the rankings by values of District.

```
   by district;
```

Create two new variables that contain ranks. The VAR statement specifies the variables to rank. The RANKS statement creates the new variables, VoteRank and YearsRank, that contain the ranks for the variables Vote and Years, respectively.

```
   var vote years;
   ranks VoteRank YearsRank;
run;
```

Print the data set. PROC PRINT prints the Results data set. The N option prints the number of observations in each BY group. The TITLE statement specifies a title.

```
proc print data=results n;
   by district;
   title 'Results of City Council Election';
run;
```

Output: Listing

In the following output, Hinkley and Thrash tied with 912 votes in the second district. They both receive a rank of 3 because TIES=LOW.

Output 56.4 *Results of City Council Election*

```
                    Results of City Council Election                    1

---------------------------------- District=1 ----------------------------------

                                                 Vote    Years
              Obs    Candidate    Vote    Years  Rank     Rank

               1     Cardella     1689      8      1       1
               2     Latham       1005      2      3       2
               3     Smith        1406      0      2       3
               4     Walker        846      0      4       3

                              N = 4


---------------------------------- District=2 ----------------------------------

                                                  Vote    Years
             Obs    Candidate      Vote    Years  Rank     Rank

              5     Hinkley         912      0      3       3
              6     Kreitemeyer    1198      0      2       3
              7     Lundell        2447      6      1       1
              8     Thrash          912      2      3       2

                              N = 4
```

Example 3: Partitioning Observations into Groups Based on Ranks

Features:

PROC RANK statement option
GROUPS=

BY statement

VAR statement

PRINT procedure

SORT procedure

Details

This example performs the following actions:

- partitions observations into groups on the basis of values of two input variables
- groups observations separately within BY groups
- replaces the original variable values with the group values

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

data swim;
   input Name $ 1-7 Gender $ 9 Back 11-14 Free 16-19;
   datalines;
Andrea  F 28.6 30.3
Carole  F 32.9 24.0
Clayton M 27.0 21.9
Curtis  M 29.0 22.6
Doug    M 27.3 22.4
Ellen   F 27.8 27.0
Jan     F 31.3 31.2
Jimmy   M 26.3 22.5
Karin   F 34.6 26.2
Mick    M 29.0 25.4
Richard M 29.7 30.2
Sam     M 27.2 24.1
Susan   F 35.1 36.1
;

proc sort data=swim out=pairs;
   by gender;
run;
```

```
proc rank data=pairs out=rankpair groups=3;
   by gender;
   var back free;
run;
proc print data=rankpair n;
   by gender;
   title 'Pairings of Swimmers for Backstroke and Freestyle';
run;
```

Program Description

Set the SAS system options. The NODATE option specifies to omit the date and time at which the SAS job began. The PAGENO= option specifies the page number for the next page of output that SAS produces. The LINESIZE= option specifies the line size. The PAGESIZE= option specifies the number of lines for a page of SAS output.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Create the Swim data set. This data set contains swimmers' first names and their times, in seconds, for the backstroke and the freestyle. This example groups the swimmers into pairs, within male and female classes, based on times for both strokes so that every swimmer is paired with someone who has a similar time for each stroke.

```
data swim;
   input Name $ 1-7 Gender $ 9 Back 11-14 Free 16-19;
   datalines;
Andrea  F 28.6 30.3
Carole  F 32.9 24.0
Clayton M 27.0 21.9
Curtis  M 29.0 22.6
Doug    M 27.3 22.4
Ellen   F 27.8 27.0
Jan     F 31.3 31.2
Jimmy   M 26.3 22.5
Karin   F 34.6 26.2
Mick    M 29.0 25.4
Richard M 29.7 30.2
Sam     M 27.2 24.1
Susan   F 35.1 36.1
;
```

Sort the Swim data set and create the Pairs output data set. PROC SORT sorts the data set by Gender. This action is required to obtain a separate set of ranks for each group. OUT= creates the Pairs output data set.

```
proc sort data=swim out=pairs;
   by gender;
run;
```

Generate the ranks that are partitioned into three groups and create an output data set. GROUPS=3 assigns one of three possible group values (0,1,2) to each swimmer for each stroke. OUT= creates the Rankpair output data set.

```
proc rank data=pairs out=rankpair groups=3;
```

Create a separate set of ranks for each BY group. The BY statement separates the rankings by Gender.

```
   by gender;
```

Replace the original values of the variables with the rank values. The VAR statement specifies that Back and Free are the variables to rank. With no RANKS statement, PROC RANK replaces the original variable values with the group values in the output data set.

```
   var back free;
run;
```

Print the data set. PROC PRINT prints the Rankpair data set. The N option prints the number of observations in each BY group. The TITLE statement specifies a title.

```
proc print data=rankpair n;
   by gender;
   title 'Pairings of Swimmers for Backstroke and Freestyle';
run;
```

Output: Listing

In the following output, the group values pair swimmers with similar times to work on each stroke. For example, Andrea and Ellen work together on the backstroke because they have the fastest times in the female class. The groups of male swimmers are unbalanced because there are seven male swimmers; for each stroke, one group has three swimmers.

Output 56.5 *Pairings of Swimmers for Backstroke and Freestyle*

Pairings of Swimmers for Backstroke and Freestyle 1

Gender=F

Obs	Name	Back	Free
1	Andrea	0	1
2	Carole	1	0
3	Ellen	0	1
4	Jan	1	2
5	Karin	2	0
6	Susan	2	2

N = 6

Gender=M

Obs	Name	Back	Free
7	Clayton	0	0
8	Curtis	2	1
9	Doug	1	0
10	Jimmy	0	1
11	Mick	2	2
12	Richard	2	2
13	Sam	1	1

N = 7

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REGISTRY Procedure

Overview: REGISTRY Procedure

What Does the REGISTRY Procedure Do?

The REGISTRY procedure maintains the SAS registry. The registry consists of two parts. One part is stored in the Sashelp library, and the other part is stored in the Sasuser library.

The REGISTRY procedure enables you to do the following:

- Import registry files to populate the Sashelp and Sasuser registries.

- Export all or part of the registry to another file.
- List the contents of the registry in the SAS log.
- Compare the contents of the registry to a file.
- Uninstall a registry file.
- Deliver detailed status information when a key or value will be overwritten or uninstalled.
- Clear out entries in the Sasuser registry.
- Validate that the registry exists.
- List diagnostic information.

For more information, see "The SAS Registry" in *SAS Language Reference: Concepts*.

Syntax: REGISTRY Procedure

PROC REGISTRY <*options*>;

Statement	Task	Example
PROC REGISTRY	Manage registry files	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6

PROC REGISTRY Statement

Maintains the SAS registry.

Examples:

"Example 1: Importing a File to the SAS Registry" on page 2038
"Example 3: Comparing the Registry to an External File" on page 2040
"Example 2: Listing and Exporting the Registry File" on page 2039
"Example 4: Comparing Registry Files" on page 2042
"Example 5: Specifying an Entire Key Sequence with the STARTAT= Option" on page 2043
"Example 6: Displaying a List of Fonts" on page 2044

Syntax

PROC REGISTRY <*options*>;

Summary of Optional Arguments

CLEARSASUSER
: erases from the Sasuser registry the keys that were added by a user.

COMPAREREG1='*libname.registry-name-1*'
: compares two registry files.

COMPAREREG2='*libname.registry-name-2*'
: compares two registry files.

COMPARETO=*file-specification*
: compares the contents of a registry to a file.

DEBUGOFF
: disables registry debugging.

DEBUGON
: enables registry debugging.

EXPORT=*file-specification*
: writes the contents of a registry to the specified file.

FOLLOWLINKS
: follows links that are found when processing the LIST command.

FULLSTATUS
: provides additional information in the SAS log about the results of the IMPORT= and UNINSTALL= options.

IMPORT=*file-specification*
: imports the specified file to a registry.

KEYSONLY
: limits the LIST, LISTUSER, LISTHELP, and LISTREG options output to display keys only.

LEVELS=*n*
: limits the number of levels to display for the LIST, LISTUSER, LISTHELP, and LISTREG options.

LIST
: writes the contents of the registry to the SAS log. This option is used with the STARTAT= option to list specific keys.

LISTHELP
: writes the contents of the Sashelp portion of the registry to the SAS log.

LISTREG='*libname.registry-name*'
: sends the contents of a registry to the log.

LISTUSER
: writes the contents of the Sasuser portion of the registry to the SAS log.

STARTAT='*key-name*'
: starts exporting or writing or comparing the contents of a registry at the specified key.

UNINSTALL=*file-specification*
: deletes from the specified registry all the keys and values that are in the specified file.

UPCASE
: uses uppercase for all incoming key names.

UPCASEALL

uses uppercase for all keys, names, and item values when you import a file.

USESASHELP
performs the specified operation on the Sashelp portion of the SAS registry.

Optional Arguments

CLEARSASUSER
erases from the Sasuser portion of the SAS registry the keys that were added by a user.

COMPAREREG1='*libname.registry-name-1*'
specifies one of two registries to compare. The results appear in the SAS log.

libname
is the name of the library in which the registry file resides.

registry-name-1
is the name of the first registry.

Requirement COMPAREREG1 must be used with COMPAREREG2.

Interaction To specify a single key and all of its subkeys, specify the STARTAT= option.

Example "Example 4: Comparing Registry Files" on page 2042

COMPAREREG2='*libname.registry-name-2*'
specifies the second of two registries to compare. The results appear in the SAS log.

libname
is the name of the library in which the registry file resides.

registry-name-2
is the name of the second registry.

Requirement COMPAREREG2 must be used with COMPAREREG1.

Example "Example 4: Comparing Registry Files" on page 2042

COMPARETO=*file-specification*
compares the contents of a file that contains registry information to a registry. It returns information about keys and values that it finds in the file that are not in the registry. It reports the following items as differences:

- keys that are defined in the external file but not in the registry
- value names for a given key that are in the external file but not in the registry
- differences in the content of like-named values in like-named keys

COMPARETO= does not report as differences any keys and values that are in the registry but not in the file because the registry could easily be composed of pieces from many different files.

File-specification is one of the following values:

'external-file'
is the path and name of an external file that contains the registry information.

fileref
is a fileref that has been assigned to an external file.

Requirement You must have previously associated the fileref with an external file in a FILENAME statement, a FILENAME function, the Explorer window, or an appropriate operating environment command.

Interaction By default, PROC REGISTRY compares *file-specification* to the Sasuser portion of the registry. To compare *file-specification* to the Sashelp portion of the registry, specify the option USESASHELP.

See Usage: REGISTRY Procedure on page 2034 for information about how to structure a file that contains registry information

Example "Example 3: Comparing the Registry to an External File" on page 2040

DEBUGON
enables registry debugging by providing more descriptive log entries.

DEBUGOFF
disables registry debugging.

EXPORT=*file-specification*
writes the contents of a registry to the specified file, where *file-specification* is one of the following values:

'external-file'
is the name of an external file that contains the registry information.

fileref
is a fileref that has been assigned to an external file.

Requirement You must have previously associated the fileref with an external file in a FILENAME statement, a FILENAME function, the Explorer window, or an appropriate operating environment command.

If *file-specification* already exists, then PROC REGISTRY overwrites it. Otherwise, PROC REGISTRY creates the file.

Interactions By default, EXPORT= writes the Sasuser portion of the registry to the specified file. To write the Sashelp portion of the registry, specify the USESASHELP option. You must have Write permission to the Sashelp library to use USESASHELP.

To export a single key and all of its subkeys, specify the STARTAT= option.

Example "Example 2: Listing and Exporting the Registry File" on page 2039

FOLLOWLINKS
follows links that are found when processing the LIST option.

Normally the LIST option displays the values of the link items. If you use the FOLLOWLINKS option, the links are treated as keys, and items contained in the links are displayed.

FULLSTATUS
lists the keys, subkeys, and values that were added or deleted as a result of running the IMPORT= and UNINSTALL options.

IMPORT=*file-specification*
specifies the file to import into the SAS registry. PROC REGISTRY does not overwrite the existing registry. Instead, it updates the existing registry with the contents of the specified file.

Note: The .sasxreg file extension is not required.

File-specification is one of the following values:

'external-file'
is the path and name of an external file that contains the registry information.

fileref
is a fileref that has been assigned to an external file.

Requirement You must have previously associated the fileref with an external file in a FILENAME statement, a FILENAME function, the Explorer window, or an appropriate operating environment command.

Interactions By default, IMPORT= imports the file to the Sasuser portion of the SAS registry. To import the file to the Sashelp portion of the registry, specify the USESASHELP option. You must have Write permission to Sashelp to use USESASHELP.

To obtain additional information in the SAS log as you import a file, use FULLSTATUS.

See Usage: REGISTRY Procedure on page 2034 for information about how to structure a file that contains registry information

Example “Example 1: Importing a File to the SAS Registry” on page 2038

KEYSONLY
limits the LIST, LISTUSER, LISTHELP, and LISTREG options output to display keys only.

LEVELS=*n*
limits the number of levels to display for the LIST, LISTUSER, LISTHELP, and LISTREG options.

Requirement LEVEL ≥ 1. LEVELS=0 behaves as if LEVELS was not specified.

LIST
writes the contents of the entire SAS registry to the SAS log.

Interaction To write a single key and all of its subkeys, use the STARTAT= option.

LISTHELP
writes the contents of the Sashelp portion of the registry to the SAS log.

Interaction To write a single key and all of its subkeys, use the STARTAT= option.

LISTREG='*libname.registry-name*'
lists the contents of the specified registry in the log.

libname
is the name of the library in which the registry file resides.

registry-name
is the name of the registry.

Here is an example:

```
proc registry listreg='sashelp.regstry';
run;
```

Interaction To list a single key and all of its subkeys, use the STARTAT= option.

LISTUSER
writes the contents of the Sasuser portion of the registry to the SAS log.

Interaction To write a single key and all of its subkeys, use the STARTAT= option.

Example "Example 2: Listing and Exporting the Registry File" on page 2039

STARTAT='*key-name*'
exports or writes the contents of a single key and all of its subkeys.

You must specify an entire key sequence if you want to start listing at any subkey under the root key.

Interaction Use STARTAT= with the EXPORT=, LIST, LISTHELP, LISTUSER, COMPAREREG1=, COMPAREREG2= and the LISTREG options.

Example "Example 4: Comparing Registry Files" on page 2042

UNINSTALL=*file-specification*
deletes from the specified registry all the keys and values that are in the specified file.

File-specification is one of the following values:

'external-file'
is the name of an external file that contains the keys and values to delete.

fileref
is a fileref that has been assigned to an external file. To assign a fileref, you can do the following:

- use the Explorer Window
- use the "FILENAME Statement" in *SAS Global Statements: Reference*

Interactions By default, UNINSTALL deletes the keys and values from the Sasuser portion of the SAS registry. To delete the keys and values from the Sashelp portion of the registry, specify the USESASHELP option. You must have Write permission to Sashelp to use this option.

Use FULLSTATUS to obtain additional information in the SAS log as you uninstall a registry.

See Usage: REGISTRY Procedure on page 2034 for information about how to structure a file that contains registry information

UPCASE
uses uppercase for all incoming key names.

UPCASEALL
uses uppercase for all keys, names, and item values when you import a file.

USESASHELP
performs the specified operation on the Sashelp portion of the SAS registry.

Interaction Use USESASHELP with the IMPORT=, EXPORT=, COMPARETO, or UNINSTALL option. To use USESASHELP with IMPORT= or UNINSTALL, you must have Write permission to Sashelp.

Usage: REGISTRY Procedure

Structure of a Registry File

You can create registry files with the SAS Registry Editor or with any text editor.

A registry file must have a particular structure. Each entry in the registry file consists of a key name, followed on the next line by one or more values. The key name identifies the key or subkey that you are defining. Any values that follow specify the names or data to associate with the key.

Specifying Key Names

Key names are entered on a single line between square brackets ([and]). To specify a subkey, enter multiple key names between the brackets, starting with the root key. Separate the names in a sequence of key names with a backslash (\). The length of a single key name or a sequence of key names cannot exceed 255 characters (including the square brackets and the backslashes). Key names can contain any character except the backslash.

Examples of valid key name sequences follow. These sequences are typical of the SAS registry:

- [CORE\EXPLORER\MENUS\ENTRIES\CLASS]
- [CORE\EXPLORER\NEWMEMBER\CATALOG]
- [CORE\EXPLORER\NEWENTRY\CLASS]
- [CORE\EXPLORER\ICONS\ENTRIES\LOG]

Specifying Values for Keys

Enter each value on the line that follows the key name that it is associated with. You can specify multiple values for each key, but each value must be on a separate line.

The general form of a value is:

value-name=value-content

A *value-name* can be an at sign (@), which indicates the default value name, or it can be any text string in double quotation marks. If the text string contains an ampersand (&), then the character (either uppercase or lowercase) that follows the ampersand is a shortcut for the value name. For more information, see "Sample Registry Entries" on page 2036.

The entire text string cannot contain more than 255 characters (including quotation marks and ampersands). It can contain any character except a backslash (\).

Value-content can be any of the following:

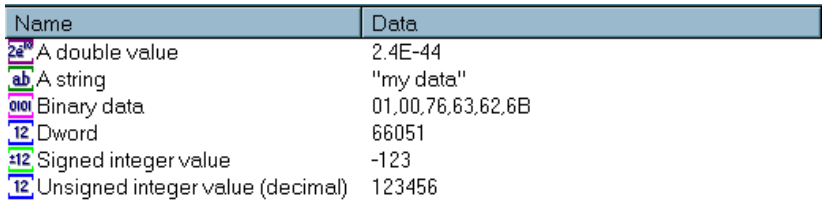
- the string **`double:`** followed by a numeric value.
- a string. You can put any character inside the quotation marks, including nothing ("").

  Note: To include a backslash in the string that is enclosed in quotation marks, use two adjacent backslashes. To include a double quotation mark, use two adjacent double quotation marks.

- the string **hex:** followed by any number of hexadecimal characters, up to the 255-character limit, separated by commas. If you extend the hexadecimal characters beyond a single line, then end the line with a backslash to indicate that the data continues on the next line. Hexadecimal values can also be referred to as "binary values" in the Registry Editor.
- the string **dword:** followed by an unsigned long hexadecimal value.
- the string **int:** followed by a signed long integer value.
- the string **uint:** followed by an unsigned long integer value.

The following display shows how the different types of values that are described above appear in the Registry Editor:

Figure 57.1 *Types of Registry Values, Displayed in the Registry Editor*



The following list contains a sample of valid registry values:

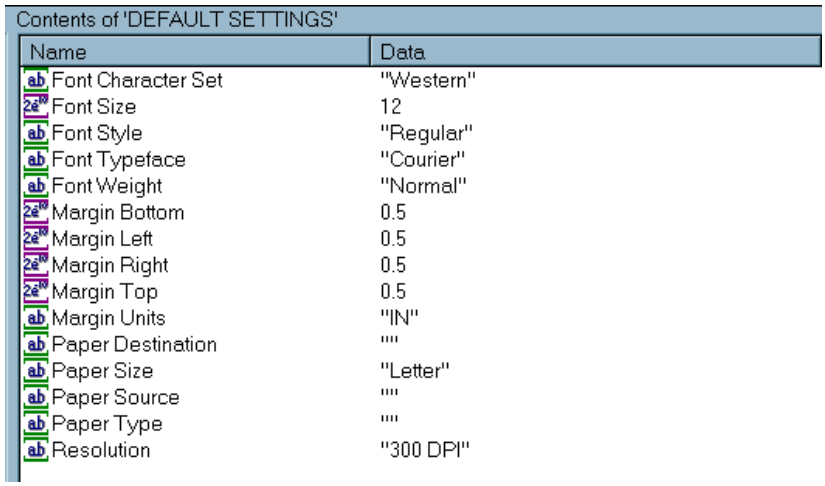
- a double value=double:2.4E-44
- a string="my data"
- binary data=hexadecimal: 01,00,76,63,62,6B
- dword=dword:00010203
- signed integer value=int:-123
- unsigned integer value (decimal)=dword:0001E240

Sample Registry Entries

Registry entries can vary in content and appearance, depending on their purpose.

The following display shows a registry entry that contains default PostScript printer settings:

Figure 57.2 *Portion of a Registry Editor Showing Settings for a PostScript Printer*



To see what the actual registry text file looks like, you can use PROC REGISTRY to write the contents of the registry key to the SAS log, using the LISTUSER and STARTAT= options.

The following example shows the syntax for sending a Sasuser registry entry to the log:

```
proc registry
     listuser
     startat='sasuser-registry-key-name';
run;
```

The following example shows a value for the STARTAT= option:

```
proc registry
     listuser
     startat='HKEY_SYSTEM_ROOT\CORE\PRINTING\PRINTERS\PostScript
\DEFAULT
SETTINGS';
run;
```

In the following example, the list of subkeys begins at the CORE\PRINTING\PRINTERS\PostScript\DEFAULT SETTINGS key.

Example Code 57.1 *A Registry Entry for a PostScript Printer*

```
NOTE: Contents of SASUSER REGISTRY starting at subkey [CORE\
PRINTING\PRINTERS\PostScript\DEFAULT SETTINGS key]

  Font Character Set="Western"
  Font Size=double:12
  Font Style="Regular"
  Font Typeface="Courier"
  Font Weight="Normal"
  Margin Bottom=double:0.5
  Margin Left=double:0.5
  Margin Right=double:0.5
  Margin Top=double:0.5
  Margin Units="IN"
  Paper Destination=""
  Paper Size="Letter"
  Paper Source=""
  Paper Type=""
  Resolution="300 DPI"
```

Examples: REGISTRY Procedure

Example 1: Importing a File to the SAS Registry

Features: IMPORT=
FILENAME statement

Details

This example imports a file into the Sasuser portion of the SAS registry. The following source file contains examples of valid key name sequences in a registry file:

```
[HKEY_USER_ROOT\AllGoodPeopleComeToTheAidOfTheirCountry]
 @="This is a string value"
  "Value2"=""
  "Value3"="C:\\This\\Is\\Another\\String\\Value"
```

Program

```
filename source 'external-file';

proc registry import=source;
run;
```

Program Description

Assign a fileref to a file that contains valid text for the registry. The FILENAME statement assigns the fileref SOURCE to the external file that contains the text to read into the registry.

```
filename source 'external-file';
```

Invoke PROC REGISTRY to import the file that contains input for the registry. PROC REGISTRY reads the input file that is identified by the fileref SOURCE. IMPORT= writes to the Sasuser portion of the SAS registry by default.

```
proc registry import=source;
run;
```

Log

Example Code 57.2 *Results from Importing a File to the SAS Registry*

```
Parsing REG file and loading the registry please wait....
Registry IMPORT is now complete.
```

Example 2: Listing and Exporting the Registry File

Features: EXPORT=
LISTUSER

Details

The registry file is usually very large. To export a portion of the registry, use the STARTAT= option.

This example lists the Sasuser portion of the SAS registry and exports it to an external file.

Program

```
proc registry
   listuser
   export='external-file';
run;
```

Program Description

Write the contents of the Sasuser portion of the registry to the SAS log. The LISTUSER option causes PROC REGISTRY to write the entire Sasuser portion of the registry to the log.

```
proc registry
   listuser
```

Export the registry to the specified file. The EXPORT= option writes a copy of the Sasuser portion of the SAS registry to the external file.

```
   export='external-file';
run;
```

Log

Example Code 57.3 *Results from Listing and Exporting a SAS Registry File*

```
Starting to write out the registry file, please wait...
The export to file external-file is now complete.
Contents of SASUSER REGISTRY.
[  HKEY_USER_ROOT]
[    CORE]
[      EXPLORER]
[        CONFIGURATION]
        Initialized= "True"
[        FOLDERS]
[          UNXHOST1]
          Closed= "658"
          Icon= "658"
          Name= "Home Directory"
          Open= "658"
          Path= "~"
```

Example 3: Comparing the Registry to an External File

Features: COMPARETO= option

FILENAME statement

Details

This example compares the Sasuser portion of the SAS registry to an external file. Comparisons such as this one are useful if you want to know the difference between a backup file that was saved with a .txt file extension and the current registry file.

To compare the Sashelp portion of the registry with an external file, specify the USESASHELP option.

This SAS log shows two differences between the Sasuser portion of the registry and the specified external file. In the registry, the value of "Initialized" is "True"; in the external file, it is "False". In the registry, the value of "Icon" is "658"; in the external file it is "343".

Program

```
filename testreg 'external-file';

proc registry
   compareto=testreg;
run;
```

Program Description

Assign a fileref to the external file that contains the text to compare to the registry. The FILENAME statement assigns the fileref TESTREG to the external file.

```
filename testreg 'external-file';
```

Compare the specified file to the Sasuser portion of the SAS registry. The COMPARETO option compares the contents of a file to a registry. It returns information about keys and values that it finds in the file that are not in the registry.

```
proc registry
   compareto=testreg;
run;
```

Log

Example Code 57.4 *Results from Comparing the Registry to an External File*

```
Parsing REG file and comparing the registry please wait....
COMPARE DIFF: Value "Initialized" in
[HKEY_USER_ROOT\CORE\EXPLORER\CONFIGURATION]: REGISTRY TYPE=STRING, CURRENT
VALUE="True"
COMPARE DIFF: Value "Initialized" in
[HKEY_USER_ROOT\CORE\EXPLORER\CONFIGURATION]: FILE TYPE=STRING, FILE
VALUE="False"
COMPARE DIFF: Value "Icon" in
[HKEY_USER_ROOT\CORE\EXPLORER\FOLDERS\UNXHOST1]: REGISTRY TYPE=STRING,
CURRENT VALUE="658"
COMPARE DIFF: Value "Icon" in
[HKEY_USER_ROOT\CORE\EXPLORER\FOLDERS\UNXHOST1]: FILE TYPE=STRING, FILE
VALUE="343"
Registry COMPARE is now complete.
COMPARE: There were differences between the registry and the file.
```

Example 4: Comparing Registry Files

Features: COMPAREREG1= and COMPAREREG2= options
STARTAT= option

Details

This example uses the REGISTRY procedure options COMPAREREG1= and COMPAREREG2= to specify two registry files for comparison.

Program

```
libname proclib 'SAS-library';
proc registry compareregl='sasuser.regstry'
   startat='CORE\EXPLORER'
   compareregl='proclib.regstry';
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library contains a registry file.

```
libname proclib 'SAS-library';
```

Start PROC REGISTRY and specify the first registry file to be used in the comparison.

```
proc registry comparereg1='sasuser.regstry'
```

Limit the comparison to the registry keys including and following the specified registry key. The STARTAT= option limits the scope of the comparison to the EXPLORER subkey under the CORE key. By default the comparison includes the entire contents of both registries.

```
   startat='CORE\EXPLORER'
```

Specify the second registry file to be used in the comparison.

```
   comparereg2='proclib.regstry';
run;
```

Log

Example Code 57.5 *Results from Comparing Two Registry Files*

```
NOTE: Comparing registry SASUSER.REGSTRY to registry PROCLIB.REGSTRY
NOTE: Diff in Key (CORE\EXPLORER\MENUS\FILES\SAS) Item (1;&Open)
SASUSER.REGSTRY Type: String len  17 data PGM;INCLUDE '%s';
PROCLIB.REGSTRY Type: String len  15 data WHOSTEDIT '%s';

NOTE: Diff in Key (CORE\EXPLORER\MENUS\FILES\SAS) Item (3;&Submit)
SASUSER.REGSTRY Type: String len  23 data PGM;INCLUDE '%s';SUBMIT
PROCLIB.REGSTRY Type: String len  21 data WHOSTEDIT '%s';SUBMIT

NOTE: Diff in Key (CORE\EXPLORER\MENUS\FILES\SAS) Item (4;&Remote Submit)
SASUSER.REGSTRY Type: String len  35 data SIGNCHECK;PGM;INCLUDE '%s';RSUBMIT;
PROCLIB.REGSTRY Type: String len  33 data SIGNCHECK;WHOSTEDIT '%s';RSUBMIT;

NOTE: Diff in Key (CORE\EXPLORER\MENUS\FILES\SAS) Item (@)
SASUSER.REGSTRY Type: String len  17 data PGM;INCLUDE '%s';
PROCLIB.REGSTRY Type: String len  15 data WHOSTEDIT '%s';

NOTE: Item (2;Open with &Program Editor) in key
      (CORE\EXPLORER\MENUS\FILES\TXT) not found in registry PROCLIB.REGSTRY
NOTE: Diff in Key (CORE\EXPLORER\MENUS\FILES\TXT) Item (4;&Submit)
SASUSER.REGSTRY Type: String len  24 data PGM;INCLUDE '%s';SUBMIT;
PROCLIB.REGSTRY Type: String len  22 data WHOSTEDIT '%s';SUBMIT;

NOTE: Diff in Key (CORE\EXPLORER\MENUS\FILES\TXT) Item (5;&Remote Submit)
SASUSER.REGSTRY Type: String len  35 data SIGNCHECK;PGM;INCLUDE '%s';RSUBMIT;
PROCLIB.REGSTRY Type: String len  33 data SIGNCHECK;WHOSTEDIT '%s';RSUBMIT;
```

Example 5: Specifying an Entire Key Sequence with the STARTAT= Option

Features: EXPORT option

STARTAT= option

Details

The following example shows how to use the STARTAT= option. You must specify an entire key sequence if you want to start listing any subkey under the root key. The root key is optional.

Program

```
proc registry export = my-fileref
startat='core\explorer\icons';
run;
```

Example 6: Displaying a List of Fonts

Features: LISTHELP option
STARTAT option

Details

The following example writes a list of ODS fonts to the SAS log.

Program

```
proc registry clearsasuser; run;
proc registry listhelp startat='ods\fonts'; run;
proc registry clearsasuser; run;
```

Log

Example Code 57.6 *Results from Displaying a List of Fonts from the SAS Registry*

```
NOTE: Contents of SASHELP REGISTRY starting at subkey [ods\fonts]
[  ods\fonts]
  dings="Wingdings"
  monospace="Courier New"
  MTdings="Monotype Sorts"
  MTmonospace="Cumberland AMT"
  MTsans-serif="Albany AMT"
  MTsans-serif-unicode="Monotype Sans WT J"
  MTserif="Thorndale AMT"
  MTserif-unicode="Thorndale Duospace WT J"
  MTsymbol="Symbol MT"
  sans-serif="Arial"
  serif="Times New Roman"
  symbol="Symbol"
[    ja_JP]
    dings="Wingdings"
    monospace="MS Gothic"
    MTdings="Wingdings"
    MTmonospace="MS Gothic"
    MTsans-serif="MS PGothic"
    MTsans-serif-unicode="MS PGothic"
    MTserif="MS PMincho"
    MTserif-unicode="MS PMincho"
    MTsymbol="Symbol"
    sans-serif="MS PGothic"
    serif="MS PMincho"
    symbol="Symbol"
[    ko_KR]
    dings="Wingdings"
    monospace="GulimChe"
    MTdings="Wingdings"
    MTmonospace="GulimChe"
    MTsans-serif="Batang"
    MTsans-serif-unicode="Batang"
    MTserif="Gulim"
    MTserif-unicode="Gulim"
    MTsymbol="Symbol"
    sans-serif="Batang"
    serif="Gulim"
    symbol="Symbol"
[    th_TH]
    dings="Wingdings"
    monospace="Thorndale Duospace WT J"
    MTdings="Monotype Sorts"
    MTmonospace="Cumberland AMT"
    MTsans-serif="Monotype Sans WT J"
    MTsans-serif-unicode="Thorndale Duospace WT J"
    MTserif="Thorndale Duospace WT J"
    MTserif-unicode="Monotype Sans WT J"
    MTsymbol="Symbol MT"
    sans-serif="Angsana New"
    serif="Thorndale Duospace WT J"
    symbol="Symbol"
```

58

REPORT Procedure

Overview: REPORT Procedure

What Does the REPORT Procedure Do?

The REPORT procedure combines features of the PRINT, MEANS, and TABULATE procedures with features of the DATA step in a single report-writing tool that can produce a variety of reports. You can use PROC REPORT in the following ways:

- in a nonwindowing environment. In this case, you submit a series of statements with the PROC REPORT statement, just as you do in other SAS procedure. You can submit these statements from the Program Editor (default is NOWINDOWS) in the PROC REPORT statement, or you can run SAS in batch, noninteractive, or interactive line mode. (See the information about "Ways to Run Your SAS Session " in *SAS Language Reference: Concepts*.)
- in an interactive report window environment with a prompting facility that guides you as you build a report. For details, see "REPORT Procedure Windows" on page 2229.
- in an interactive report window environment without the prompting facility. For details, see "REPORT Procedure Windows" on page 2229.
- the ability to create accessible output tables. When the ACCESSIBLETABLE system option is specified, changes are made to the layout of some tables to make them accessible. You can use the ACCESSIBLECHECK system option to check if your tables are accessible. When the ACCESSIBLETABLE system option is used and the CAPTION= option is used with PROC REPORT, captions are visible in the output.

For more information about creating accessible tables with PROC REPORT, see "Overview of Table Accessibility " in *Creating Accessible SAS Output Using ODS and ODS Graphics* . This feature applies to SAS 9.4M6 and later releases.

What Types of Reports Can PROC REPORT Produce?

A **detail report** contains one row for every observation selected for the report. Each of these rows is a report row, a **detail report row**. A **summary report** consolidates data so that each row represents multiple observations. Each of these rows is also called a detail row or a **summary report row**.

Both detail and summary reports can contain **summary report lines** (break lines) as well as report rows. A summary line summarizes numerical data for a set of detail rows or for all detail rows. PROC REPORT provides both default and customized summaries. (See "Using Break Lines" on page 2066.)

This overview illustrates the types of reports that PROC REPORT can produce. The statements that create the data sets and formats used in these reports are in "Example 1: Selecting Variables and Creating a Summary Line for a Report" on page 2171. The formats are stored in a permanent SAS library. See the REPORT procedure examples for more reports and for the statements that create them.

What Do the Various Types of Reports Look Like?

The data set that these reports use contains one day's sales figures for eight stores in a chain of grocery stores.

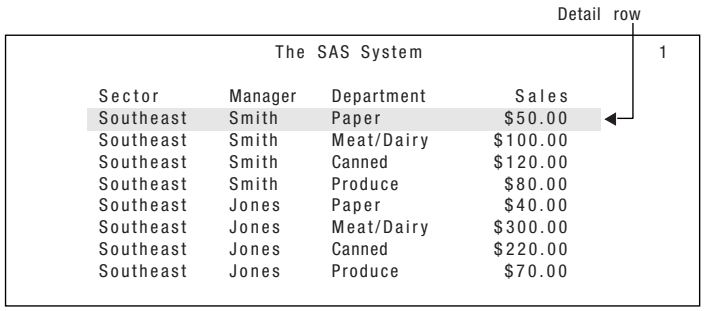
A simple PROC REPORT step produces a report similar to one produced by a simple PROC PRINT step. Figure 58.61 on page 2050 illustrates the simplest type of report that you can produce with PROC REPORT. The statements that produce the report follow. The data set and formats that the program uses are created in "Example 1: Selecting Variables and Creating a Summary Line for a Report" on page 2171. Although the WHERE and FORMAT statements are not essential, here they limit the amount of output and make the values easier to understand.

```
libname proclib
'SAS-library';

options nodate pageno=1 linesize=64 pagesize=60
        fmtsearch=(proclib);

proc report data=grocery;
   where sector='se';
   format sector $sctrfmt. manager $mgrfmt.
          dept $deptfmt. sales dollar10.2;
run;
```

Figure 58.1 *Simple Detail Report with a Detail Row for Each Observation*

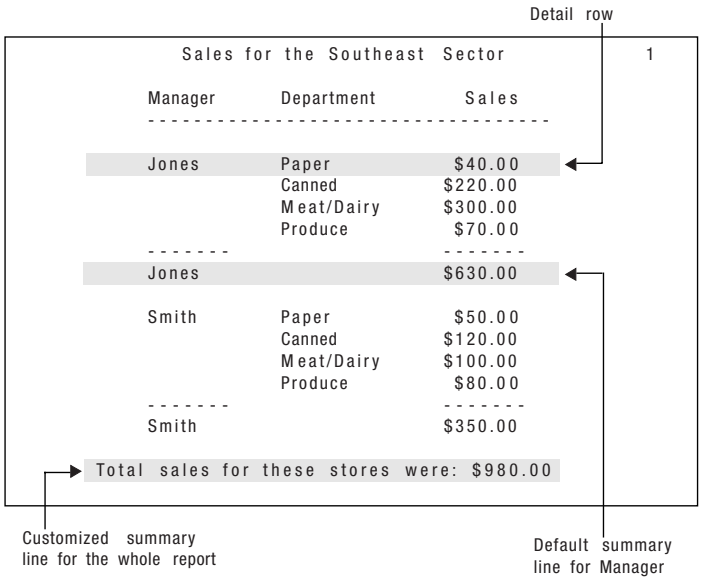


The report in the following figure uses the same observations as the above figure. However, the statements that produce this report

- order the rows by the values of Manager and Department.
- create a default summary line for each value of Manager.
- create a customized summary line for the whole report. A customized summary lets you control the content and appearance of the summary information, but you must write additional PROC REPORT statements to create one.

For an explanation of the program that produces this report, see "Example 2: Ordering the Rows in a Report" on page 2174.

Figure 58.2 *Ordered Detail Report with Default and Customized Summaries*

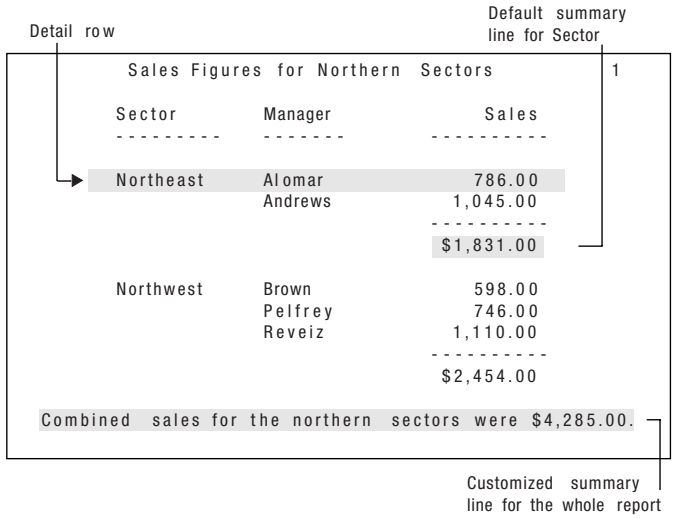


The summary report in the following figure contains one row for each store in the northern sector. Each detail row represents four observations in the input data set, one observation for each department. Information about individual departments does not appear in this report. Instead, the value of Sales in each detail row is the sum of the values of Sales in all four departments. In addition to consolidating multiple observations into one row of the report, the statements that create this report

- customize the text of the column headings
- create default summary lines that total the sales for each sector of the city
- create a customized summary line that totals the sales for both sectors

For an explanation of the program that produces this report, see "Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183.

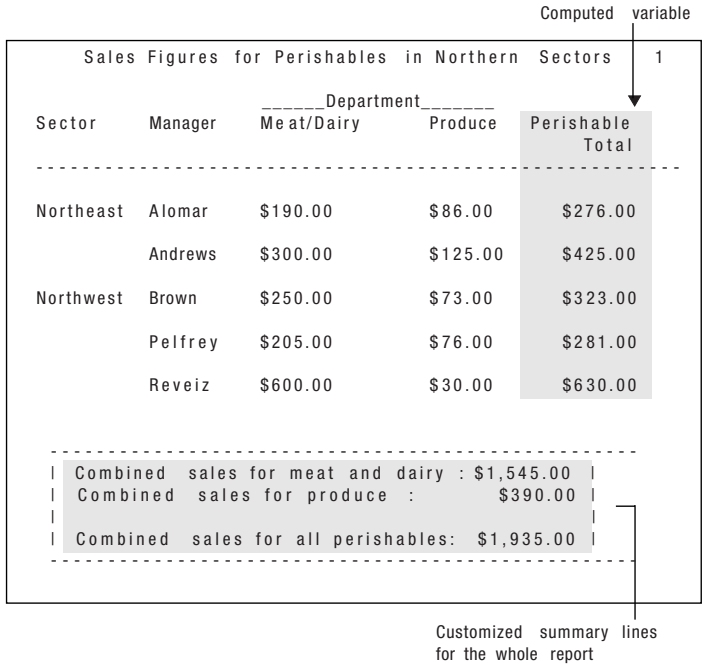
Figure 58.3 *Summary Report with Default and Customized Summaries*



The summary report in the following figure is similar to the above figure. The major difference is that it also includes information for individual departments. Each selected value of Department forms a column in the report. In addition, the statements that create this report compute and display a variable that is not in the input data set

For an explanation of the program that produces this report, see "Example 6: Creating a Column for Each Value of a Variable" on page 2187.

Figure 58.4 *Summary Report with a Column for Each Value of a Variable*

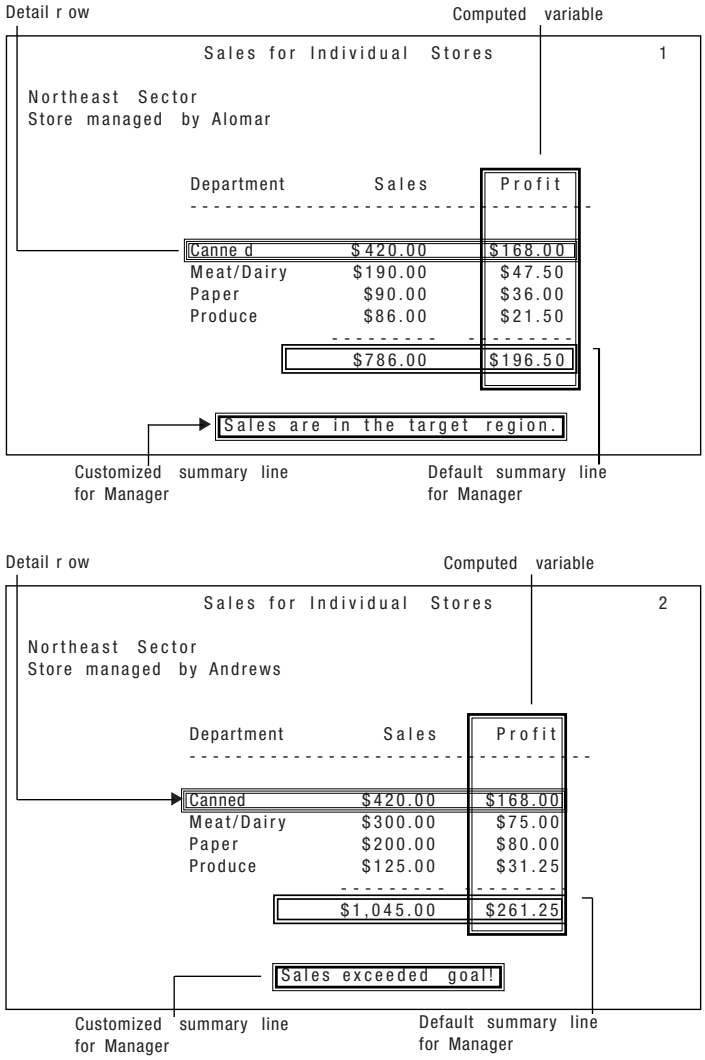


The customized report in the following figure shows each manager's store on a separate page. Only the first two pages appear here. The statements that create this report create

- a customized heading for each page of the report
- a computed variable (Profit) that is not in the input data set
- a customized summary with text that is dependent on the total sales for that manager's store

For an explanation of the program that produces this report, see "Example 7: Writing a Customized Summary on Each Page" on page 2190.

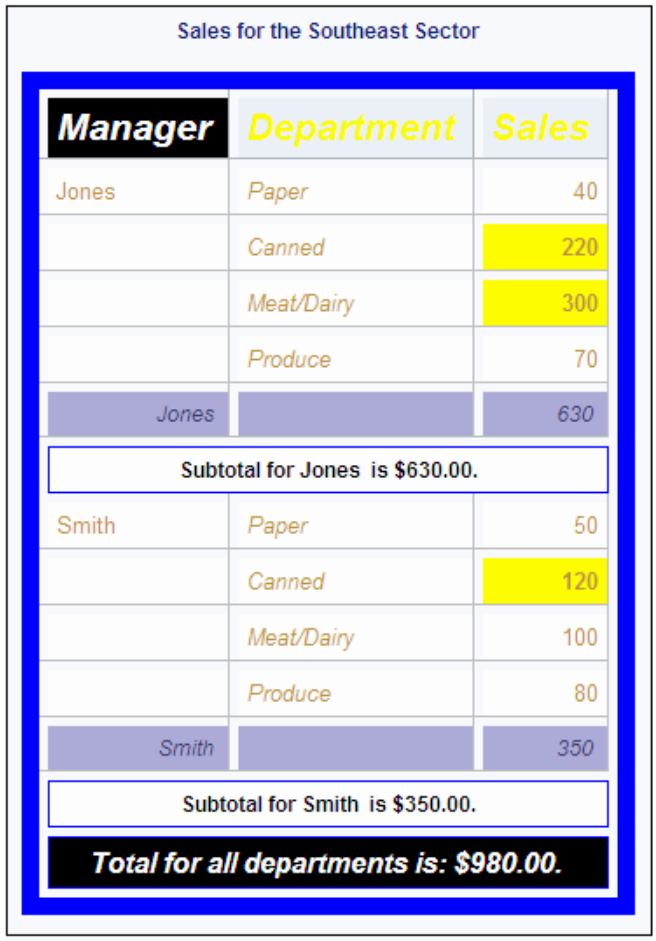
Figure 58.5 *Customized Summary Report*



The report in the following figure uses customized style elements to control things like font faces, font sizes, and justification, as well as the width of the border of the table and the width of the spacing between cells. This report was created by using the HTML destination of the Output Delivery System (ODS) and the STYLE= option in several statements in the procedure.

For an explanation of the program that produces this report, see "Example 13: Specifying Style Elements for ODS Output in Multiple Statements" on page 2212. For information about ODS, see "Output Delivery System" on page 72.

Figure 58.6 HTML Output



Sales for the Southeast Sector

Manager	Department	Sales
Jones	Paper	40
	Canned	220
	Meat/Dairy	300
	Produce	70
Jones		630
Subtotal for Jones is $630.00.		
Smith	Paper	50
	Canned	120
	Meat/Dairy	100
	Produce	80
Smith		350
Subtotal for Smith is $350.00.		
Total for all departments is: $980.00.		

Concepts: REPORT Procedure

Laying Out a Report

Planning the Layout

Report writing is simplified if you approach it with a clear understanding of what you want the report to look like. The most important thing to determine is the

layout of the report. To design the layout, ask yourself the following types of questions:

- What do I want to display in each column of the report?
- In what order do I want the columns to appear?
- Do I want to display a column for each value of a particular variable?
- Do I want a row for every observation in the report, or do I want to consolidate information for multiple observations into one row?
- In what order do I want the rows to appear?

When you understand the layout of the report, use the COLUMN and DEFINE statements in PROC REPORT to construct the layout.

The COLUMN statement lists the items that appear in the columns of the report, describes the arrangement of the columns, and defines headings that span multiple columns. A report item can be

- a data set variable
- a statistic calculated by the procedure
- a variable that you compute from other items in the report

Omit the COLUMN statement if you want to include all variables in the input data set in the same order as they occur in the data set.

The DEFINE statement defines the characteristics of an item in the report. These characteristics include how PROC REPORT uses the item in the report, the text of the column heading, and the format to use to display values.

Note: The DEFINE statement equates to the DEFINITION window if you are using the WINDOWS environment.

Usage of Variables in a Report

Much of a report's layout is determined by the usages that you specify for variables in the DEFINE statements. For data set variables, these usages are

DISPLAY ORDER ACROSS GROUP ANALYSIS

A report can contain variables that are not in the input data set. These variables must have a usage of COMPUTED.

Display Variables

A report that contains one or more display variables has a row for every observation in the input data set. Display variables do not affect the order of the rows in the report. If no order variables appear to the left of a display variable, then the order of the rows in the report reflects the order of the observations in the data

set. By default, PROC REPORT treats all character variables as display variables. For an example, see "Example 1: Selecting Variables and Creating a Summary Line for a Report" on page 2171.

Order Variables

A report that contains one or more order variables has a row for every observation in the input data set. If no display variable appears to the left of an order variable, then PROC REPORT orders the detail rows according to the ascending, formatted values of the order variable. You can change the default order with ORDER= and DESCENDING in the DEFINE statement.

If the report contains multiple order variables, then PROC REPORT establishes the order of the detail rows by sorting these variables from left to right in the report. PROC REPORT does not repeat the value of an order variable from one row to the next if the value does not change, unless an order variable to its left changes values. For an example, see "Example 2: Ordering the Rows in a Report" on page 2174.

The order of observations is not inherently defined for DBMS tables. If you specify the ORDER=DATA option for input data in a DBMS table, the order of rows written to a database table from PROC REPORT is not likely to be preserved.

Group Variables

If a report contains one or more group variables, then PROC REPORT tries to consolidate into one row all observations from the data set that have a unique combination of formatted values for all group variables.

When PROC REPORT creates groups, it orders the detail rows by the ascending, formatted values of the group variable. You can change the default order with ORDER= and DESCENDING in the DEFINE statement or with the DEFINITION window.

If the report contains multiple group variables, then the REPORT procedure establishes the order of the detail rows by sorting these variables from left to right in the report. PROC REPORT does not repeat the values of a group variable from one row to the next if the value does not change, unless a group variable to its left changes values.

If you are familiar with procedures that use class variables, then you see that group variables are class variables that are used in the row dimension in PROC TABULATE.

Note: You cannot always create groups. PROC REPORT cannot consolidate observations into groups if the report contains any order variables or any display variables that do not have one or more statistics associated with them. (See the COLUMN statement on page 2109.) In the interactive report window environment, if PROC REPORT cannot immediately create groups, then the procedure changes all display and order variables to group variables so that it can create the group

variable that you requested. In the nonwindowing (default) environment, it returns to the SAS log a message that explains why it could not create groups. Instead, it creates a detail report that displays group variables the same way as it displays order variables. Even when PROC REPORT creates a detail report, the variables that you define as group variables retain that usage in their definitions.

See "Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183.

Analysis Variables

An analysis variable is a numeric variable that is used to calculate a statistic for all the observations represented by a cell of the report. (Across variables, in combination with group variables or order variables, determine which observations a cell represents.) You associate a statistic with an analysis variable in the variable's definition or in the COLUMN statement. By default, PROC REPORT uses numeric variables as analysis variables that are used to calculate the Sum statistic.

The value of an analysis variable depends on where it appears in the report:

- In a detail report, the value of an analysis variable in a detail row is the value of the statistic associated with that variable calculated for a single observation. Calculating a statistic for a single observation is not practical. However, using the variable as an analysis variable enables you to create summary lines for sets of observations or for all observations.
- In a summary report, the value displayed for an analysis variable is the value of the statistic that you specify calculated for the set of observations represented by that cell of the report.
- In a summary line for any report, the value of an analysis variable is the value of the statistic that you specify calculated for all observations represented by that cell of the summary line.

For more information, see the "BREAK Statement" on page 2097 and "RBREAK Statement" on page 2134 statements.

For examples, refer to "Example 2: Ordering the Rows in a Report" on page 2174, "Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177, "Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183, and "Example 6: Creating a Column for Each Value of a Variable" on page 2187.

Note: Be careful when you use SAS dates in reports that contain summary lines. SAS dates are numeric variables. Unless you explicitly define dates as some other type of variable (ORDER, GROUP, or DISPLAY), PROC REPORT summarizes them.

Across Variables

PROC REPORT creates a column for each value of an across variable. PROC REPORT orders the columns by the ascending, formatted values of the across variable. You can change the default order with ORDER= and DESCENDING in the DEFINE statement. If no other variable helps define the column, then PROC REPORT displays the N statistic (the number of observations in the input data set that belong to that cell of the report.) See the COLUMN statement on page 2109.

Note: When a display variable and an across variable share a column, the report must also contain another variable that is not in the same column. When referring to columns created by an across variable, you must use the _cn_ syntax.

If you are familiar with procedures that use class variables, then you see that across variables are like class variables that are used in the column dimension with PROC TABULATE. Generally, you use Across variables in conjunction with order or group variables. For an example, see "Example 6: Creating a Column for Each Value of a Variable" on page 2187.

Computed Variables

Computed variables are variables that you define for the report. They are not in the input data set, and PROC REPORT does not add them to the input data set. However, computed variables are included in an output data set if you create one.

You add a computed variable by

- including the computed variable in the COLUMN statement
- defining the variable's usage as COMPUTED in the DEFINE statement
- computing the value of the variable in a compute block associated with the variable

For examples, refer to "Example 6: Creating a Column for Each Value of a Variable" on page 2187, "Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195, and "Example 10: Creating an Output Data Set and Storing Computed Variables" on page 2202.

Interactions of Position and Usage

The position and usage of each variable in the report determine the report's structure and content. PROC REPORT orders the rows of the report according to the formatted values of order and group variables, considered from left to right as specified in the COLUMN statement. Similarly, PROC REPORT orders columns for an across variable from left to right, according to the values of the variable.

Several items can collectively define the contents of a column in a report. For example, in the following figure, the values that appear in the third and fourth columns are collectively determined by Sales, an analysis variable, and by Department, an across variable. You create this type of report with the COLUMN statement or, in the interactive report window environment, by placing report items above or below each other. This arrangement is called stacking items in the report because each item generates a heading, and the headings are stacked one above the other.

```
options nodate pageno=1 fmtsearch=(proclib);
proc report data=grocery split='*';
   column sector manager department,sales perish;
   define sector / group format=$sctrfmt. 'Sector' '';
   define manager / group format=$mgrfmt. 'Manager* ';
   define department/ across format=$deptfmt. '_Department_';
   define sales / analysis sum format=dollar11.2 ' ';
   define perish / computed format=dollar11.2 'Perishable Total';
   break after manager / skip;
   compute perish;
      perish=_c3_+_c4_;
   endcomp;
   title "Sales Figures for Perishables in Northern Sectors";
   where sector contains 'n' and (department='p1' or department='p2');
run;
title;
```

Figure 58.7 *Stacking Department and Sales*

Sales Figures for Perishables in Northern Sectors

Sector	Manager	_____Department_____ Meat/Dairy	Produce	Perishable Total
Northeast	Aloma r	$190.00	$86.00	$276.00
	Andrews	$300.00	$125.00	$425.00
Northwest	Brown	$250.00	$73.00	$323.00
	Pelfrey	$205.00	$76.00	$281.00
	Reveiz	$600.00	$30.00	$630.00

When you use multiple items to define the contents of a column, at most one of the following can be in a column:

- a display variable with or without a statistic above or below it
- an analysis variable with or without a statistic above or below it
- an order variable
- a group variable
- a computed variable

More than one of these items in a column creates a conflict for PROC REPORT about which values to display.

The following table shows which report items can share a column.

Note: You cannot stack order variables with other report items.

Table 58.1 *Report Items That Can Share Columns*

	Display	Analysis	Order	Group	Computed	Across	Statistic
Display						X*	X
Analysis						X	X
Order							
Group						X	
Computed variable						X	
Across	X*	X			X	X	X
Statistic	X	X				X	

*When a display variable and an across variable share a column, the report must also contain another variable that is not in the same column.

When a column is defined by stacked report items, PROC REPORT formats the values in the column by using the format that is specified for the lowest report item in the stack that does not have an ACROSS usage.

The following items can stand alone in a column:

- display variable
- analysis variable
- order variable
- group variable
- computed variable
- across variable
- N statistic

Note: The values in a column that is occupied only by an across variable are frequency counts.

Using Compute Blocks

What Is a Compute Block?

A **compute block** is one or more programming statements that appear between a COMPUTE statement and an ENDCOMP statement. Between these two statements, you can use other SAS statements (assignment, CALL DEFINE, and LINE statements) that customize your output. PROC REPORT processes a data set by reading the variables in the order in which they appear from left to right in the COLUMN statement. The procedure builds the report one column and one row at a time, and COMPUTE statements are executed as the report is built.

You create a compute block with the COMPUTE statement. A COMPUTE statement can contain a number of arguments of the following types:

report-item
A report item can be a data set variable, a statistic, or a computed variable.

location
Specifies at what point in the process the compute block executes in relation to the value for *target*. The location can be at the top or bottom of the report; before or after a set of observations.

target
Controls when the compute block executes. You can specify a *target* if you specify a location (BEFORE or AFTER) for the COMPUTE statement. A target can be a group or order variable or a _PAGE_ variable.

Note: When you use the COMPUTE statement, you do not have to use a corresponding BREAK or RBREAK statement. See "Using Break Lines" on page 2066. Also see "Example 2: Ordering the Rows in a Report" on page 2174, which uses COMPUTE AFTER but does not use the RBREAK statement. Use these statements only when you want to implement one or more BREAK statement or RBREAK statement options. See "Example 7: Writing a Customized Summary on Each Page" on page 2190, which uses both COMPUTE AFTER MANAGER and BREAK AFTER MANAGER.)

For an in-depth look at Using a Compute Block, refer to The REPORT Procedure: A Primer for the Compute Block .

The Purpose of Compute Blocks

A compute block that is associated with a report item can perform the following tasks:

- define a variable that appears in a column of the report but is not in the input data set.
- define display attributes for a report item. (See “CALL DEFINE Statement” on page 2105.)
- define or change the value for a report item, such as showing the word “Total” on a summary line.

A compute block that is associated with a location can write a customized summary.

In addition, all compute blocks can use most SAS language elements to perform calculations. (See “The Contents of Compute Blocks” on page 2062.) A PROC REPORT step can contain multiple compute blocks, but they cannot be nested.

The Contents of Compute Blocks

A compute block begins with a COMPUTE statement and ends with an ENDCOMP statement. Within a compute block, you can use these SAS language elements:

- %INCLUDE statement
- these DATA step statements:

ARRAY	END
array-reference	IF-THEN/ELSE
assignment	LENGTH
CALL	RETURN
CONTINUE	sum
DO (all forms) END	

- comments
- null statements
- macro variables and macro invocations
- all DATA step functions

Within a compute block, you can also use these PROC REPORT features:

- Compute blocks for a customized summary can contain one or more LINE statements, which place customized text and formatted values in the summary. (See the “LINE Statement” on page 2132.)
- Compute blocks for a report item can contain one or more CALL DEFINE statements, which set attributes like color and format each time a value for the item is placed in the report. (See the “CALL DEFINE Statement” on page 2105.)
- Any compute block can reference the automatic variable _BREAK_. (See “The Automatic Variable _BREAK_” on page 2068.)

Four Ways to Reference Report Items in a Compute Block

A compute block can reference any report item that forms a column in the report (whether the column is visible). You reference report items in a compute block in one of four ways:

- by name.
- by a compound name that identifies both the variable and the name of the statistic that you calculate with it. A compound name has this form

variable-name.statistic

- by an alias that you create in the COLUMN statement or in the DEFINITION window.
- by column number, in the form

'_C*n*_'

where *n* is the number of the column (from left to right) in the report.

Note: The only time a column number is necessary is when a COMPUTED variable is sharing a column with an ACROSS variable.

Note: Even though the columns that you define with NOPRINT and NOZERO do not appear in the report, you must count them when you are referencing columns by number. See the discussion of "NOPRINT" on page 2125 and "NOZERO" on page 2126.

Note: Referencing variables that have missing values leads to missing values. If a compute block references a variable that has a missing value, then PROC REPORT displays that variable as a blank (for character variables) or as a period (for numeric variables).

The following table shows how to use each type of reference in a compute block.

Variable Type	Referenced By	Example
Group	Name*	Department
Order	Name*	Department
Computed	Name*	Department
Display	Name*	Department

Variable Type	Referenced By	Example
Display sharing a column with a statistic	A compound name*	Sales.sum
Analysis	A compound name*	Sales.mean
Any type sharing a column with an across variable	Column number **	'_c3_'

*If the variable has an alias, then you must reference it with the alias.

**Even if the variable has an alias, you must reference it by column number.

Refer to "Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177, which references analysis variables by their aliases; "Example 6: Creating a Column for Each Value of a Variable" on page 2187, which references variables by column number; and "Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195, which references group variables and computed variables by name.

Compute Block Processing

In general, compute blocks are executed in the following order:

1. COMPUTE report-item;
2. COMPUTE BEFORE;
3. COMPUTE BEFORE target;
4. COMPUTE BEFORE _PAGE_;
5. COMPUTE AFTER;
6. COMPUTE AFTER target;
7. COMPUTE AFTER _PAGE_;

The COMPUTE statement's behavior is dependent on the arguments that you include. The following syntax and behavior explains the actions of the compute block based on specific arguments in the COMPUTE statement.

Note: PROC REPORT assigns values to the columns in a row of a report from left to right. Consequently, you cannot base the calculation of a computed variable on any variable that appears to its right in the report. For information about how PROC REPORT (in general) builds a report, see Results: REPORT Procedure on page 2158.

COMPUTE *report-item*;

When you include the *report-item* argument, the compute block executes on every observation when that particular column is processed. In general, this statement is used for a specific *report-item* column so that you can calculate a value, change a value, change a format, apply style attributes, or create a temporary variable.

COMPUTE BEFORE;

With this syntax, the compute block is executed before the first detail row. The block is executed only once. Overall summary values for the analysis variables are available in the compute block. In addition, values of temporary variables that are created in this block are available to other compute blocks. Values for group or order variables are not available in this block. Text that is generated by LINE statements appears below the headers and above the first detail row in the report. CALL DEFINE statements set attributes on rows that are created by an RBREAK BEFORE statement.

COMPUTE BEFORE *target*;

When you use this syntax, the compute block is executed when the value of the target variable changes. In this syntax:

- *target* specifies either a group variable or an order variable.
- BEFORE is a value for *location*. This value specifies that the compute block is executed at the top (or beginning) of the section for a specific value of *target*.
- The value of the target variable for this specific section of the report is available to the compute block.
- The values of temporary variables created in this block are available to other compute blocks.
- Summary values for this specific *target* value are available to the compute block.
- CALL DEFINE statements set attributes on rows that are created by a BREAK BEFORE *target* statement.

COMPUTE BEFORE _PAGE_;

The compute block is executed once for each page. The page break can be generated either by the destination to which you send the output or by using the following BREAK statement syntax:

```
BREAK <location> <break-var> /PAGE;
```

Typically, this block outputs text by using a LINE statement. The text appears at the top of the page above the headers. However, it is still part of the table. Any variable that is listed in the LINE statement takes its value from the first detail row in the report.

COMPUTE AFTER;

The compute block is executed after the last detail row, and the block is executed only once (for each report). Overall summary values for the analysis variables are also available in the compute block. Values for group or order variables are not available in this block. Text that is generated by LINE statements appears after the last detail row in the report. This block is executed after each BY value if the PROC REPORT code contains a BY statement. CALL DEFINE statements set attributes on rows created by an RBREAK AFTER statement.

COMPUTE AFTER *target*;

With this syntax, the compute block is executed when the value of the target (break) variable changes. In this syntax:

- *target* specifies a variable that is defined as either a group variable or an order variable.
- AFTER is a value for *location*. This value specifies that the compute block is executed at the bottom (or end) of the section for a specific value of *target*.
- The value of the target variable for this specific section of the report is available to the compute block.
- Summary values for this specific *target* value are available to the compute block.
- CALL DEFINE statements set attributes on rows created by a BREAK AFTER *target* statement.

COMPUTE AFTER _PAGE_;

The compute block is executed once for each page. The page break can be generated either by the destination to which you send the output or by using the following BREAK statement syntax:

```
BREAK <location> <break-var> /PAGE;
```

Any variable that is listed in the LINE statement takes its value from the last detail row in the report. The text is placed at the end of the table, but it is still part of the table.

Note: The exact location of the text might change for each page, based on the amount of information that is output to each page. The text is placed on the last page of a table if it spans multiple pages.

Using Break Lines

What Are Break Lines?

Break lines are lines of text (including blanks) that appear at particular locations, called **breaks**, in a report. A report can contain multiple breaks. Generally, break lines are used to visually separate parts of a report, to summarize information, or both. They can occur in the following locations:

- at the beginning or end of a report
- at the top or bottom of each page
- between sets of observations (whenever the value of a group or order variable changes)

Break lines can contain the following items:

- text
- values calculated for either a set of rows or for the whole report

Creating Break Lines

There are two ways to create break lines. The first way is simpler. It produces a default summary. The second way is more flexible. It produces a customized summary and provides a way to slightly modify a default summary. Default summaries and customized summaries can appear at the same location in a report.

Default summaries are produced with the BREAK statement, the RBREAK statement. You can use default summaries to visually separate parts of the report, to summarize information for numeric variables, or both. Options provide some control over the appearance of the break lines, but if you choose to summarize numeric variables, then you have no control over the content and the placement of the summary information. (A break line that summarizes information is a summary line.)

Customized summaries are produced in a compute block. You can control both the appearance and content of a customized summary, but you must write the code to do so.

Order of Break Lines

You control the order of the lines in a customized summary. However, PROC REPORT controls the order of lines in a default summary and the placement of a customized summary relative to a default summary. When a default summary contains multiple break lines, the order in which the break lines appear is as follows:

1. summary line
2. page break

For LISTING output, the order in which the break lines appear is as follows:

1. overlining or double overlining (in LISTING output only)
2. summary line
3. underlining or double underlining
4. blank line (in LISTING output only)
5. page break

If you define a customized summary for the same location, then customized break lines appear after underlining or double underlining. This occurs only in LISTING output.

The Automatic Variable _BREAK_

PROC REPORT automatically creates a variable called _BREAK_. This variable contains the following:

- a blank if the current line is not part of a break
- the value of the break variable if the current line is part of a break between sets of observations
- the value **_RBREAK_** if the current line is part of a break at the beginning or end of the report
- the value **_PAGE_** if the current line is part of a break at the beginning or end of a page

Using Compound Names

When you use a statistic in a report, you generally refer to it in compute blocks by a compound name like Sales.sum. However, in different parts of the report, that same name has different meanings. Consider the report in the following output. The statements that create the output follow. The user-defined formats that are used are created by a PROC FORMAT step on page 2173.

```
libname proclib
'SAS-library';

options nodate pageno=1 fmtsearch=(proclib);
proc report data=grocery;
   column sector manager sales;
   define sector / group format=$sctrfmt.;
   define sales  / analysis sum
                   format=dollar9.2;
   define manager / group format=$mgrfmt.;
   break after sector / summarize;
   rbreak after / summarize;
   compute after;
      sector='Total:';
   endcomp;
run;
```

Example Code 58.1 *Three Different Meanings of Sales.sum*

```
                          The SAS System
1

                Sector     Manager      Sales
                Northeast  Alomar     $786.00     1
                           Andrews  $1,045.00
                ---------             ---------
                Northeast             $1,831.00     2

                Northwest  Brown      $598.00
                           Pelfrey    $746.00
                           Reveiz   $1,110.00
                ---------             ---------
                Northwest             $2,454.00

                Southeast  Jones      $630.00
                           Smith      $350.00
                ---------             ---------
                Southeast                $980.00

                Southwest  Adams      $695.00
                           Taylor     $353.00
                ---------             ---------
                Southwest             $1,048.00

                =========             =========
                Total:                $6,313.00     3
                =========             =========
```

Here Sales.sum has three different meanings:

1. In detail rows, the value is the sales for one manager's store in a sector of the city. For example, the first detail row of the report shows that the sales for the store that Alomar manages were $786.00.
2. In the group summary lines, the value is the sales for all the stores in one sector. For example, the first group summary line shows that sales for the Northeast sector were $1,831.00.
3. In the report summary line, the value $6,313.00 is the sales for all stores in the city.

Note: When you refer in a compute block to a statistic that has an alias, do not use a compound name. Generally, you must use the alias. However, if the statistic shares a column with an across variable, then you must reference it by column number. (See "Four Ways to Reference Report Items in a Compute Block" on page 2063.)

ODS Destinations Supported by PROC REPORT

PROC REPORT supports all ODS destinations. For more information, see "Understanding ODS Destinations" in *SAS Output Delivery System: User's Guide* .

The PROC REPORT STYLE= option supports all ODS destinations except LISTING and OUTPUT. For more information, see "Using ODS Styles with PROC REPORT" on page 2142.

PROC REPORT supports the ODS DOCUMENT procedure. The DOCUMENT destination enables you to restructure, navigate, and replay your data in different ways and to different destinations without rerunning your analysis or repeating your database query. The DOCUMENT destination makes your entire output stream available in "raw" form and accessible to you to customize. The output is kept in the original internal representation as a data component plus a table definition. For more information, see "DOCUMENT Procedure" in *SAS Output Delivery System: Procedures Guide*.

PROC REPORT supports the OUTPUT destination for SAS output data sets. Because ODS already knows the logical structure of the data and its native form, ODS can output a SAS data set that represents exactly the same resulting data set that the procedure worked with internally. For more information, see "ODS OUTPUT Statement" in *SAS Output Delivery System: User's Guide*.

Threaded Processing of Input DATA Sets

The THREAD option enables or disables parallel processing of the input data set. Threaded processing achieves a degree of parallelism in the processing operations. This parallelism is intended to reduce the real time to completion for a given operation and therefore limit the cost of additional CPU resources. For more information, see "Support for Parallel Processing" in *SAS Language Reference: Concepts*.

The value of the SAS system option CPUCOUNT= affects the performance of the threaded sort. CPUCOUNT= suggests how many system CPUs are available for use by the threaded procedures.

For more information, see the "THREADS System Option" in *SAS System Options: Reference* and the "CPUCOUNT= System Option" in *SAS System Options: Reference*.

Calculated statistics can vary slightly, depending on the order in which observations are processed. Such variations are due to numerical errors that are introduced by floating–point arithmetic, the results of which should be considered approximate and not exact. The order of observation processing can be affected by nondeterministic effects of multithreaded or parallel processing. The order of processing can also be affected by inconsistent or nondeterministic ordering of observations that are produced by a data source, such as a DBMS that delivers query results through an ACCESS engine. For more information, see "Numerical Accuracy in SAS Software" in *SAS Language Reference: Concepts* and "Threading in Base SAS" in *SAS Language Reference: Concepts*.

Syntax: REPORT Procedure

Restriction: PROC REPORT does not support VARCHAR data types.

Accessibility note: Starting with SAS 9.4M6, you can use the ACCESSIBLECHECK and ACCESSIBLETABLE system options. ACCESSIBLETABLE changes the layout of some tables to make them accessible and adds visual captions to tables. ACCESSIBLECHECK checks to see if the table is accessible and outputs information to the SAS log. For more information, see "Overview of Table Accessibility " in *Creating Accessible SAS Output Using ODS and ODS Graphics* .

Starting with SAS 9.4M6, you can use the ACCESSIBLETABLE system option along with the CAPTION= option and the CONTENTS= option to see visible captions for tables and visible changes in the Table of Contents using By directives.

Accessibility note: Starting with SAS 9.4M6, you can use the ACCESSIBLETABLE system option along with the CAPTION= option and the CONTENTS= option to see visible captions for tables and visible changes in the Table of Contents using By directives.

Tips: Supports the Output Delivery System. For details, see "Output Delivery System: Basic Concepts" in *SAS Output Delivery System: User's Guide*.

You can use the ATTRIB, FORMAT, LABEL, and WHERE statements with the PROC SORT procedure. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

For in-database processing to occur, your data must reside within a supported version of a DBMS that has been properly configured for SAS in-database processing. For more information, see "In-Database Processing for PROC REPORT" on page 2154.

PROC REPORT<*options*>;
  BREAK *location break-variable* </ *options*>
  BY *variable-1*
    <<DESCENDING> *variable-2* ...> <NOTSORTED>;
  COLUMN*column-specification(s)*;
    COMPUTE *location* <*target*>
      </ STYLE=<*style-override(s)*> >;
        LINE *specification(s)*;
        . . . select SAS language elements . . .
        ENDCOMP;
    COMPUTE *report-item* </ *type-specification*>;
        CALL DEFINE (*column-id* ', < ' *attribute-name*', *value*>
          | _ROW_, < '*attribute-name*', *value*>);
        . . . select SAS language elements . . .
        ENDCOMP;
  DEFINE *report-item* / <*options*>;

FREQ *variable*;

RBREAK *location* </ *options*>;

WEIGHT *variable*;

Statement	Task	Example
PROC REPORT	Produce a summary or detail report	Ex. 1, Ex. 2, Ex. 6, Ex. 4, Ex. 9, Ex. 10, Ex. 13
BREAK	Produce a default summary at a change in the value of a group or order variable	Ex. 2, Ex. 5, Ex. 6, Ex. 7
BY	Create a separate report for each BY group	
CALL DEFINE	Set the value of an attribute for a particular column in the current row	Ex. 5, Ex. 13
COLUMN	Describe the arrangement of all columns and of headings that span more than one column	Ex. 1, Ex. 3, Ex. 6, Ex. 4, Ex. 8, Ex. 9
COMPUTE	Specify one or more programming statements that PROC REPORT executes as it builds the report	Ex. 2, Ex. 3, Ex. 5, Ex. 6, Ex. 7, Ex. 8, Ex. 10, Ex. 13
ENDCOMP	Specify one or more programming statements that PROC REPORT executes as it builds the report	Ex. 2
DEFINE	Describe how to use and display a report item	Ex. 2, Ex. 3, Ex. 5, Ex. 6, Ex. 4, Ex. 7, Ex. 8, Ex. 10, Ex. 10, Ex. 11, Ex. 13
FREQ	Treat observations as if they appear multiple times in the input data set	
LINE	Provide a subset of features of the PUT statement for writing customized summaries	Ex. 2, Ex. 3, Ex. 5, Ex. 6, Ex. 7
RBREAK	Produce a default summary at the beginning or end of a report or at the beginning and end of each BY group	Ex. 1, Ex. 8
WEIGHT	Specify weights for analysis variables in the statistical calculations	

PROC REPORT Statement

Combines features of the PRINT, MEANS, and TABULATE procedures with features of the DATA step in a single report-writing tool that can produce a variety of reports.

Examples:

"Example 1: Selecting Variables and Creating a Summary Line for a Report" on page 2171

"Example 2: Ordering the Rows in a Report" on page 2174

"Example 6: Creating a Column for Each Value of a Variable" on page 2187

"Example 4: Displaying Multiple Statistics for One Variable" on page 2181

"Example 9: How PROC REPORT Handles Missing Values" on page 2198

"Example 10: Creating an Output Data Set and Storing Computed Variables" on page 2202

"Example 13: Specifying Style Elements for ODS Output in Multiple Statements" on page 2212

"Example 14: Using the CELLWIDTH= Style Attribute with PROC REPORT" on page 2220

Syntax

PROC REPORT <*options*>;

Summary of Optional Arguments

CAPTION=*text* <#BYLINE> <#BYVAL> <#BYVAR>

DATA=*SAS-data-set*
: specifies the input data set.

NOALIAS
: uses a report that was created before compute blocks required aliases.

NOCENTER
: See CENTER | NOCENTER.

NOCOMPLETECOLS
: See COMPLETECOLS | NOCOMPLETECOLS.

NOCOMPLETEROWS
: See COMPLETEROWS | NOCOMPLETEROWS.

NOTHREADS
: See THREADS | NOTHREADS.

NOWINDOWS
: See WINDOWS | NOWINDOWS.

OUT=*SAS-data-set*
: specifies the output data set.

PCTLDEF=
See QNTLDEF=.

THREADS

NOTHREADS
overrides the SAS system option THREADS | NOTHREADS.

WINDOWS

NOWINDOWS
selects the interactive report window or the nonwindowing environment.

Control classification levels

COMPLETECOLS

NOCOMPLETECOLS
creates all possible combinations of the across variable values.

COMPLETEROWS

NOCOMPLETEROWS
creates all possible combinations of the group variable values.

Control ODS output

CONTENTS='*link-text*' <#BYLINE> <#BYVAL> <#BYVAR>
specifies text for the table of contents entry for the output.

SPANROWS
specifies that a single cell occupies the column in all the rows for which the value is the same.

STYLE<(*location(s)*)>=<*style-override(s)*>
specifies one or more style overrides to use for different parts of the report.

Control the interactive report window environment

COMMAND
displays command lines rather than menu bars in all REPORT windows.

HELP=*libref.catalog*
identifies the library and catalog containing user-defined help for the report.

PROMPT
opens the REPORT window and starts the PROMPT facility.

Control the layout of the report

BOX
uses formatting characters to add line-drawing characters to the report.

BYPAGENO=*number*
resets the page number between BY groups.

CENTER

NOCENTER
specifies whether to center or left-justify the report and summary text.

COLWIDTH=*column-width*
specifies the default number of characters for columns containing computed variables or numeric data set variables.

FORMCHAR <(*position(s)*)>='*formatting-character(s)*'

defines the characters to use as line-drawing characters in the report.

LS=*line-size*
specifies the length of a line of the report.

MISSING
considers missing values as valid values for group, order, or across variables.

PANELS=*number-of-panels*
specifies the number of panels on each page of the report.

PS=*page-size*
specifies the number of lines in a page of the report. This option affects only the LISTING output.

PSPACE=*space-between-panels*
specifies the number of blank characters between panels.

SHOWALL
overrides options in the DEFINE statement that suppress the display of a column.

SPACING=*space-between-columns*
specifies the number of blank characters between columns.

WRAP
displays one value from each column of the report, on consecutive lines if necessary, before displaying another value from the first column.

Control the statistical analysis

EXCLNPWGT
excludes observations with nonpositive weight values from the analysis.

QMARKERS=*number*
specifies the sample size to use for the P^2 quantile estimation method.

QMETHOD=OS | P2
specifies the quantile estimation method.

QNTLDEF=1 | 2 | 3 | 4 | 5
specifies the mathematical definition to calculate quantiles.

VARDEF=*divisor*
specifies the divisor to use in the calculation of variances.

Customize column headings

NAMED
writes name= in front of each value in the report, where name= is the column heading for the value.

NOHEADER
suppresses column headings.

SPLIT='*character*'
specifies the split character.

ODS Listing

HEADLINE
underlines all column headings and the spaces between them.

HEADSKIP
writes a blank line beneath all column headings.

Store and retrieve report definitions, PROC REPORT statements, and your report profile

LIST
: writes to the SAS log the PROC REPORT code that creates the current report.

NOEXEC
: suppresses the building of the report.

OUTREPT=*libref.catalog.entry*
: stores in the specified catalog the report definition that is defined by the PROC REPORT step that you submit.

PROFILE=*libref.catalog*
: identifies the report profile to use.

REPORT=*libref.catalog.entry*
: specifies the report definition to use.

Optional Arguments

BOX
uses formatting characters to add line-drawing characters to the report. These characters

- surround each page of the report
- separate column headings from the body of the report
- separate rows and columns from each other
- separate values in a summary line from other values in the same columns
- separate a customized summary from the rest of the report

Restriction: This option affects only the LISTING output. It has no affect on other ODS output.

Interaction: You cannot use BOX if you use WRAP in the PROC REPORT statement or in the ROPTIONS window or if you use FLOW in any item definition.

See: the discussion of "FORMCHAR <(*position(s)*)>='*formatting-character(s)*' " on page 2081

BYPAGENO=*number*
If a BY statement is present, specifies the page number at the start of each BY group.

Range: any positive integer greater than 0.

Restriction: This option has no effect if a BY statement is not present.

Interaction: The BYPAGENO= option also affects the ODS ESCAPECHAR THISPAGE function.

CAPTION=*text* <#BYLINE> <#BYVAL> <#BYVAR>
specifies a caption text string to add before each table. If no string is specified, the caption defaults to the text specified by the CONTENTS= option.

This option makes table captions both visual and accessible if the ACCESSIBLETABLE system option is specified.

If the NOACCESSIBLETABLE system option is specified, then no caption is displayed, however the caption text is still accessible.

Starting with SAS 9.4M6, these options are available if a BY statement is in effect:

#BYLINE
substitutes the entire BY line without leading or trailing blanks for #BYLINE in the text string. The BY line uses the format *variable-name=value*.

#BYVAL*n*
#BYVAL(*BY-variable-name*)
substitutes the current value of the specified BY variable for #BYVAL in the text string.

Specify the variable with one of the following:

n
specifies a variable by its position in the BY statement. For example, #BYVAL2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAL(YEAR) specifies the BY variable, YEAR. *Variable-name* is not case sensitive.

#BYVAR*n*
#BYVAR(*BY-variable-name*)
substitutes the name of the BY-variable or the label associated with the variable (whatever the BY line would normally display) for #BYVAR in the text string.

Specify the variable with one of the following:

n
specifies a variable by its position in the BY statement. For example, #BYVAR2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAR(SITES) specifies the BY variable, SITES. *Variable-name* is not case sensitive.

Restrictions The ACCESSIBLETABLE system option must be specified to enable captions.

The CAPTION= option is not valid in the LISTING destination.

Note This feature applies to SAS 9.4M6 and to later releases.

Tip You can use the PROC DOCUMENT OBBNOTE option to display or edit the caption.

See "Overview of Table Accessibility " in *Creating Accessible SAS Output Using ODS and ODS Graphics*

CENTER | NOCENTER

specifies whether to center or left-justify the report and summary text (customized break lines).

PROC REPORT honors the first of these centering specifications that it finds:

- the CENTER or NOCENTER option in the PROC REPORT statement or the CENTER toggle in the ROPTIONS window
- the CENTER or NOCENTER option stored in the report definition that is loaded with REPORT= in the PROC REPORT statement
- the SAS system option CENTER or NOCENTER

Interaction When CENTER is in effect, PROC REPORT ignores spacing that precedes the leftmost variable in the report.

COLWIDTH=*column-width*

specifies the default number of characters for columns containing computed variables or numeric data set variables.

When setting the width for a column, PROC REPORT first looks at WIDTH= in the definition for that column. If WIDTH= is not present, then PROC REPORT uses a column width large enough to accommodate the format for the item. If no format is associated with the item, then the column width depends on variable types as shown in the following table.

Table 58.2 *Using References in a Compute Block*

Variable	Resulting Column Width
Character variable in the input data set	Length of the variable
Numeric variable in the input data set	Value of the COLWIDTH= option
Computed variable (numeric or character)	Value of the COLWIDTH= option

For information about formats, see the discussion of "FORMAT=*format*" on page 2123.

Default 9

Range 1 to the line size

Restriction This option affects only the LISTING output. It has no affect on other ODS output. For the formatted ODS destinations, use the STYLE= option with the WIDTH=, CELLWIDTH=, or OUTPUTWIDTH= style attributes. Refer to "Style Attributes Tables" in *SAS Output Delivery System: Advanced Topics* for details. See how style attributes WIDTH= and CELLWIDTH= can be used with PROC

REPORT in "Example 14: Using the CELLWIDTH= Style Attribute with PROC REPORT" on page 2220.

COMMAND
displays command lines rather than menu bars in all REPORT windows.

After you have started PROC REPORT in the interactive report window environment, you can display the menu bars in the current window by issuing the COMMAND command. You can display the menu bars in all PROC REPORT windows by issuing the PMENU command. The PMENU command affects all the windows in your SAS session. Both of these commands are toggles.

You can store a setting of COMMAND in your report profile. PROC REPORT honors the first of these settings that it finds:

- the COMMAND option in the PROC REPORT statement
- the setting in your report profile

Restriction This option has no effect in the nonwindowing environment.

COMPLETECOLS | NOCOMPLETECOLS
creates all possible combinations for the values of the across variables even if one or more of the combinations do not occur within the input data set. Consequently, the column headings are the same for all logical pages of the report within a single BY group.

Default COMPLETECOLS

Interaction The PRELOADFMT option in the DEFINE statement ensures that PROC REPORT uses all user-defined format ranges for the combinations of across variables, even when a frequency is zero.

COMPLETEROWS | NOCOMPLETEROWS
displays all possible combinations of the values of the group variables, even if one or more of the combinations do not occur in the input data set. Consequently, the row headings are the same for all logical pages of the report within a single BY group.

Default NOCOMPLETEROWS

Interaction The PRELOADFMT option in the DEFINE statement ensures that PROC REPORT uses all user-defined format ranges for the combinations of group variables, even when a frequency is zero.

CONTENTS='*link-text*' <#BYLINE> <#BYVAL> <#BYVAR>
specifies the text for the entries in the table of contents created by default or by options settings in ODS destinations that support the STYLE= option.

Starting in SAS 9.4M6, if the ACCESSIBLETABLE system option is specified, you can use the By directives to create visual output in the Table of Contents.

Starting with SAS 9.4M6, these options are available if a BY statement is in effect:

#BYLINE
substitutes the entire BY line without leading or trailing blanks for #BYLINE in the text string. The BY line uses the format *variable-name=value*.

#BYVAL*n*
#BYVAL(*BY-variable-name*)
substitutes the current value of the specified BY variable for #BYVAL in the text string.

Specify the variable with one of the following:

n
specifies a variable by its position in the BY statement. For example, #BYVAL2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAL(YEAR) specifies the BY variable, YEAR. *Variable-name* is not case sensitive.

#BYVAR*n*
#BYVAR(*BY-variable-name*)
substitutes the name of the BY-variable or the label associated with the variable (whatever the BY line would normally display) for #BYVAR in the text string.

Specify the variable with one of the following:

n
specifies a variable by its position in the BY statement. For example, #BYVAR2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAR(SITES) specifies the BY variable, SITES. *Variable-name* is not case sensitive.

Restriction The ACCESSIBLETABLE system option must be specified to use the By Directives to create visible output text in the Table of Contents. You can use CONTENTS='*link-text*' without the ACCESSSIBLETABLE option.

Note The use of the By directives with the CONTENT= option applies to SAS 9.4M6 and to later releases.

Tip All ODS destinations except OUTPUT and LISTING support the STYLE= option.

See Creating Accessible Tables with the REPORT Procedure in *Creating Accessible SAS Output Using ODS and ODS Graphics*

DATA=*SAS-data-set*
specifies the input data set.

See "Input Data Sets" on page 26

EXCLNPWGT

excludes observations with nonpositive weight values (zero or negative) from the analysis. By default, PROC REPORT treats observations with negative weights like observations with zero weights and counts them in the total number of observations.

Alias EXCLNPWGTS

Requirement You must use a WEIGHT statement.

See "WEIGHT Statement" on page 2139

FORMCHAR <(*position(s)*)>='*formatting-character(s)*'

defines the characters to use as line-drawing characters in the report.

position(s)

identifies the position of one or more characters in the SAS formatting-character string. A space or a comma separates the positions.

Default Omitting (*position(s)*) is the same as specifying all 20 possible SAS formatting characters, in order.

Note PROC REPORT uses 12 of the 20 formatting characters that SAS provides. Table 58.107 on page 2081 shows the formatting characters that PROC REPORT uses. Figure 58.68 on page 2083 illustrates the use of some commonly used formatting character in the output from PROC REPORT.

formatting-character(s)

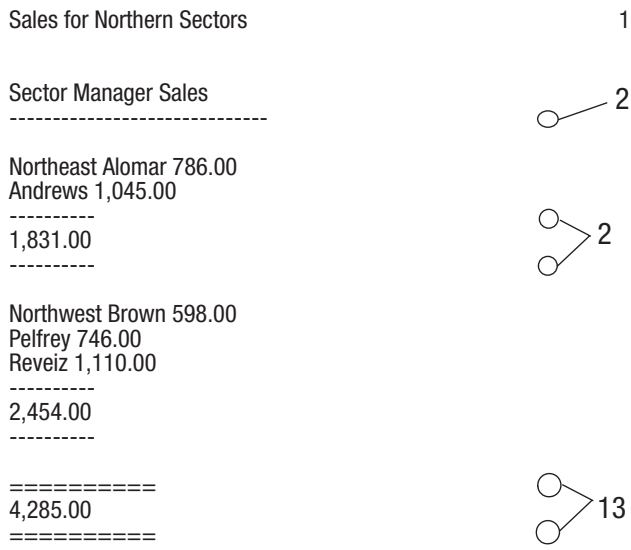
lists the characters to use for the specified positions. PROC REPORT assigns characters in *formatting-character(s)* to *position(s)*, in the order in which they are listed. For example, the following option assigns the asterisk (*) to the third formatting character, the number sign (#) to the seventh character, and does not alter the remaining characters: `formchar(3,7)='*#'`

Table 58.3 *Formatting Characters Used by PROC REPORT*

Position	Default	Used to Draw
1	|	Right and left borders and the vertical separators between columns
2	-	Top and bottom borders and the horizontal separators between rows. Also, underlining and overlining in break lines as well as the underlining that the HEADLINE option draws

3	-	Top character in the left border
4	-	Top character in a line of characters that separates columns
5	-	Top character in the right border
6	|	Leftmost character in a row of horizontal separators
7	+	Intersection of a column of vertical characters and a row of horizontal characters
8	|	Rightmost character in a row of horizontal separators
9	-	Bottom character in the left border
10	-	Bottom character in a line of characters that separate columns
11	-	Bottom character in the right border
13	=	Double overlining and double underlining in break lines

Figure 58.8 *Formatting Characters in PROC REPORT Output*



Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interaction The SAS system option FORMCHAR= specifies the default formatting characters. The system option defines the entire string of formatting characters. The FORMCHAR= option in a procedure can redefine selected characters.

Tip You can use any character in *formatting-characters*, including hexadecimal characters. If you use hexadecimal characters, then you must put `x` after the closing quotation mark. For example, the following option assigns the hexadecimal character 2-D to the third formatting character, the hexadecimal character 7C to the seventh character, and does not alter the remaining characters:

```
formchar(3,7)='2D7C'x
```

HEADLINE

underlines all column headings and the spaces between them at the top of each page of the report.

The HEADLINE option underlines with the second formatting character. (See the discussion of "FORMCHAR <(*position(s)*)>='*formatting-character(s)*' " on page 2081.)

Default hyphen (-)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Tip In LISTING output, you can underline column headings without underlining the spaces between them, by using two hyphens `('--')` as the last line of each column heading instead of using HEADLINE.

HEADSKIP
writes a blank line beneath all column headings (or beneath the underlining that the HEADLINE option writes) at the top of each page of the report.

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

HELP=*libref.catalog*
identifies the library and catalog containing user-defined help for the report. This help can be in CBT or HELP catalog entries. You can write a CBT or HELP entry for each item in the report with the BUILD procedure in SAS/AF software. Store all such entries for a report in the same catalog.

Specify the entry name for help for a particular report item in the DEFINITION window for that report item or in a DEFINE statement.

Restriction This option works only in the Report Window.

LIST
writes to the SAS log the PROC REPORT code that creates the current report.

This listing might differ in these ways from the statements that you submit:

- It shows some defaults that you might not have specified.
- It omits some statements that are not specific to the REPORT procedure, whether you submit them with the PROC REPORT step or had previously submitted them. These statements include

BY FOOTNOTE FREQ TITLE WEIGHT WHERE

- It omits these PROC REPORT statement options:

LIST
OUT=
OUTREPT=
PROFILE=
REPORT=
WINDOWS | NOWINDOWS

- It includes these style(<*location*>)= options:

CENTER SPACING
HEADER USAGE
LEFT WIDTH
RIGHT

Note: WIDTH and SPACING are LISTING only.

- It omits SAS system options.
- It resolves automatic macro variables.

Restriction The LIST option does not support styles by columns if you specify style(column)= in the DEFINE statement.

LS=*line-size*
specifies the length of a line of the report.

PROC REPORT honors the line size specifications that it finds in the following order of precedence:

- the LS= option in the PROC REPORT statement or LINESIZE= in the ROPTIONS window
- the LS= setting stored in the report definition loaded with REPORT= in the PROC REPORT statement
- the SAS system option LINESIZE=

Note: The PROC REPORT LS= option takes precedence over all other line size options.

Range 64-256 (integer)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

MISSING
considers missing values as valid values for group, order, or across variables. Special missing values used to represent numeric values (the letters A through Z and the underscore (_) character) are each considered as a different value. A group for each missing value appears in the report. If you omit the MISSING option, then PROC REPORT does not include observations with a missing value for any group, order, or across variables in the report.

See The "Missing Values" in *SAS Language Reference: Concepts*.

Example "Example 9: How PROC REPORT Handles Missing Values" on page 2198

NAMED
writes *name*= in front of each value in the report, where *name* is the column heading for the value.

Interaction When you use the NAMED option, PROC REPORT automatically uses the NOHEADER option.

Tip Use NAMED in conjunction with the WRAP option to produce a report that wraps all columns for a single row of the report onto consecutive lines rather than placing columns of a wide report on separate pages.

NOALIAS
lets you use a report that was created before compute blocks required aliases. If you use NOALIAS, then you cannot use aliases in compute blocks.

NOCENTER
See "CENTER|NOCENTER " on page 2078.

NOCOMPLETECOLS
See "COMPLETECOLS|NOCOMPLETECOLS" on page 2079.

NOCOMPLETEROWS
See "COMPLETEROWS|NOCOMPLETEROWS" on page 2079.

NOEXEC
suppresses the building of the report. Use NOEXEC with OUTREPT= to store a report definition in a catalog entry. Use NOEXEC with LIST and REPORT= to display a listing of the specified report definition.

Alias NOEXECUTE

NOHEADER
suppresses column headings, including headings that span multiple columns.

When you suppress the display of column headings in the interactive report window environment, you cannot select any report items.

NOTHREADS
See "THREADS|NOTHREADS" on page 2095.

NOWINDOWS
See "WINDOWS|NOWINDOWS " on page 2096.

Alias NOWD

Default The default mode is now the nonwindowing environment. You no longer have to specify NOWINDOWS or NOWD.

OUT=*SAS-data-set*
names the output data set. If this data set does not exist, then PROC REPORT creates it. The data set contains one observation for each report row and one observation for each unique summary line. If you use both customized and default summaries at the same place in the report, then the output data set contains only one observation because the two summaries differ only in how they present the data. Information about customization (underlining, color, text, and so on) is not data and is not saved in the output data set.

The output data set contains one variable for each column of the report. PROC REPORT tries to use the name of the report item as the name of the corresponding variable in the output data set. However, it cannot perform this substitution if a data set variable is under or over an across variable or if a data set variable appears multiple times in the COLUMN statement without aliases. In these cases, the name of the variable is based on the column number (_C1_, _C2_, and so on).

Output data set variables that are derived from input data set variables retain the formats of their counterparts in the input data set. PROC REPORT derives labels for these variables from the corresponding column headings in the report unless the only item defining the column is an across variable. In that case, the variables have no label. If multiple items are stacked in a column, then the labels of the corresponding output data set variables come from the analysis variable in the column.

The output data set also contains a character variable named _BREAK_. If an observation in the output data set derives from a detail row in the report, then

the value of _BREAK_ is missing or blank. If the observation derives from a summary line, then the value of _BREAK_ is the name of the break variable that is associated with the summary line, or **_RBREAK_**. If the observation derives from a COMPUTE BEFORE _PAGE_ or COMPUTE AFTER _PAGE_ statement, then the value of _BREAK_ is **_PAGE_**. Note, however, that for COMPUTE BEFORE _PAGE_ and COMPUTE AFTER _PAGE_, the **_PAGE_** value is written only to the output data set; it is not available as a value of the automatic variable _BREAK_ during execution of the procedure.

Tip An output data set can be created by using an ODS OUTPUT statement. The data set created by ODS OUTPUT is the same as the one created by the OUT= option. Refer to the "ODS OUTPUT Statement" in *SAS Output Delivery System: User's Guide*.

Examples "Example 10: Creating an Output Data Set and Storing Computed Variables" on page 2202

"Example 10: Creating an Output Data Set and Storing Computed Variables" on page 2202

OUTREPT=*libref.catalog.entry*

stores in the specified catalog entry the REPORT definition that is defined by the PROC REPORT step that you submit. PROC REPORT assigns the entry a type of REPT.

The stored report definition might differ in these ways from the statements that you submit:

- It omits some statements that are not specific to the REPORT procedure, whether you submit them with the PROC REPORT step or whether they are already in effect when you submit the step. These statements include

BY	TITLE
FOOTNOTE	WEIGHT
FREQ	WHERE

- It includes these PROC REPORT statement options. Others are omitted.

BOX	NOHEADER
CENTER	PAGESIZE
COLWIDTH	PANELS
COMPLETECOLS	PCTLDEF
COMPLETEROWS	PSPACE
FORMCHAR	QMARKERS
HEADLINE	QMETHOD
HEADSKIP	SHOWALL
HELP	SPACING
LINESIZE	SPLIT
MISSING	VARDEF
NAMED	WRAP

- It omits SAS system options.

- It resolves automatic macro variables.

PANELS=*number-of-panels*
specifies the number of panels on each page of the report. If the width of a report is less than half of the line size, then you can display the data in multiple sets of columns so that rows that would otherwise appear on multiple pages appear on the same page. Each set of columns is a *panel*. A familiar example of this type of report is a telephone book, which contains multiple panels of names and telephone numbers on a single page.

When PROC REPORT writes a multipanel report, it fills one panel before beginning the next.

The number of panels that fits on a page depends on the following:

- width of the panel
- space between panels
- line size

Default 1

Note This option affects only the LISTING output. It has no affect on other ODS output. However, the COLUMNS= option in the ODS PRINTER, ODS PDF, and ODS RTF statements produces similar results. For details, see the statements in *SAS Output Delivery System: User's Guide*.

Tip If *number-of-panels* is larger than the number of panels that can fit on the page, then PROC REPORT creates as many panels as it can. Let PROC REPORT put your data in the maximum number of panels that can fit on the page by specifying a large number of panels (for example, 99).

See For information about the space between panels and the line size, see the discussions of PSPACE= on page 2090 and the discussion of LS= on page 2085.

PCTLDEF=
See QNTLDEF= on page 2090.

PROFILE=*libref.catalog*
identifies the report profile to use. A report profile does the following:

- specifies the location of menus that define alternative menu bars and menus for the REPORT and COMPUTE windows
- sets defaults for WINDOWS, PROMPT, and COMMAND

PROC REPORT uses the entry REPORT.PROFILE in the catalog that you specify as your profile. If no such entry exists, or if you do not specify a profile, then PROC REPORT uses the entry REPORT.PROFILE in SASUSER.PROFILE. If you have no profile, then PROC REPORT uses default menus and the default settings of the options.

You create a profile from the PROFILE window while using PROC REPORT in an interactive report window environment. To create a profile:

- Invoke PROC REPORT with the WINDOWS option.
- Select **Tools** ⇨ **Report Profile**.
- Fill in the fields to meet your needs.
- Select **OK** to exit the PROFILE window. When you exit the window, PROC REPORT stores the profile in SASUSER.PROFILE.REPORT.PROFILE. Use the CATALOG procedure or the Explorer window to copy the profile to another location.

Note: If, after opening the PROFILE window, you decide not to create a profile, then select **CANCEL** to close the window.

PROMPT

opens the REPORT window and starts the PROMPT facility. This facility guides you through creating a new report or adding more data set variables or statistics to an existing report.

If you start PROC REPORT with prompting, then the first window gives you a chance to limit the number of observations that are used during prompting. When you exit the prompter, PROC REPORT removes these limits:

- the PROMPT option in the PROC REPORT statement
- the setting in your report profile

If you omit PROMPT from the PROC REPORT statement, then the procedure uses the setting in your report profile, if you have one. If you do not have a report profile, then PROC REPORT does not use the prompt facility. For information about report profiles, see "PROFILE Window" on page 2246.

Restriction When you use the PROMPT option, you open the REPORT window. When the REPORT window is open, you cannot send procedure output to any ODS destination.

Tip You can store a setting of PROMPT in your report profile. PROC REPORT honors the first of these settings that it finds.

PS=*page-size*

specifies the number of lines in a page of the report.

PROC REPORT honors the first of these page size specifications that it finds:

- the PS= option in the PROC REPORT statement
- the PS= setting in the report definition specified with REPORT= in the PROC REPORT statement
- the SAS system option PAGESIZE=

Range 15-32,767 (integer)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

PSPACE=*space-between-panels*
specifies the number of blank characters between panels. PROC REPORT separates all panels in the report by the same number of blank characters. For each panel, the sum of its width and the number of blank characters separating it from the panel to its left cannot exceed the line size.

Default 4

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

QMARKERS=*number*
specifies the default number of markers to use for the P^2 estimation method. The number of markers controls the size of fixed memory space.

Default The default value depends on which quantiles you request. For the median (P50), *number* is 7. For the quartiles (P25 and P75), *number* is 25. For the quantiles P1, P5, P10, P90, P95, or P99, *number* is 105. If you request several quantiles, then PROC REPORT uses the largest default value of *number*.

Range any odd integer greater than 3

Tip Increase the number of markers above the default settings to improve the accuracy of the estimates; you can reduce the number of markers to conserve computing resources.

QMETHOD=OS | P2
specifies the method that PROC REPORT uses to process the input data when it computes quantiles. If the number of observations is less than or equal to the value of the QMARKERS= option, and the value of the QNTLDEF= option is 5, then both methods produce the same results.

OS
uses order statistics. PROC UNIVARIATE uses this technique.

Note: This technique can be very memory intensive.

P2
uses the P^2 method to approximate the quantile.

Default OS

Restriction When QMETHOD=P2, PROC REPORT does not compute MODE and weighted quantiles.

Tip When QMETHOD=P2, reliable estimates of some quantiles (P1, P5, P95, P99) might not be possible for some data sets such as data sets with heavily tailed or skewed distributions.

QNTLDEF=1 | 2 | 3 | 4 | 5
specifies the mathematical definition that the procedure uses to calculate quantiles when the value of the QMETHOD= option is OS. When QMETHOD=P2, you must use QNTLDEF=5.

Alias PCTLDEF=

Default 5

See "Quantile and Related Statistics" on page 2706

REPORT=*libref.catalog.entry*
specifies the report definition to use. PROC REPORT stores all report definitions as entries of type REPT in a SAS catalog.

Interaction If you use REPORT=, then you cannot use the COLUMN statement.

See "OUTREPT=*libref.catalog.entry*" on page 2087

SHOWALL
overrides options in the DEFINE statement that suppress the display of a column.

See NOPRINT and NOZERO in "DEFINE Statement" on page 2116

SPACING=*space-between-columns*
specifies the number of blank characters between columns. For each column, the sum of its width and the blank characters between it and the column to its left cannot exceed the line size.

Default 2

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interactions PROC REPORT separates all columns in the report by the number of blank characters specified by SPACING= in the PROC REPORT statement unless you use SPACING= in the DEFINE statement to change the spacing to the left of a specific item.

When CENTER is in effect, PROC REPORT ignores spacing that precedes the leftmost variable in the report.

SPANROWS
specifies that when the value of a GROUP or ORDER column is the same in multiple rows, the value is displayed in a single cell that occupies that column in all the rows for which the value is the same. A box is essentially created for that part of the column, and no rows appear in that box.

The SPANROWS option also allows GROUP and ORDER variables values to repeat when the values break across pages. Only the PDF, PS, and TAGSETS.RTF destinations support this part of the feature.

Notes The SPANROWS option has no effect on the Report Window, data sets, LISTING, or OUTPUT destinations.

When the LINE statement occurs at the bottom of a page, the GROUP and ORDER variables values do not repeat when the values break across RTF and TAGSETS.RTF pages.

Tip If a summary row appears in the middle of a set of rows that would otherwise be spanned by a single cell, the summary row introduces its own cell in that column. This action breaks the spanning cell into two cells even when the value of the GROUP or ORDER variable that comes after the summary row is unchanged.

SPLIT='*character*'
specifies the split character. PROC REPORT breaks column text when it reaches that character and continues the text on the next line. The split character itself is not part of the column heading or text value although each occurrence of the split character counts toward the 256-character maximum for a label.

Default slash (/)

Restriction This option works only in the column heading on ODS destinations other than LISTING output.

Interaction The FLOW option in the DEFINE statement honors the split character.

STYLE<(*location(s)*)>=<*style-override(s)*>
specifies one or more style overrides to use for different parts of the report.

location(s)
identifies the part of the report that the STYLE= option affects. The following table shows what parts of a report are affected by values of *location*.

The valid and default values for *location* vary by what statement the STYLE= option appears in. The following table shows valid and default *location* values for each statement. To specify more than one value of *location* in the same STYLE= option, separate each value with a space.

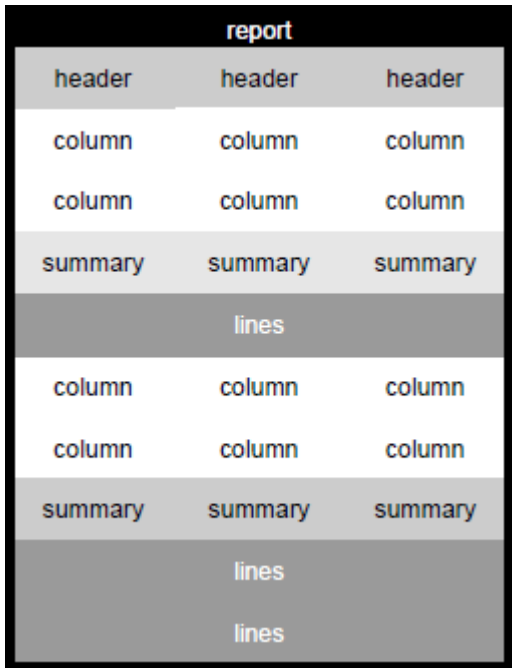
Table 58.4 *Locations and Default Style Elements for Each Statement in PROC REPORT*

Statement	Valid Location Values	Default Location Value	Part of Report Affected	Default Style Element
PROC REPORT	COLUMN HEADER | HDR SUMMARY REPORT LINES CALLDEF	REPORT	Report as a whole	Table
BREAK	SUMMARY LINES	SUMMARY	Summary lines	DataEmphasis

Statement	Valid Location Values	Default Location Value	Part of Report Affected	Default Style Element
CALL DEFINE	CALLDEF	CALLDEF	Cells identified by a CALL DEFINE statement	Data
COMPUTE	LINES	LINES	Lines generated by LINE statements	LineContent
DEFINE	COLUMN HEADER| HDR	COLUMN HEADER	Column cells Column headings	COLUMN: Data HEADER: Header
RBREAK	SUMMARY LINES	SUMMARY	Summary lines Lines generated by LINE statements	DataEmphasis

All names shown in the following table can be used in place of *location(s)* in the PROC statement. The DEFINE statement accepts column and header. The BREAK and RBREAK statement accept summary and lines.

Figure 58.9 *PROC REPORT Locations and Corresponding Statements*



Specifications in a PROC REPORT statement other than the PROC REPORT location override the same specification in the PROC REPORT statement. However, any style attributes that you specify in the PROC REPORT

statement and do not override in another PROC REPORT statement are inherited. For example, if you specify a blue background and a white foreground for all column headings in the PROC REPORT statement, and you specify a gray background for the column headings of a variable in the PROC REPORT DEFINE statement, then the background for that particular column heading is gray, and the foreground is white (as specified in the PROC REPORT statement).

style-override
specifies one or more style attributes or style elements to override the default style element and attributes in a specific area of a report. You can specify a style override in two ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.

Note: These style overrides take precedence over those specified in the PROC statement.

style-override has the following form:

style-element-name | [*style-attribute-name-1*=*style-attribute-value-1*

<*style-attribute-name-2*=*style-attribute-value-2* ...>]

Note: You can use braces ({ and }) instead of square brackets ([and]).

style-element-name
is the name of a style element that is part of an ODS style template. SAS provides some style templates. Users can create their own style templates with the TEMPLATE procedure. See *SAS Output Delivery System: Procedures Guide*

See For information about using styles with PROC REPORT, see "Using ODS Styles with PROC REPORT" on page 2142.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions " on page 2149.

style-attribute-name
specifies the attribute to change. For a list of the commonly used style attributes that you can set with the STYLE= option in PROC PRINT, PROC TABULATE, and PROC REPORT, see Table 58.114 on page 2146.

See For information about using styles with PROC REPORT, see "Using ODS Styles with PROC REPORT" on page 2142.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions " on page 2149.

style-attribute-value
specifies a value for the attribute. Each attribute has a different set of valid values. A SAS format can also be used as an attribute value for conditional formatting.

See For information about using styles with PROC REPORT, see "Using ODS Styles with PROC REPORT" on page 2142.

For information about using SAS formats as style attribute values, see "Using a Format to Assign a Style Attribute Value" on page 2152.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions " on page 2149.

Restriction All ODS destinations except OUTPUT and LISTING support the STYLE= option.

Tip FONT names that contain characters other than letters or underscores must be enclosed in quotation marks.

See "Style Elements and Style Attributes for Table Regions " on page 2149 for details.

Example "Example 13: Specifying Style Elements for ODS Output in Multiple Statements" on page 2212

THREADS | NOTHREADS
enables or disables parallel processing of the input data set. This option overrides the SAS system option THREADS | NOTHREADS unless the system option is restricted. (See Restriction.) See "Support for Parallel Processing" in *SAS Language Reference: Concepts* for more information.

Default value of SAS system option THREADS | NOTHREADS.

Restriction Your site administrator can create a restricted options table. A restricted options table specifies SAS system option values that are established at start-up and cannot be overridden. If the THREADS | NOTHREADS system option is listed in the restricted options table, any attempt to set these system options is ignored and a warning message is written to the SAS log.

Interaction PROC REPORT uses the value of the SAS system option THREADS except when a BY statement is specified or the value of the SAS system option CPUCOUNT is less than 2. You can specify the THREADS option in the PROC REPORT statement to force PROC REPORT to use parallel processing in these situations.

Note When threaded processing, also known as parallel processing, is in effect, observations might be returned in an unpredictable order. However, the observations are sorted correctly when a BY statement is specified.

VARDEF=*divisor*
specifies the divisor to use in the calculation of the variance and standard deviation. The following table shows the possible values for *divisor* and associated divisors.

Table 58.5 *Possible Values for VARDEF=*

Value	Divisor	Formula for Divisor
DF	Degrees of freedom	$n - 1$
N	Number of observations	n
WDF	Sum of weights minus one	$(\Sigma_i w_i) - 1$
WEIGHT | WGT	Sum of weights	$\Sigma_i w_i$

The procedure computes the variance as $CSS/divisor$, where CSS is the corrected sums of squares and equals $\Sigma (x_i - \bar{x})^2$. When you weight the analysis variables, CSS equals $\Sigma w_i(x_i - \bar{x}_w)^2$, where $\bar{x}_w$ is the weighted mean.

Default DF

Requirement To compute the standard error of the mean and Student's *t*-test, use the default value of VARDEF=.

Tips When you use the WEIGHT statement and VARDEF=DF, the variance is an estimate of σ^2 , where the variance of the *i*th observation is $var(x_i) = \sigma^2/w_i$ and w_i is the weight for the *i*th observation. This yields an estimate of the variance of an observation with unit weight.

When you use the WEIGHT statement and VARDEF=WGT, the computed variance is asymptotically (for large *n*) an estimate of $\sigma^2/\overline{w}$, where $\overline{w}$ is the average weight. This yields an asymptotic estimate of the variance of an observation with average weight.

See "WEIGHT" on page 82

WINDOWS | NOWINDOWS
selects an interactive report window or nonwindowing environment.

When you use WINDOWS, SAS opens the REPORT window for the interactive report interface, which enables you to modify a report repeatedly and to see the modifications immediately. When you use NOWINDOWS, PROC REPORT runs

without the REPORT window and sends its output to the open output destinations.

Alias WD | NOWD

Default NOWD. You no longer have to specify NOWINDOWS or NOWD to work in the nonwindowing environment.

Restriction When you use the WINDOWS option, you can send the output only to a SAS data set or to a Printer destination.

See If you are using the WINDOWS environment, see information about the report profile in PROFILE= on page 2088.

Example "Example 1: Selecting Variables and Creating a Summary Line for a Report" on page 2171

WRAP

displays one value from each column of the report, on consecutive lines if necessary, before displaying another value from the first column. By default, PROC REPORT displays only values for as many columns as it can fit on one page. It fills a page with values for these columns before starting to display values for the remaining columns on the next page.

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interaction When WRAP is in effect, PROC REPORT ignores PAGE in any item definitions.

Tip Typically, you use WRAP in conjunction with the NAMED option in order to avoid wrapping column headings.

BREAK Statement

Produces a default summary at a break (a change in the value of a group or order variable). The information in a summary applies to a set of observations. The observations share a unique combination of values for the break variable and all other group or order variables to the left of the break variable in the report.

Examples:

"Example 2: Ordering the Rows in a Report" on page 2174

"Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183

"Example 6: Creating a Column for Each Value of a Variable" on page 2187

"Example 7: Writing a Customized Summary on Each Page" on page 2190

Syntax

BREAK *location break-variable* </ *options*>;

Summary of Optional Arguments

COLOR=*color*
: specifies the color of the break lines in the REPORT window.

CONTENTS='*link-text*'
: specifies the link text used in the table of contents.

DOL
: double overlines each value.

DUL
: double underlines each value.

OL
: overlines each value.

PAGE
: starts a new page after the last break line.

SKIP
: writes a blank line for the last break line.

STYLE<*location(s)*>=<*style-override*>
: specifies a style override to use for default summary lines, customized summary lines or both.

SUMMARIZE
: writes a summary line in each group of break lines.

SUPPRESS
: suppresses the printing of the value of the break variable in the summary line and of any underlining or overlining in the break lines in the column containing the break variable.

UL
: underlines each value.

Required Arguments

location
controls the placement of the break lines and is either

AFTER
places the break lines immediately after the last row of each set of rows that have the same value for the break variable.

BEFORE
places the break lines immediately before the first row of each set of rows that have the same value for the break variable.

break-variable
is a group or order variable. The REPORT procedure writes break lines each time the value of this variable changes.

Optional Arguments

COLOR=*color*
specifies the color of the break lines in the REPORT window. The default color is the color of **Foreground** in the SASCOLOR window. You can use the following colors:

Table 58.6 *Colors Allowed for Break Lines*

BLACK	MAGENTA
BLUE	ORANGE
BROWN	PINK
CYAN	RED
GRAY	WHITE
GREEN	YELLOW

Default The color of **Foreground** in the SASCOLOR window. (For more information, see the online Help for the SASCOLOR window.)

Restriction This option affects only output in the interactive report window environment.

Note Not all operating environments and devices support all colors, and on some operating systems and devices, one color might map to another color. For example, if the DEFINITION window displays the word BROWN in yellow characters, then selecting BROWN results in a yellow item.

CONTENTS='*link-text*'
specifies the text for the entries in the table of contents created by default or by options settings in ODS destinations that support the STYLE= option. If the PAGE= option and the CONTENTS= option with *link-text* is specified, PROC REPORT uses the value of *link-text* as a link for tables created in the table of contents.

Default If the BREAK AFTER statement does not have a CONTENTS= option specified, but does have the PAGE option specified, then the default link text in the table of contents is “Table N” where N is an integer.

Restriction If CONTENTS= is specified, but no PAGE option is specified, then PROC REPORT generates a warning message in the SAS log file.

Interactions If the DEFINE statement has a page option and there is a BREAK BEFORE statement with a PAGE option and the CONTENTS= option has a value other than empty quotation marks specified, then PROC REPORT adds a directory to the table of contents and

puts links to the tables in that directory. For more information about this interaction, see the CONTENTS= option in the DEFINE statement on page 2116.

If there is a BREAK BEFORE statement specified and a CONTENTS=' ' option and a PAGE= option specified, then PROC REPORT does not create a directory in the table of contents. Instead, PROC REPORT uses the CONTENTS= value from the DEFINE statement to create links to the table of contents. If there is no CONTENTS= option in the DEFINE statement, then PROC REPORT creates links using the default text described in the DEFINE statement. Refer to the DEFINE statement on page 2116 CONTENTS= option for an explanation of the default text information.

For RTF output, the CONTENTS= option has no effect on the RTF body file unless you turn on the CONTENTS=YES option in the ODS RTF statement. In that case, a Table of Contents page is inserted at the front of your RTF output file. Your CONTENTS= option text from PROC REPORT then shows up in this separate Table of Contents page.

Note If a BREAK BEFORE statement is present and the PAGE option is specified but no CONTENTS= option is specified, then the default link text is the location variable plus the value of the location variable. The location variable is associated with the BREAK variable. The value is the BREAK variable value. As shown in the following code, the value is rep and the location is before rep. `break before rep / summarize page;`

Tips If the CONTENTS= option is specified where the value is empty quotation marks, then no table link is created in the table of contents. An example of this code is `CONTENTS=''`

If there are multiple BREAK BEFORE statements, then the link text is the concatenation of all of the CONTENTS= values or of all the default values.

DOL

(for double overlining) uses the 13th formatting character to overline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default equal sign (=)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interaction If you specify both the OL and DOL options, then PROC REPORT honors only OL.

See The discussion of FORMCHAR= on page 2081.

DUL
(for double underlining) uses the 13th formatting character to underline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default equal sign (=)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interaction If you specify both the UL and DUL options, then PROC REPORT honors only UL.

See The discussion of FORMCHAR= on page 2081.

OL
(for overlining) uses the second formatting character to overline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default hyphen (-)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interaction If you specify both the OL and DOL options, then PROC REPORT honors only OL.

See The discussion of FORMCHAR= on page 2081.

PAGE
in LISTING output, starts a new page. In the ODS destinations that support the STYLE= option, the PAGE option starts a new table. All ODS destinations except OUTPUT and LISTING support the STYLE= option.

Restriction In the OUTPUT destination, this option has no effect.

Interaction If you use PAGE in the BREAK statement and you create a break at the end of the report, then the summary for the whole report appears on a separate page.

Example "Example 7: Writing a Customized Summary on Each Page" on page 2190

SKIP
writes a blank line for the last break line.

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

STYLE<*location(s)*>=<*style-override*>
specifies the style override to use for default summary lines that are created with the BREAK statement.

You can specify a style override in two ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.

style-override has the following form:

style-element-name | [*style-attribute-name-1=style-attribute-value-1*
<*style-attribute-name-2=style-attribute-value-2* ...>]

Restriction All ODS destinations except OUTPUT and LISTING support the STYLE= option.

Tip FONT names that contain characters other than letters or underscores must be enclosed in quotation marks.

See "Style Elements and Style Attributes for Table Regions " on page 2149

SUMMARIZE
writes a summary line in each group of break lines. A summary line for a set of observations contains values for the following:

- the break variable (which you can suppress with the SUPPRESS option)
- other group or order variables to the left of the break variable
- statistics
- analysis variables
- computed variables

The following table shows how PROC REPORT calculates the value for each type of report item in a summary line that is created by the BREAK statement:

Report Item	Value
Break variable	Current value of the variable (or a missing value if you use SUPPRESS)
A group or order variable to the left of the break variable	Current value of the variable
A group or order variable to the right of the break variable, or a display variable anywhere in the report	Missing*

Report Item	Value
A statistic	Value of the statistic over all observations in the set
An analysis variable	Value of the statistic specified as the usage option in the item's definition. PROC REPORT calculates the value of the statistic over all observations in the set. The default usage is SUM.
A computed variable	Results of the calculations based on the code in the corresponding compute block. (See "COMPUTE Statement" on page 2112.)

* If you reference a variable with a missing value in a customized summary line, then PROC REPORT displays that variable as a blank (for character variables) or a period (for numeric variables).

Note: PROC REPORT cannot create groups in a report that contains order or display variables.

Accessibility note: If the SUPPRESS option and SUMMARIZE options are both specified, the summary row headers are not displayed and the table is not accessible.

Examples:
"Example 2: Ordering the Rows in a Report" on page 2174

"Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183

"Example 7: Writing a Customized Summary on Each Page" on page 2190

SUPPRESS

suppresses printing of

- the value of the break variable in the summary line
- any underlining and overlining in the break lines in the column that contains the break variable

Interaction: If you use SUPPRESS, then the value of the break variable is unavailable for use in customized break lines unless you assign a value to it in the compute block that is associated with the break. (See "COMPUTE Statement" on page 2112.)

Accessibility note: If the SUPPRESS option and SUMMARIZE options are both specified, the summary row headers are not displayed and the table is not accessible.

Example "Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183

UL

(for underlining) uses the second formatting character to underline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default hyphen (-)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interaction If you specify both the UL and DUL options, then PROC REPORT honors only UL.

See the discussion of FORMCHAR= on page 2081.

Details

Order of Break Lines

When a default summary contains more than one break line, the following is the order in which the break lines appear:

1. overlining or double overlining (OL or DOL)
2. summary line (SUMMARIZE)
3. underlining or double underlining (UL or DUL)
4. skipped line (SKIP)
5. page break (PAGE)

Note: If you define a customized summary for the break, then customized break lines appear after underlining or double underlining. For more information about customized break lines, see "COMPUTE Statement" on page 2112 and "LINE Statement" on page 2132.

BY Statement

Creates a separate report on a separate page for each BY group.

Restriction: If you use the BY statement, then you must use the PROC REPORT statement in the nonwindowing environment (NOWINDOWS or NOWD option).

Interaction: If you use the RBREAK statement in a report that uses BY processing, then PROC REPORT creates a default summary for each BY group. In this case, you cannot summarize information for the whole report.

Tip: Using the BY statement does not make the FIRST. and LAST. variables available in compute blocks.

See: "BY" on page 74

Syntax

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...> <NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, then the observations in the data set either must be sorted by all the variables that you specify or must be indexed appropriately. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the data set is sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. For example, the data are grouped in chronological order.

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

CALL DEFINE Statement

Sets the value of an attribute for a particular column in the current row. The CALL DEFINE statement is often used to write report definitions that other people use in an interactive report window environment. Only the FORMAT, URL, URLBP, and URLP attributes have an effect in the

nonwindowing environment. In fact, URL, URLBP, and URLP are effective only in the nonwindowing environment. The STYLE= and URL attributes are effective only when you are using ODS to create output.

Restriction: Valid only in a compute block that is attached to a report item.

Tip: All ODS destinations except OUTPUT and LISTING support the STYLE= option.

Example:

```
compute sales;
      if sales.sum>100 and _break_=' ' then
          call define(_col_, "style",
                  "style=[backgroundcolor=yellow
                          fontfamily=helvetica
                          fontweight=bold]");
endcomp;

compute weight;
      if weight > 100.0 then
          call define(_row_, "style/merge", "style={font_weight=bold}");
endcomp;
```

Examples:

"Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183

"Example 13: Specifying Style Elements for ODS Output in Multiple Statements" on page 2212

"Example 15: Using STYLE/MERGE in PROC REPORT CALL DEFINE Statement" on page 2223

"Example 16: Using STYLE/REPLACE in PROC REPORT CALL DEFINE Statement" on page 2225

Syntax

CALL DEFINE (*column-id* | _ROW_, ' *attribute-name*', *value*);

Required Arguments

column-id
specifies a column name or a column number (that is, the position of the column from the left edge of the report). A column ID can be one of the following:

- a character literal (in quotation marks) that is the column name
- a character expression that resolves to the column name
- a numeric literal that is the column number
- a numeric expression that resolves to the column number
- a name of the form '_C*n*_', where *n* is the column number
- the automatic variable _COL_, which identifies the column that contains the report item that the compute block is attached to

ROW
is an automatic variable that indicates the entire current row.

attribute-name
is the attribute to define. For attribute names, refer to Table 58.111 on page 2107.

Note: The attributes BLINK, HIGHLIGHT, and RVSVIDEO do not work on all devices.

value
sets the value for the attribute. For values for each attribute, refer to Table 58.111 on page 2107.

Table 58.7 *Attribute Descriptions*

Attribute	Description	Values	Affects
BLINK	Controls blinking of current value	1 turns blinking on; 0 turns it off	Interactive report window environment
COLOR	Controls the color of the current value in the REPORT window	'blue', 'red', 'pink', 'green', 'cyan', 'yellow', 'white', 'orange', 'black', 'magenta', 'gray', 'brown'	Interactive report window environment
COMMAND	Specifies that a series of commands follows	A quoted string of SAS commands to submit to the command line	Interactive report window environment
FORMAT	Specifies a format for the column	A SAS format or a user-defined format	Interactive report window and nonwindowing environments
HIGHLIGHT	Controls highlighting of the current value	1 turns highlighting on; 0 turns it off	Interactive report window environment
RVSVIDEO	Controls display of the current value	1 turns reverse video on; 0 turns it off	Interactive report window environment
STYLE	Specifies the style override of the column or row	an ODS style attribute	All ODS destinations.
STYLE/ MERGE	Merge the style specified with the existing styles in the same row or column	an ODS style attribute	All ODS destinations.
STYLE/ REPLACE	Replace the existing style in the row or column	an ODS style attribute	All ODS destinations.

Attribute	Description	Values	Affects
URL	Makes the contents of each cell of the column a link to the specified Uniform Resource Locator (URL)	A quoted URL (either single or double quotation marks can be used)	ODS HTML, HTML5, RTF, PDF, PowerPoint, EPUB destinations
URLBP	Makes the contents of each cell of the column a link. The link points to a Uniform Resource Locator that is a concatenation of 1 the string that is specified by the BASE= option in the ODS HTML statement 2 the string that is specified by the PATH= option in the ODS HTML statement 3 the value of the URLBP attribute 1	A quoted URL (either single or double quotation marks can be used)	ODS HTML and HTML5 destinations
URLP	Makes the contents of each cell of the column a link. The link points to a Uniform Resource Locator that is a concatenation of 1 the string that is specified by the PATH= option in the ODS HTML statement 2 the value of the URLP attribute	A quoted URL (either single or double quotation marks can be used)	ODS HTML and HTML5 destinations

1 For information about the BASE= and PATH= options, see the documentation for the ODS HTML Statement in *SAS Output Delivery System: User's Guide*.

Details

Using Style Attributes with the CALL DEFINE Statement

The STYLE attribute specifies the style-override to use in the cells that are affected by the CALL DEFINE statement.

The STYLE= value functions like the STYLE= option in other statements in PROC REPORT. However, instead of acting as an option in a statement, it becomes the value for the STYLE attribute. For example, the following CALL DEFINE statement sets the background color to yellow and the font size to 7 for the specified column:

```
call define(_col_, "style",
            "style=[backgroundcolor=yellow fontsize=7]");
```

For information about style precedence, see "Order of Precedence When Applying Style Attributes to Data Cells" on page 2151.

Restriction: All ODS destinations except OUTPUT and LISTING support the STYLE= option.

Interaction: If you set a style override for the CALLDEF location in the PROC REPORT statement and you want to use that exact style override in a CALL DEFINE statement, use an empty string as the value for the STYLE attribute, as shown here:

```
call define (_col_, "STYLE", "" );
```

Tip: FONT names that contain characters other than letters or underscores must be enclosed in quotation marks.

Featured in: "Example 13: Specifying Style Elements for ODS Output in Multiple Statements" on page 2212

Using STYLE/REPLACE and STYLE/MERGE Style Attributes

The STYLE/MERGE and STYLE/REPLACE attributes work only with styles specified by the CALL DEFINE statement. You cannot merge or replace a style that is specified by a STYLE(COLUMN)= option. A good time to use STYLE/REPLACE and STYLE/MERGE is when you have two or more COMPUTE blocks that have a CALL DEFINE statement, and these CALL DEFINE statements refer to the same cell.

STYLE= and STYLE/REPLACE attributes specify the style element to be used for ODS. If a style already exists for a cell or row, these STYLE attributes tell CALL DEFINE to replace the style specified by the STYLE= option. For an example program, see "Example 16: Using STYLE/REPLACE in PROC REPORT CALL DEFINE Statement" on page 2225.

The STYLE/MERGE attribute tells CALL DEFINE to merge the style specified by the STYLE= value with the existing style attributes that are in the same cell or row. If there is no previously existing STYLE= value to merge, STYLE/MERGE acts the same as the STYLE or STYLE/REPLACE attributes. For an example program, see "Example 15: Using STYLE/MERGE in PROC REPORT CALL DEFINE Statement" on page 2223.

COLUMN Statement

Describes the arrangement of all columns and of headings that span more than one column.

Restriction: You cannot use the COLUMN statement if you use REPORT= in the PROC REPORT statement.

Examples:
"Example 1: Selecting Variables and Creating a Summary Line for a Report" on page 2171

"Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177

"Example 6: Creating a Column for Each Value of a Variable" on page 2187

"Example 4: Displaying Multiple Statistics for One Variable" on page 2181
"Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195
"Example 9: How PROC REPORT Handles Missing Values" on page 2198

Syntax

COLUMN *column-specification(s)*;

Required Argument

column-specification(s)
is one or more of the following:

- *report-item(s)*
- *report-item-1*, *report-item-2* <. . . , *report-item-n*>
- (*'header-1 '* < . . . *'header-n '*> *report-item(s)*)
- *report-item=name*

where *report-item* is the name of a data set variable, a computed variable, or a statistic. See "Statistics That Are Available in PROC REPORT" on page 2140 for a list of available statistics.

report-item(s)
identifies items that each form a column in the report.

Examples "Example 1: Selecting Variables and Creating a Summary Line for a Report" on page 2171

"Example 9: How PROC REPORT Handles Missing Values" on page 2198

report-item-1, report-item-2 <. . . , report-item-n>
identifies report items that collectively determine the contents of the column or columns. These items are said to be stacked in the report because each item generates a heading, and the headings are stacked one above the other. The heading for the leftmost item is on top. If one of the items is an analysis variable, a computed variable, a group variable, or a statistic, then its values fill the cells in that part of the report. Otherwise, PROC REPORT fills the cells with frequency counts.

If you stack a statistic with an analysis variable, then the statistic that you name in the column statement overrides the statistic in the definition of the analysis variable. For example, the following PROC REPORT step produces a report that contains the minimum value of Sales for each sector:

```
proc report data=grocery;
column sector sales,min;
define sector/group;
define sales/analysis sum;
run;
```

If you stack a display variable under an across variable, then all the values of that display variable appear in the report.

Interaction A series of stacked report items can include only one analysis variable or statistic. If you include more than one analysis variable or statistic, then PROC REPORT returns an error because it cannot determine which values to put in the cells of the report.

Tip You can use parentheses to group report items whose headings should appear at the same level rather than stacked one above the other.

Examples "Example 6: Creating a Column for Each Value of a Variable" on page 2187

"Example 4: Displaying Multiple Statistics for One Variable" on page 2181

"Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195

('header-1' <... 'header-n '> report-item(s))
creates one or more headings that span multiple columns.

header
is a string of characters that spans one or more columns in the report. PROC REPORT prints each heading on a separate line. You can use split characters in a heading to split one heading over multiple lines. See the discussion of SPLIT= on page 2092.

In LISTING output, if the first and last characters of a heading are one of the following characters, then PROC REPORT uses that character to expand the heading to fill the space over the column or columns. Note that the <> and the >< must be paired. `- = . _ * + <> ><`

Similarly, if the first character of a heading is < and the last character is >, or vice versa, then PROC REPORT expands the heading to fill the space over the column by repeating the first character before the text of the heading and the last character after it.

Note: The use of expanding characters is supported only in LISTING destinations. Therefore, PROC REPORT simply removes the expanding characters when the output is directed to any other destination. Refer to "Understanding ODS Destinations" in *SAS Output Delivery System: User's Guide* for more information.

report-item(s)
specifies the columns to span.

Example "Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195

report-item=name
specifies an alias for a report item. You can use the same report item more than once in a COLUMN statement. However, you can use only one DEFINE statement for any given name. (The DEFINE statement designates characteristics such as formats and customized column headings. If you omit a DEFINE statement for an item, then the REPORT procedure uses defaults.) Assigning an alias in the COLUMN statement does not by itself alter the report. However, it does enable you to use separate DEFINE statements for each occurrence of a variable or statistic.

Note You cannot always use an alias. When you refer in a compute block to a report item that has an alias, you must use the alias. However, if the report item shares a column with an across variable, then you must reference the column by column number. (See "Four Ways to Reference Report Items in a Compute Block" on page 2063.)

Example "Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177

COMPUTE Statement

Starts a compute block containing one or more programming statements that PROC REPORT executes as it builds the report.

Restriction: If you are sending a report to multiple ODS destinations or to an ODS document that is replayed later, avoid the use of non-deterministic functions in a COMPUTE block (for example, LAG, DIF, RANUNI, DATETIME, and so on). If you need to use data created by such functions in your report, call the functions in a DATA step and store the results in the data set before running PROC REPORT.

Interaction: An ENDCOMP statement must mark the end of the group of statements in the compute block.

Note: A compute block can be associated with a report item or with a location (at the top or bottom of a report; at the top or bottom of a page; before or after a set of observations). You create a compute block with the COMPUTE window or with the COMPUTE statement. One form of the COMPUTE statement associates the compute block with a report item. Another form associates the compute block with a location. For a list of the SAS language elements that you can use in compute blocks, see "The Contents of Compute Blocks" on page 2062.

Tip: For information about how to use compute blocks, see The REPORT Procedure: A Primer for the Compute Block

Examples:
"Example 2: Ordering the Rows in a Report" on page 2174
"Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177
"Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183
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"Example 7: Writing a Customized Summary on Each Page" on page 2190

"Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195
"Example 10: Creating an Output Data Set and Storing Computed Variables" on page 2202
"Example 13: Specifying Style Elements for ODS Output in Multiple Statements" on page 2212

Syntax

COMPUTE *location* <*target*>
</ STYLE=<*style-override(s)* > >;

LINE *specification(s)*;

. . . select SAS language elements . . .

ENDCOMP;

COMPUTE *report-item* </ *type-specification*>;

CALL DEFINE (*column-id*, '*attribute-name*', *value*);

. . . select SAS language elements . . .

ENDCOMP;

Required Arguments

You must specify either a location or a report item in the COMPUTE statement.

location
determines where the compute block executes in relation to *target*.

AFTER
executes the compute block at a break in one of the following places:

- immediately after the last row of a set of rows that have the same value for the variable that you specify as *target* or, if there is a default summary on that variable, immediately after the creation of the preliminary summary line. (See Results: REPORT Procedure on page 2158.)
- in LISTING output, near the bottom of each page, immediately before any footnotes, if you specify _PAGE_ as *target*.
- at the end of the report if you omit a target.

BEFORE
executes the compute block at a break in one of the following places:

- immediately before the first row of a set of rows that have the same value for the variable that you specify as *target* or, if there is a default summary on that variable, immediately after the creation of the preliminary summary line. (See Results: REPORT Procedure on page 2158.)
- in LISTING output, near the top of each page, between any titles and the column headings, if you specify _PAGE_ as *target*.
- immediately before the first detail row if you omit a target.

Note If a report contains more columns than fit on a printed page, PROC REPORT generates an additional page or pages to contain the remaining columns. In this case, when you specify _PAGE_ as *target*, the COMPUTE block does NOT re-execute for each of these additional pages; the COMPUTE block re-executes only after all columns have been printed.

Examples "Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177

"Example 7: Writing a Customized Summary on Each Page" on page 2190

report-item
specifies a data set variable, a computed variable, or a statistic to associate the compute block with. If you are working in the nonwindowing environment, then you must include the report item in the COLUMN statement. If the item is a computed variable, then you must include a DEFINE statement for it.

Note The position of a computed variable is important. PROC REPORT assigns values to the columns in a row of a report from left to right. Consequently, you cannot base the calculation of a computed variable on any variable that appears to its right in the report.

Examples "Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183

"Example 6: Creating a Column for Each Value of a Variable" on page 2187

Optional Arguments

STYLE<(*location(s)*)>=<*style-override(s)*>
specifies the style to use for the text that is created by any LINE statements in this compute block.

You can specify a style override in two ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.

style-override has the following form:

style-element-name | [*style-attribute-name-1=style-attribute-value-1*

<*style-attribute-name-2=style-attribute-value-2* ...>]

Restriction All ODS destinations except OUTPUT and LISTING support the STYLE= option.

Tip FONT names that contain characters other than letters or underscores must be enclosed in quotation marks.

See "Style Elements and Style Attributes for Table Regions " on page 2149

Example "Example 13: Specifying Style Elements for ODS Output in Multiple Statements" on page 2212

target

controls when the compute block executes. If you specify a location (BEFORE or AFTER) for the COMPUTE statement, then you can also specify *target*, which can be one of the following:

break-variable

is a group or order variable.

When you specify a break variable, PROC REPORT executes the statements in the compute block each time the value of the break variable changes.

PAGE </ justification>

in LISTING output destinations, causes the compute block to execute once for each page, either immediately after printing any titles or immediately before printing any footnotes. *justification* controls the placement of text and values. It can be one of the following:

CENTER

centers each line that the compute block writes.

LEFT

left-justifies each line that the compute block writes.

RIGHT

right-justifies each line that the compute block writes.

Default CENTER

Example "Example 7: Writing a Customized Summary on Each Page" on page 2190

type-specification

specifies the type. (Optional) Also specifies the length of *report-item*. If the report item that is associated with a compute block is a computed variable, then PROC REPORT assumes that it is a numeric variable unless you use a type specification to specify that it is a character variable. A type specification has the form

CHARACTER <LENGTH=*length*>

where

CHARACTER

specifies that the computed variable is a character variable. If you do not specify a length, then the variable's length is 8.

Alias CHAR

Example "Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195

LENGTH=*length*
specifies the length of a computed character variable.

Default 8

Range 1 to 200

Interaction If you specify a length, then you must use CHARACTER to indicate that the computed variable is a character variable.

Example "Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195

DEFINE Statement

Describes how to use and display a report item.

Restriction: A weight cannot be applied to a *report-item* alias without also applying it to the report-item. The WEIGHT= option must appear in the DEFINE statement for the *report-item*.

Accessibility note: When the DEFINE statement includes an ORDER or GROUP option, the SPANROWS option must also be included in the PROC REPORT statement to generate an accessible table.

Tip: If you do not use a DEFINE statement, then PROC REPORT uses default characteristics.

Examples:
"Example 2: Ordering the Rows in a Report" on page 2174
"Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177
"Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183
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"Example 11: Using a Format to Create Groups" on page 2206
"Example 13: Specifying Style Elements for ODS Output in Multiple Statements" on page 2212
"Example 12: Using Multilabel Formats" on page 2209
"Example 14: Using the CELLWIDTH= Style Attribute with PROC REPORT" on page 2220

Syntax

DEFINE *report-item* / <*options*>;

Summary of Optional Arguments

Control the placement of values and column headings

CENTER
: centers the formatted values of the report item within the column width and center the column heading over the values.

COLOR=*color*
: specifies the color in the REPORT window of the column heading and of the values of the item that you define.

column-header
: defines the column heading for the report item.

LEFT
: left-justifies the formatted values of the report item within the column width and left-justifies the column headings over the values.

RIGHT
: right-justifies the formatted values of the report item within the column width and right-justifies the column headings over the values.

Customize the appearance of a report item

EXCLUSIVE
: excludes all combinations of the item that are not found in the preloaded range of user-defined formats.

FORMAT=*format*
: assigns a SAS or user-defined format to the item.

MISSING
: considers missing values as valid values for the item.

MLF
: enables PROC REPORT to use the format label or labels to create subgroup combinations that have multilabel formats.

ORDER=DATA | FORMATTED | FREQ | INTERNAL
: orders the values of a group, order, or across variable according to the specified order.

PRELOADFMT
: specifies that all formats are preloaded for the item.

SPACING=*horizontal-positions*
: for LISTING output, defines the number of blank characters to leave between the column being defined and the column immediately to its left.

statistic
: associates a statistic with an analysis variable.

STYLE<(*location(s)*)>=<*style-overrides(s)*>

specifies a style element (for the Output Delivery System) for the report item.

WEIGHT=*weight-variable*
specifies a numeric variable whose values weight the value of the analysis variable.

WIDTH=*column-width*
defines the width of the column in which PROC REPORT displays the report item.

Specify how to use a report item

ACROSS
defines the item, which must be a data set variable, as an across variable.

ANALYSIS
defines the item, which must be a data set variable, as an analysis variable.

COMPUTED
defines the item as a computed variable.

DISPLAY
defines the item, which must be a data set variable, as a display variable.

GROUP
defines the item, which must be a data set variable, as a group variable.

ORDER
defines the item, which must be a data set variable, as an order variable.

Specify options for a report item

CONTENTS='*link-text*'
creates a link in the table of contents.

DESCENDING
reverses the order in which PROC REPORT displays rows or values of a group, order, or across variable.

FLOW
wraps the value of a character variable in its column.

ID
specifies that the item that you are defining is an ID variable.

NOPRINT
suppresses the display of the report item.

NOZERO
suppresses the display of the report item if its values are all zero or missing.

PAGE
inserts a page break just before printing the first column containing values of the report item.

Required Argument

report-item
specifies the name or alias (established in the COLUMN statement) of the data set variable, computed variable, or statistic to define. The following are types of names that can be used for *report-item*:

- a SAS identifier (determined by the VALIDVARNAME option)
- a name literal
- a numbered range list
- a name range list
- a special name list
- a name prefix list
- a statistic

Notes The names in variable range lists refer to variables in the input data set, not statistic names, or computed variable names. Use only one name for each DEFINE statement. That one name, however, can be a range list. Example syntax using a variable range list is: `DEFINE Var1-Var3/ width=10 center "#Visit#Date";`

Do not specify a usage option in the definition of a statistic. The name of the statistic tells PROC REPORT how to use it.

See "Names in the SAS Language" in *SAS Language Reference: Concepts*, "SAS Variable Lists" in *SAS Language Reference: Concepts*, and "VALIDVARNAME= System Option" in *SAS System Options: Reference*.

Optional Arguments

ACROSS

defines *report-item*, which must be a data set variable, as an across variable. (See "Across Variables" on page 2058.)

Example "Example 6: Creating a Column for Each Value of a Variable" on page 2187

ANALYSIS

defines *report-item*, which must be a data set variable, as an analysis variable. (See "Analysis Variables" on page 2057.)

By default, PROC REPORT calculates the Sum statistic for an analysis variable. Specify an alternate statistic with the *statistic* option in the DEFINE statement.

Note: Naming a statistic in the DEFINE statement implies the ANALYSIS option, so you never need to specify ANALYSIS. However, specifying ANALYSIS can make your code easier for novice users to understand.

Note: Special missing values show up as missing values when they are defined as ANALYSIS variables.

Examples "Example 2: Ordering the Rows in a Report" on page 2174

"Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177

"Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183

CENTER
centers the formatted values of the report item within the column width and centers the column heading over the values. This option has no effect on the CENTER option in the PROC REPORT statement, which centers the report on the page.

Restriction This option affects the header and the data of LISTING output. In ODS output, only the data is affected by this option.

COLOR=*color*
specifies the color in the REPORT window of the column heading and of the values of the item that you are defining. You can use the following colors:

BLACK	MAGENTA
BLUE	ORANGE
BROWN	PINK
CYAN	RED
GRAY	WHITE
GREEN	YELLOW

Note: Not all operating environments and devices support all colors, and in some operating environments and devices, one color might map to another color. For example, if the DEFINITION window displays the word BROWN in yellow characters, then selecting BROWN results in a yellow item.

Default The color of **Foreground** in the SASCOLOR window. (For more information, see the online Help for the SASCOLOR window.)

Restriction This option affects output in the interactive report window environment only.

column-header
defines the column heading for the report item. Enclose each heading in single or double quotation marks. When you specify multiple column headings, PROC REPORT uses a separate line for each one. The split character also splits a column heading over multiple lines.

In LISTING output, if the first and last characters of a heading are one of the following characters, then PROC REPORT uses that character to expand the heading to fill the space over the column: `:- = \_ .* +`

Similarly, if the first character of a heading is < and the last character is >, or vice versa, then PROC REPORT expands the heading to fill the space over the column by repeating the first character before the text of the heading and the last character after it.

The following table shows the default variables and statistics:

Item	Header
Variable without a label	Variable name
Variable with a label	Variable label
Statistic	Statistic name

Tips If you want to use names when labels exist, then submit the following SAS statement before invoking PROC REPORT: `options nolabel;`

HEADLINE underlines all column headings and the spaces between them. In LISTING output, you can underline column headings without underlining the spaces between them, by using the special characters `'--'` as the last line of each column heading instead of using HEADLINE. (See "Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183.)

See SPLIT= on page 2092

Examples "Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177

"Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183

"Example 6: Creating a Column for Each Value of a Variable" on page 2187

COMPUTED

defines the specified item as a computed variable. Computed variables are variables that you define for the report. They are not in the input data set, and PROC REPORT does not add them to the input data set.

In the interactive report window environment, you add a computed variable to a report from the COMPUTED VAR window.

In the nonwindowing environment, you add a computed variable as by

- including the computed variable in the COLUMN statement
- defining the variable's usage as COMPUTED in the DEFINE statement
- computing the value of the variable in a compute block associated with the variable

Examples "Example 6: Creating a Column for Each Value of a Variable" on page 2187

"Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195

CONTENTS='*link-text*'

specifies the text for the entries in the table of contents created by default or by options settings in ODS destinations that support the STYLE= option. If the DEFINE statement has the PAGE= option and the CONTENTS= option specified with a *link-text* value assigned, then PROC REPORT adds a directory to the table of contents and uses the value of *link-text* as a link for tables created in the table of contents.

Default If the DEFINE statement has a PAGE option, but does not have a CONTENTS= option specified, then a directory is created with the directory text as COLA-COLB. COLA is the name or alias of the leftmost column and COLB is the name or alias of the rightmost column. If the table has only one column, then the directory text is the column name or alias.

Restriction If CONTENTS= is specified, but no PAGE option is specified, then PROC REPORT generates a warning message in the SAS log file.

Interactions If the DEFINE statement has a page option and there is a BREAK BEFORE statement with a PAGE option and the CONTENTS= option specified has a value other than empty quotation marks, then PROC REPORT adds a directory to the table of contents and puts links to the tables in that directory.

If the DEFINE statement has a PAGE option and there is a BREAK BEFORE statement with no PAGE option, then PROC REPORT does not create a directory in the table of contents. Instead, PROC REPORT uses the CONTENTS= value from the DEFINE statement to create links to the table of contents. If there is no CONTENTS= option in the DEFINE statement, then PROC REPORT creates links using the default text COLA–COLB. Refer to the Default explanation above.

If there is a BREAK BEFORE statement with a CONTENTS='' option specified and a PAGE option specified, then PROC REPORT does not create a directory in the table of contents. Instead, PROC REPORT uses the CONTENTS= value from the DEFINE statement to create links to the table of contents. If there is no CONTENTS= option in the DEFINE statement, then PROC REPORT creates links using the default text COLA–COLB. Refer to the Default explanation above.

Tips If the DEFINE statement specifies the CONTENTS= option where the value is empty quotation marks, then the directory to the table of contents is not added. An example of this code is as follows:

```
CONTENTS=''
```

If there are multiple BREAK BEFORE statements, then the link text is the concatenation of all of the CONTENTS= values or of all the default values.

All ODS destinations except OUTPUT and LISTING support the STYLE= option.

DESCENDING
reverses the order in which PROC REPORT displays rows or values of a group, order, or across variable.

Tip By default, PROC REPORT orders group, order, and across variables by their formatted values. Use the ORDER= option in the DEFINE statement to specify an alternate sort order.

DISPLAY
defines *report-item*, which must be a data set variable, as a display variable. (See "Display Variables" on page 2055.)

EXCLUSIVE
excludes from the report and the output data set all combinations of the group variables and the across variables that are not found in the preloaded range of user-defined formats.

Requirement You must specify the PRELOADFMT option in the DEFINE statement in order to preload the variable formats.

FLOW
wraps the value of a character variable in its column. The FLOW option honors the split character. If the text contains no split character, then PROC REPORT tries to split text at a blank.

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

FORMAT=*format*
assigns a SAS or user-defined format to the item. This format applies to *report-item* as PROC REPORT displays it; the format does not alter the format associated with a variable in the data set. For data set variables, PROC REPORT honors the first of these formats that it finds:

- the format that is assigned with FORMAT= in the DEFINE statement
- the format that is assigned in a FORMAT statement when you invoke PROC REPORT
- the format that is associated with the variable in the data set

If none of these formats is present, then PROC REPORT uses BEST*w*. for numeric variables and $*w*. for character variables. The value of *w* is the default column width. For character variables in the input data set, the default column width is the variable's length. For numeric variables in the input data set and for computed variables (both numeric and character), the default column width is the value specified by COLWIDTH= in the PROC REPORT statement or in the ROPTIONS window.

In the interactive report window environment, if you are unsure what format to use, then type a question mark (?) in the format field in the DEFINITION window to access the FORMATS window.

Alias F=

Examples "Example 2: Ordering the Rows in a Report" on page 2174

"Example 4: Displaying Multiple Statistics for One Variable" on page 2181

GROUP

defines *report-item*, which must be a data set variable, as a group variable. (See "Group Variables" on page 2056.)

Accessibility note When the DEFINE statement includes an ORDER or GROUP option, the SPANROWS option must also be included in the PROC REPORT statement to generate an accessible table.

Examples "Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183

"Example 4: Displaying Multiple Statistics for One Variable" on page 2181

"Example 11: Using a Format to Create Groups" on page 2206

ID

specifies that the item that you are defining is an ID variable. An ID variable and all columns to its left appear at the left of every page of a report. ID ensures that you can identify each row of the report when the report contains more columns than fits on one page.

LEFT

left-justifies the formatted values of the report item within the column width and left-justifies the column headings over the values. If the format width is the same as the width of the column, then the LEFT option has no effect on the placement of values.

Restriction This option affects the header and the data of LISTING output. In ODS output, only the data is affected by this option.

MISSING

considers missing values as valid values for the report item. Special missing values that represent numeric values (the letters A through Z and the underscore (_) character) are each considered as a separate value.

Default If you omit the MISSING option, then PROC REPORT excludes from the report and the output data sets all observations that have a missing value for any group, order, or across variable.

MLF

enables PROC REPORT to use the format label or labels for a given range or for overlapping ranges to create subgroup combinations that use multilabel

formatting. These multilabel formats are used only with group and across variables.

MLF is supported on all ODS destinations, the LISTING destination, data sets, and the REPORT WINDOW.

Note: PROC REPORT supports assigning a numeric variable that has a multilabel format to a character variable.

Requirement Use PROC FORMAT and the MULTILABEL option in the VALUE statement to create a multilabel format.

Tips The MLF option has no effect unless the variable is associated with a multilabel format. If there is no MULTILABEL format associated with the column, then an additional FORMAT statement or FORMAT= option in the DEFINE statement is needed to associate an existing format or informat with one or more variables. If MULTILABEL format is already associated with the column (using any regular method to associate a format with the variable), then no additional FORMAT statement or FORMAT= option is needed.

If the MLF option is omitted, PROC REPORT uses the primary format labels to determine the subgroup combinations. The primary format labels correspond to the first external format value.

See MULTILABEL option on page 1124 in the VALUE statement of the FORMAT procedure.

Example “Example 12: Using Multilabel Formats” on page 2209

NOPRINT

suppresses the display of the report item. Use this option

- if you do not want to show the item in the report but you need to use its values to calculate other values that you use in the report.
- to establish the order of rows in the report.
- if you do not want to use the item as a column but want to have access to its values in summaries. (See “Example 7: Writing a Customized Summary on Each Page” on page 2190.)

Interactions Even though the columns that you define with NOPRINT do not appear in the report, you must count them when you are referencing columns by number. (See “Four Ways to Reference Report Items in a Compute Block” on page 2063.)

SHOWALL in the PROC REPORT statement or the ROPTIONS window overrides all occurrences of NOPRINT.

Examples “Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable” on page 2177

"Example 7: Writing a Customized Summary on Each Page" on page 2190

NOZERO
suppresses the display of the report item if its values are all zero or missing.

Interactions Even though the columns that you define with NOZERO do not appear in the report, you must count them when you are referencing columns by number. (See "Four Ways to Reference Report Items in a Compute Block" on page 2063.)

SHOWALL in the PROC REPORT statement or in the ROPTIONS window overrides all occurrences of NOZERO.

ORDER
defines *report-item*, which must be a data set variable, as an order variable. (See "Order Variables" on page 2056.)

Accessibility note When the DEFINE statement includes an ORDER or GROUP option, the SPANROWS option must also be included in the PROC REPORT statement to generate an accessible table.

Example "Example 2: Ordering the Rows in a Report" on page 2174

ORDER=DATA | FORMATTED | FREQ | INTERNAL
orders the values of a group, order, or across variable according to the specified order, where

DATA
orders values according to their order in the input data set.

Note If you specify the ORDER=DATA option for input data in a DBMS table, the order of rows written to a database table from PROC REPORT is not likely to be preserved.

FORMATTED
orders values by their formatted (external) values. If no format has been assigned to a class variable, then the default format, BEST12., is used.

FREQ
orders values by ascending frequency count.

INTERNAL
orders values by their unformatted values. This order depends on your operating environment. This sort sequence is particularly useful for displaying dates chronologically.

Specifying ORDER=INTERNAL usually, but not always, produces the same results as PROC SORT. For more information about ordering data, see "Controlling the Order of Data Values" on page 27.

Default FORMATTED

Interaction DESCENDING in the item's definition reverses the sort sequence for an item. By default, the order is ascending.

Note The default value for the ORDER= option in PROC REPORT is not the same as the default value in other SAS procedures. In other SAS procedures, the default is ORDER=INTERNAL. The default for the option in PROC REPORT might change in a future release to be consistent with other procedures. Therefore, in production jobs where it is important to order report items by their formatted values, specify ORDER=FORMATTED even though it is currently the default. Doing so ensures that PROC REPORT continues to produce the reports that you expect even if the default changes.

Example "Example 2: Ordering the Rows in a Report" on page 2174

PAGE

inserts a page break just before printing the first column containing values of the report item.

Restriction This option has no affect on the OUTPUT destination.

Interaction PAGE is ignored if you use WRAP in the PROC REPORT statement or in the ROPTIONS window.

Tip In the listing destination, a PAGE option in the DEFINE statement causes PROC REPORT to print this column and all columns to its right on a new page. However, for nonlisting destinations, the page break does not occur until all the rows in the report have been printed. Therefore, PROC REPORT prints all the rows for all the columns to the left of the PAGE column and then starts over at the top of the report and prints the PAGE column and the columns to the right.

PRELOADFMT

specifies that the format is preloaded for the variable.

Restriction PRELOADFMT applies only to group and across variables.

Requirement PRELOADFMT has no effect unless you specify either EXCLUSIVE or ORDER=DATA and you assign a format to the variable.

Interactions To limit the report to the combination of formatted variable values that are present in the input data set, use the EXCLUSIVE option in the DEFINE statement.

To include all ranges and values of the user-defined formats in the output, use the COMPLETEROWS option in the PROC REPORT statement.

Notes If you do not specify NOCOMPLETECOLS when you define the across variables, then the report includes a column for every formatted variable. If you specify COMPLETEROWS when you define the group variables, then the report includes a row for every formatted value. Some combinations of rows and columns might not make sense when the report includes a column for every formatted value of the across variable and a row for every formatted value of the group variable.

When preloading a character format, there must be at least one representative raw value that produces the label. If a range does not have any raw values, the range is considered unreachable and an error is generated. For example, you cannot preload a multi-label character format with both Other= and Low-High ranges. Other is a special keyword that refers to values or ranges that remain after all labels have been defined. For character formats, missing values are included in the low range so that there are no raw values left to occupy the Other range.

Example "Example 12: Using Multilabel Formats" on page 2209

RIGHT

right-justifies the formatted values of the specified item within the column width and right-justifies the column headings over the values. If the format width is the same as the width of the column, then RIGHT has no effect on the placement of values.

Restriction This option affects the header and the data of LISTING output. In ODS output, only the data is affected by this option.

SPACING=*horizontal-positions*

defines the number of blank characters to leave between the column being defined and the column immediately to its left. For each column, the sum of its width and the blank characters between it and the column to its left cannot exceed the line size.

Default 2

Restriction This option has no effect on ODS destinations other than the LISTING destination.

Interactions When PROC REPORT's CENTER option is in effect, PROC REPORT ignores spacing that precedes the leftmost variable in the report.

SPACING= in an item's definition overrides the value of SPACING= in the PROC REPORT statement or in the ROPTIONS window.

statistic

associates a statistic with an analysis variable. You must associate a statistic with every analysis variable in its definition. PROC REPORT uses the statistic that you specify to calculate values for the analysis variable for the observations that are represented by each cell of the report. You cannot use *statistic* in the definition of any other type of variable.

See "Statistics That Are Available in PROC REPORT" on page 2140 for a list of available statistics.

Default SUM

Note PROC REPORT uses the name of the analysis variable as the default heading for the column. You can customize the column heading with the *column-header* option in the DEFINE statement.

Examples "Example 2: Ordering the Rows in a Report" on page 2174

"Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177

"Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183

STYLE<(*location(s)*)>=<*style-overrides(s)*>
specifies the style element to use for column headings and for text inside cells for this report item.

You can specify a style override in two ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.

style-override has the following form:

style-element-name | [*style-attribute-name-1=style-attribute-value-1*

<*style-attribute-name-2=style-attribute-value-2* ...>]

Restriction All ODS destinations except OUTPUT and LISTING support the STYLE= option.

Tip FONT names that contain characters other than letters or underscores must be enclosed in quotation marks.

See "Style Elements and Style Attributes for Table Regions " on page 2149

Example "Example 13: Specifying Style Elements for ODS Output in Multiple Statements" on page 2212

WEIGHT=*weight-variable*
specifies a numeric variable whose values weight the values of the analysis variable that is specified in the DEFINE statement. The variable value does not have to be an integer. The following table describes how PROC REPORT treats various values of the WEIGHT variable.

Weight Value	PROC REPORT Response
0	Counts the observation in the total number of observations
Less than 0	Converts the value to zero and counts the observation in the total number of observations
Missing	Excludes the observation

To exclude observations that contain negative and zero weights from the analysis, use the EXCLNPWGT option in the PROC REPORT statement. Note that most SAS/STAT procedures, such as PROC GLM, exclude negative and zero weights by default.

Alias WGT=

Restrictions to compute weighted quantiles, use QMETHOD=OS in the PROC REPORT statement.

A weight cannot be applied to a *report-item* alias without also applying it to the *report-item*. The WEIGHT= option must appear in the DEFINE statement for the *report-item*.

Tips When you use the WEIGHT= option, consider which value of the VARDEF= option in the PROC REPORT statement is appropriate.

Use the WEIGHT= option in separate variable definitions in order to specify different weights for the variables.

WIDTH=*column-width*

defines the width of the column in which PROC REPORT displays *report-item*. This option affects only LISTING output.

For information about formats, see the discussion of "FORMAT=*format*" on page 2123.

Default A column width that is just large enough to handle the format. If there is no format, then PROC REPORT uses the value of the COLWIDTH= option in the PROC REPORT statement.

Range 1 to the value of the SAS system option LINESIZE=

Restriction This option has no effect on ODS destinations other than LISTING output. For ODS destinations, use the STYLE= option with the WIDTH= style attribute or the CELLWIDTH= style attribute. Refer to "Style Attributes Tables" in *SAS Output Delivery System: Advanced Topics* for details. See how style attributes WIDTH= and CELLWIDTH= can be used with PROC REPORT in "Example 14: Using the CELLWIDTH= Style Attribute with PROC REPORT" on page 2220.

Interaction WIDTH= in an item definition overrides the value of COLWIDTH= in the PROC REPORT statement or the ROPTIONS window.

Tip When you stack items in the same column in a report, the width of the item that is at the bottom of the stack determines the width of the column.

ENDCOMP Statement

Marks the end of one or more programming statements that PROC REPORT executes as it builds the report.

Restriction: A COMPUTE statement must precede the ENDCOMP statement.

See: COMPUTE statement

Example: "Example 2: Ordering the Rows in a Report" on page 2174

Syntax

ENDCOMP;

FREQ Statement

Treats observations as if they appear multiple times in the input data set.

Tip: The effects of the FREQ and WEIGHT statements are similar except when calculating degrees of freedom.

See: For an example that uses the FREQ statement, see "Example" on page 80

Syntax

FREQ *variable*;

Required Argument

variable
specifies a numeric variable whose value represents the frequency of the observation. If you use the FREQ statement, then the procedure assumes that each observation represents *n* observations, where *n* is the value of *variable*. If *n* is not an integer, then SAS truncates it. If *n* is less than 1 or is missing, then the procedure does not use that observation to calculate statistics.

Details

Frequency Information Is Not Saved

When you store a report definition, PROC REPORT does not store the FREQ statement.

LINE Statement

Provides a subset of the features of the PUT statement for writing customized summaries.

Restrictions: This statement is valid only in a compute block that is associated with a location in the report.

You cannot use the LINE statement in conditional statements (IF-THEN, IF-THEN/ELSE, and SELECT) because it is not executed until PROC REPORT has executed all other statements in the compute block.

Accessibility note: Using the LINE statement causes an inaccessible table to be generated.

Examples:
"Example 2: Ordering the Rows in a Report" on page 2174
"Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177
"Example 5: Consolidating Multiple Observations into One Row of a Report" on page 2183
"Example 6: Creating a Column for Each Value of a Variable" on page 2187
"Example 7: Writing a Customized Summary on Each Page" on page 2190

Syntax

LINE *specification(s)*;

Required Argument

specification(s)
can have one of the following forms. You can mix different forms of specifications in one LINE statement.

item item-format
specifies the item to display and the format to use to display it, where

item
is the name of a data set variable, a computed variable, or a statistic in the report. For information about referencing report items, see "Four Ways to Reference Report Items in a Compute Block" on page 2063.

item-format
is a SAS format or user-defined format. You must specify a format for each item.

Example "Example 2: Ordering the Rows in a Report" on page 2174

'character-string'
specifies a string of text to display. When the string is a blank and nothing else is in *specification(s)*, PROC REPORT prints a blank line.

Note: A hexadecimal value (such as **'DF'x**) that is specified within *character-string* is not resolved because it is specified within quotation marks. To resolve a hexadecimal value, use the **%sysfunc(byte(num))** function, where **num** is the hexadecimal value. Be sure to enclose *character-string* in double quotation marks (" ") so that the macro function resolves.

Example "Example 2: Ordering the Rows in a Report" on page 2174

number-of-repetitions'character-string'*
specifies a character string and the number of times to repeat it.

Example "Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177

pointer-control
specifies the column in which PROC REPORT displays the next specification. You can use either of the following forms for pointer controls:

@column-number
specifies the number of the column in which to begin displaying the next item in the specification list.

+column-increment
specifies the number of columns to skip before beginning to display the next item in the specification list.

Both *column-number* and *column-increment* can be either a variable or a literal value.

Restriction The pointer controls are designed for LISTING output. They have no effect on other ODS destinations.

Details

Differences between the LINE and PUT Statements

The LINE statement does not support the following features of the PUT statement:

- automatic labeling signaled by an equal sign (=), also known as named output
- the _ALL_, _INFILE_, and _PAGE_ arguments and the OVERPRINT option

- grouping items and formats to apply one format to a list of items
- pointer control using expressions
- line pointer controls (# and /)
- trailing at signs (@ and @@)
- format modifiers
- array elements

RBREAK Statement

Produces a default summary at the beginning or end of a report or at the beginning or end of each BY group.

Examples: "Example 1: Selecting Variables and Creating a Summary Line for a Report" on page 2171

"Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195

Syntax

RBREAK *location* </ *options*>;

Summary of Optional Arguments

COLOR=*color*
: specifies the color of the break lines in the REPORT window.

CONTENTS='*link-text*'
: specifies the link text used in the table of contents.

DOL
: double overlines each value.

DUL
: double underlines each value.

OL
: overlines each value.

PAGE
: starts a new page after the last break line of a break located at the beginning of the report.

SKIP
: writes a blank line for the last break line of a break located at the beginning of the report.

STYLE<(*location(s)*)>=<*style-overrides(s)*>
: specifies a style element (for the Output Delivery System) for default summary lines, customized summary lines, or both.

SUMMARIZE
includes a summary line as one of the break lines.

UL
underlines each value.

Required Argument

location
controls the placement of the break lines and is either of the following:

AFTER
places the break lines at the end of the report.

BEFORE
places the break lines at the beginning of the report.

Optional Arguments

COLOR=*color*
specifies the color of the break lines in the REPORT window. You can use the following colors:

BLACK	MAGENTA
BLUE	ORANGE
BROWN	PINK
CYAN	RED
GRAY	WHITE
GREEN	YELLOW

Default The color of **Foreground** in the SASCOLOR window. (For more information, see the online Help for the SASCOLOR window.)

Restriction This option affects output in the interactive report window environment only.

Note Not all operating environments and devices support all colors, and in some operating environments and devices, one color might map to another color. For example, if the DEFINITION window displays the word BROWN in yellow characters, then selecting BROWN results in a yellow item.

CONTENTS='*link-text*'
specifies the text for the entries in the table of contents created by default or by options settings in ODS destinations that support the STYLE= option. Only the RBREAK BEFORE statement with the PAGE and SUMMARIZE options specified creates a table within the table of contents. If the CONTENTS= option plus the

PAGE and SUMMARIZE options are specified, then PROC REPORT uses the value of *link-text* and places that text in the table of contents for the tables that are created. If the value of CONTENTS= is empty quotation marks, then no link is created in the table of contents.

Default If an RBREAK BEFORE statement is present and the PAGE and SUMMARIZE options are specified, but no CONTENTS= option is specified, then the default link text in the table of contents will show **Summary**.

Restriction If CONTENTS= is specified, but no PAGE option is specified, then PROC REPORT generates a warning message in the SAS log file. Only RBREAK BEFORE / with the SUMMARIZE and PAGE options specified can actually create a table in the table of contents.

Tips HTML output can now have additional anchor tags.

All ODS destinations except OUTPUT and LISTING support the STYLE= option.

DOL

(for double overlining) uses the 13th formatting character to overline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default equal sign (=)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interaction If you specify both the OL and DOL options, then PROC REPORT honors only OL.

See The discussion of FORMCHAR= on page 2081.

DUL

(for double underlining) uses the 13th formatting character to underline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default equal sign (=)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interaction If you specify both the UL and DUL options, then PROC REPORT honors only UL.

See The discussion of FORMCHAR= on page 2081.

OL
(for overlining) uses the second formatting character to overline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default hyphen (-)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interaction If you specify both the OL and DOL options, then PROC REPORT honors only OL.

See the discussion of FORMCHAR= on page 2081.

PAGE
starts a new page after the last break line of a break located at the beginning of the report. On RBREAK BEFORE, the PAGE option starts a new table.

Restriction This option has no affect on the OUTPUT destination.

SKIP
writes a blank line after the last break line of a break located at the beginning of the report.

Restriction This option has no effect on ODS destinations other than the LISTING destination.

STYLE<(*location(s)*)>=<*style-overrides(s)*>
specifies the style element to use for default summary lines that are created with the RBREAK statement.

Restriction All ODS destinations except OUTPUT and LISTING support the STYLE= option.

Tip FONT names that contain characters other than letters or underscores must be enclosed in quotation marks.

See "Style Elements and Style Attributes for Table Regions " on page 2149

SUMMARIZE
includes a summary line as one of the break lines. A summary line at the beginning or end of a report contains values for the following:

- statistics
- analysis variables
- computed variables

The following table shows how PROC REPORT calculates the value for each type of report item in a summary line created by the RBREAK statement:

Report Item	Resulting Value
Statistic	Value of the statistic over all observations in the set
Analysis variable	Value of the statistic specified as the usage option in the DEFINE statement. PROC REPORT calculates the value of the statistic over all observations in the set. The default usage is SUM.
Computed variable	Results of the calculations based on the code in the corresponding compute block. (See "COMPUTE Statement" on page 2112.)

Examples "Example 1: Selecting Variables and Creating a Summary Line for a Report" on page 2171

"Example 8: Displaying a Calculated Percentage Column in a Report" on page 2195

UL

(for underlining) uses the second formatting character to underline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option.

Default hyphen (-)

Restriction This option affects only the LISTING output. It has no affect on other ODS output.

Interaction If you specify both the UL and DUL options, then PROC REPORT honors only UL.

See The discussion of FORMCHAR= on page 2081.

Details

Order of Break Lines

When a default summary contains more than one break line, the order in which the break lines appear is

1 overlining or double overlining (OL or DOL, LISTING output only)

2 summary line (SUMMARIZE)

3 underlining or double underlining (UL or DUL, LISTING output only)

4 skipped line (SKIP, LISTING output only)

5 page break (PAGE)

Note: If you define a customized summary for the break, then customized break lines appear after underlining or double underlining. For more information about customized break lines, see the COMPUTE statement on page 2112 and the LINE statement "LINE Statement" on page 2132.

WEIGHT Statement

Specifies weights for analysis variables in the statistical calculations.

See: For information about calculating weighted statistics see "Calculating Weighted Statistics" on page 83. For an example that uses the WEIGHT statement, see "Weighted Statistics Example" on page 84.

Syntax

WEIGHT *variable*;

Required Argument

variable
specifies a numeric variable whose values weight the values of the analysis variables. The value of the variable does not have to be an integer.

Table 58.8 *Variable Values and How PROC REPORT Responds*

Weight Value	PROC REPORT Response
0	Counts the observation in the total number of observations
Less than 0	Converts the value to zero and counts the observation in the total number of observations
Missing	Excludes the observation

Restriction PROC REPORT will not compute MODE when a weight variable is active. Instead, try using PROC UNIVARIATE when MODE needs to be computed and a weight variable is active.

Tip When you use the WEIGHT statement, consider which value of the VARDEF= option is appropriate. See VARDEF= on page 2096 and the calculation of weighted statistics in "Keywords and Formulas" on page 2700 for more information.

Details

Weight Information Is Not Saved

When you store a report definition, PROC REPORT does not store the WEIGHT statement.

Usage: REPORT Procedure

Statistics That Are Available in PROC REPORT

Use the following keywords to specify statistic keywords in the KEYWORD or KEYLABEL statement.

Table 58.9 *Statistics Available in PROC REPORT*

Descriptive statistic keywords	
CSS	PCTSUM
CV	RANGE
MAX	STD
MEAN	STDERR
MIN	SUM
MODE	SUMWGT

N	USS
NMISS	VAR
PCTN	
Quantile statistic keywords	
MEDIAN | P50	Q3 | P75
P1	P60
P5	P70
P10	P80
P20	P90
P30	P95
P40	P99
Q1 | P25	QRANGE
Hypothesis testing keyword	
PRT | PROBT	T

These statistics, the formulas that are used to calculate them, and their data requirements are discussed in "Keywords and Formulas" on page 2700.

To compute standard error and the Student's **t**-test, you must use the default value of VARDEF=, which is DF.

Every statistic except N must be associated with a variable. You associate a statistic with a variable either by placing the statistic above or below a numeric display variable or by specifying the statistic as a usage option in the DEFINE statement or in the DEFINITION window for an analysis variable.

You can place N anywhere because it is the number of observations in the input data set that contribute to the value in a cell of the report. The value of N does not depend on a particular variable.

Note: If you use the MISSING option in the PROC REPORT statement, then N includes observations with missing group, order, or across variables.

Using ODS Styles with PROC REPORT

Using Styles with Base SAS Procedures

Most Base SAS procedures that support ODS use one or more table templates to produce output objects. These table templates include templates for table elements: columns, headers, and footers. Each table element can specify the use of one or more style elements for various parts of the output. These style elements cannot be specified within the syntax of the procedure, but you can use customized styles for the ODS destinations that you use. For more information about customizing tables and styles, see "TEMPLATE Procedure: Creating a Style Template" in *SAS Output Delivery System: Procedures Guide*.

The Base SAS reporting procedures, PROC PRINT, PROC REPORT, and PROC TABULATE, enable you to quickly analyze your data and organize it into easy-to-read tables. You can use the STYLE= option with these procedure statements to modify the appearance of your report. The STYLE= option enables you to make changes in sections of output without changing the default style for all of the output. You can customize specific sections of procedure output by specifying the STYLE= option in specific statements within the procedure.

The following program uses the STYLE= option to create the background colors in the PROC REPORT output below:

```
title "Height and Weight by Gender and Age";
proc report nowd data=sashelp.class
   style(header)=[background=white];
   col age (('Gender' sex),(weight height));
   define age / style(header)=[background=lightgreen];
   define sex / across style(header)=[background=yellow] ' ';
   define weight / style(header)=[background=orange];
   define height / style(header)=[background=tan];
run;
```

Output 58.1 *Enhanced PROC REPORT Output*

Height and Weight by Gender and Age

	Gender			
	F		M	
Age	Weight	Height	Weight	Height
253	811	545.3	1089.5	639.1

Styles, Style Elements, and Style Attributes

Understanding Styles, Style Elements, and Style Attributes

The appearance of SAS output is controlled by ODS style templates (ODS styles). ODS styles are produced from compiled STYLE templates written in PROC TEMPLATE style syntax. An ODS style template is a collection of style elements that provides specific visual attributes for your SAS output.

- A style element is a named collection of style attributes that apply to a particular part of the output. Each area of ODS output has a style element name that is associated with it. The style element name specifies where the style attributes are applied. For example, a style element might contain instructions for the presentation of column headings or for the presentation of the data inside the cells. Style elements might also specify default colors and fonts for output that uses the style.
- A style attribute is a visual property, such as color, font properties, and line characteristics, that is defined in ODS with a reserved name and value. Style attributes are collectively referenced by a style element within a style template. Each *style attribute* specifies a value for one aspect of the presentation. For example, the BACKGROUNDCOLOR= attribute specifies the color for the background of an HTML table or for a colored table in printed output. The FONTSTYLE= attribute specifies whether to use a Roman font or an italic font.

Note: Because styles control the presentation of the data, they have no effect on output objects that go to the LISTING, DOCUMENT, or OUTPUT destination.

Available styles are in the SASHELP.TMPLMST item store. In SAS Enterprise Guide, the list of style sheets is shown by the Style Wizard. In batch mode or SAS Studio, you can display the list of available style templates by using the LIST statement in PROC TEMPLATE:

```
proc template;
   list styles / store=sashelp.tmplmst;
run;
```

For complete information about viewing ODS styles, see "Viewing ODS Styles Supplied by SAS" in *SAS Output Delivery System: Advanced Topics*.

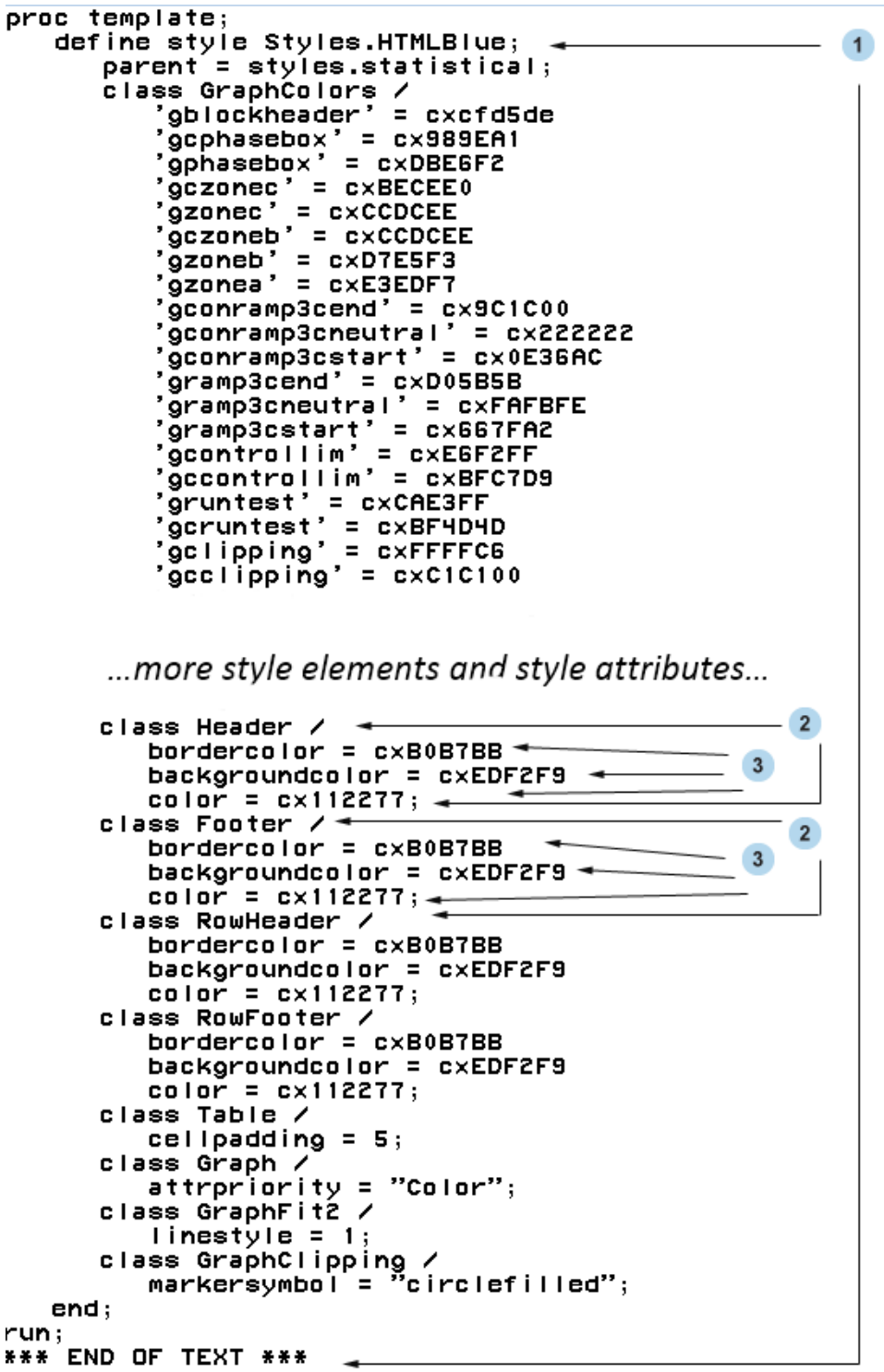
By default, HTML 4 output uses the HTMLBlue style template and HTML 5 output uses the HTMLEncore style template. To help you become familiar with styles, style elements, and style attributes, look at the relationship between them.

You can use the SOURCE statement in PROC TEMPLATE to display the structure of a style template. The following code prints the structure of the HTMLBlue style template to the SAS log:

```
proc template;
   source styles.HTMLBlue;
run;
```

The following figure illustrates the structure of a style. The figure shows the relationship between the style, the style elements, and the style attributes.

Figure 58.10 Diagram of the HtmlBlue Style



The following list corresponds to the numbered items in the preceding figure:

1 Styles.HtmlBlue is the *style*. Styles describe how to display presentation aspects (color, font, font size, and so on) of the SAS output. A style determines the overall appearance of the ODS documents that use it. The default style for HTML output is HtmlBlue. Each style consists of style elements.

You can create new styles with the "DEFINE STYLE Statement" in *SAS Output Delivery System: Procedures Guide*. New styles can be created independently or from an existing style. You can use "PARENT= Statement" in *SAS Output Delivery System: Procedures Guide* to create a new style from an existing style. For complete documentation about ODS styles, see "Style Templates" in *SAS Output Delivery System: Advanced Topics*.

2 Header and Footer are examples of *style elements*. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program. For example, a style element might contain instructions for the presentation of column headings or for the presentation of the data inside table cells. Style elements might also specify default colors and fonts for output that uses the style. Style elements exist inside styles and consist of one or more style attributes. Style elements can be user-defined or supplied by SAS. User-defined style elements can be created by the "STYLE Statement" in *SAS Output Delivery System: Procedures Guide*.

Note: For a list of the default style elements used for HTML and markup languages and their inheritance, see "Style Elements" in *SAS Output Delivery System: Advanced Topics*.

3 BORDERCOLOR=, BACKGROUNDCOLOR=, and COLOR= are examples of *style attributes*. Style attributes specify a value for one aspect of the area of the output that its style element applies to. For example, the COLOR= attribute specifies the value `cx112277` for the font color. For a list of style attributes supplied by SAS, see "Style Attributes" in *SAS Output Delivery System: Advanced Topics*.

Style attributes can be referenced with style references. See "style-reference" in *SAS Output Delivery System: Advanced Topics* for more information about style references.

The following table shows commonly used style attributes that you can set with the STYLE= option in PROC PRINT, PROC TABULATE, and PROC REPORT. Most of these attributes apply to parts of the table other than cells (for example, table borders and the lines between columns and rows). Note that not all attributes are valid in all destinations. For more information about these style attributes, their valid values, and their applicable destinations, see "Style Attributes Tables" in *SAS Output Delivery System: Advanced Topics*.

Table 58.10 *Style Attributes for PROC REPORT, PROC TABULATE, and PROC PRINT*

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
ASIS=	X	X		X		X

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
BACKGROUNDCOLOR=	X	X	X	X	X	X
BACKGROUNDIMAGE=	X	X	X	X	X	X
BORDERBOTTOMCOLOR=	X	X		X		
BORDERBOTTOMSTYLE=	X	X	X	X		
BORDERBOTTOMWIDTH=	X	X	X	X		
BORDERLEFTCOLOR=	X	X		X		
BORDERLEFTSTYLE=	X	X	X	X		
BORDERLEFTWIDTH=	X	X	X	X		
BORDERCOLOR=	X	X		X	X	X
BORDERCOLORDARK=	X	X	X	X	X	X
BORDERCOLORLIGHT=	X	X	X	X	X	X
BORDERRIGHTCOLOR=	X	X		X		
BORDERRIGHTSTYLE=	X	X	X	X		
BORDERRIGHTWIDTH=	X	X	X	X		
BORDERTOPCOLOR=	X	X		X		

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
BORDERTOPSTYLE=	X	X	X	X		
BORDERTOPWIDTH=	X	X	X	X		
BORDERWIDTH=	X	X	X	X	X	X
CELLPADDING=	X		X		X	
CELLSPACING=	X		X		X	
CELLWIDTH=	X	X	X	X		X
CLASS=	X	X	X	X	X	X
COLOR=	X	X	X			
FLYOVER=	X	X		X		X
FONT=	X	X	X	X	X	X
FONTFAMILY=	X	X	X	X	X	X
FONTSIZE=	X	X	X	X	X	X
FONTSTYLE=	X	X	X	X	X	X
FONTWEIGHT=	X	X	X	X	X	X
FONTWIDTH=	X	X	X	X		X
FRAME=	X		X		X	
HEIGHT=	X	X		X	X	X
HREFTARGET=		X		X		X
HTMLSTYLE=	X	X	X	X	X	
NOBREAKSPACE=[2]	X	X		X		X
OUTPUTWIDTH=	X	X	X	X	X	
POSTHTML=[1]	X	X	X	X	X	X

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
POSTIMAGE=	X	X	X	X	X	X
POSTTEXT=[1]	X	X	X	X	X	X
PREHTML=[1]	X	X	X	X	X	X
PREIMAGE=	X	X	X	X	X	X
PRETEXT=[1]	X	X	X	X	X	X
PROTECTSPECIALCHARS=		X		X	X	X
RULES=	X		X		X	
TAGATTR=	X	X	X	X	X	X
TEXTALIGN=	X	X	X	X	X	X
URL=		X		X		X
VERTICALALIGN=		X		X		X
WIDTH=	X	X	X	X	X	

1 When you use these attributes in this location, they affect only the text that is specified with the PRETEXT=, POSTTEXT=, PREHTML=, and POSTHTML= attributes. To alter the foreground color or the font for the text that appears in the table, you must set the corresponding attribute in a location that affects the cells rather than the table. For complete documentation about style attributes and their values, see "Style Attributes" in *SAS Output Delivery System: Advanced Topics*.

2 To help prevent unexpected wrapping of long text strings when using PROC REPORT with the ODS RTF destination, set NOBREAKSPACE=OFF in a location that affects the LINE statement. The NOBREAKSPACE=OFF attribute must be set in the PROC REPORT code either on the LINE statement or on the PROC REPORT statement where style(lines) is specified.

Style Elements and Style Attributes for Table Regions

The following table lists the default style elements and style attributes for various regions of PROC REPORT output. The locations in this table correspond to the locations in on page 2092. The table lists defaults for the most commonly used ODS destinations: HTML, PDF, and RTF. Each destination has a default style template that is applied to all output that is written to the destination.

- The default style for HTML output is HTMLBlue.
- The default style for PRINTER output is Pearl.
- The default style for RTF output is RTF.

For complete documentation about the ODS destinations and their default styles, see "Style Templates" in *SAS Output Delivery System: Advanced Topics*.

Table 58.11 *Default Style Elements and Style Attributes for Table Locations*

Locations	Style Element	HTML Style Attributes	PDF Style Attributes	RTF Style Attributes
Header	Header	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = bold FONTSTYLE = roman COLOR = cx112277 BACKGROUNDCOLOR = cxedf2f9	FONTFAMILY = "Arial, 'Albany AMT'" FONTSIZE = 8pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxffffff BORDERWIDTH = NaN	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 11pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxbbbbbb
Column	Data	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = medium FONTSTYLE = roman BACKGROUNDCOLOR = cxffffff	FONTFAMILY ="'Albany AMT', Albany" FONTSIZE = 8pt FONTWEIGHT = medium FONTSTYLE = roman COLOR = cx000000 BORDERWIDTH = NaN COLOR = cx000000	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 10pt FONTWEIGHT = medium FONTSTYLE = roman COLOR = cx000000
Summary	DataEmphasis	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = medium FONTSTYLE = roman BACKGROUNDCOLOR = cxffffff	FONTFAMILY ="'Albany AMT', Albany" FONTSIZE = 8pt FONTWEIGHT = medium FONTSTYLE = roman COLOR = cx000000 BORDERWIDTH = NaN	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 10pt FONTWEIGHT = medium FONTSTYLE = italic COLOR = cx000000

Order of Precedence When Applying Style Attributes to Data Cells

PROC REPORT determines the style attributes to apply to a particular cell from a default order of precedence. Each step in the order of precedence specifies more granularity.

For example, use the style precedence for non-summary rows shown below. First, for a particular cell, PROC REPORT uses the default style attributes. Next, for each cell in a column, PROC REPORT overrides the default style attributes. By step five, the previous styles that were applied are overwritten, but only for the cells specified by the *column-id*.

The following lists the style precedence for the summary rows and the non-summary rows.

Style precedence for non-summary rows.

1. PROC REPORT uses the default style attributes from the default style element (Data).
2. The STYLE (COLUMN)= option in the PROC REPORT statement overrides the default style attributes.
3. A STYLE (COLUMN)= option in the DEFINE statement applies to all of the cells in the column.
4. A row style that is specified by the _ROW_ argument in the CALL DEFINE statement applies to all of the cells in the row.
5. A style specified by the *column-id* _COL_ in the CALL DEFINE statement applies to all of the cells in the column.

Style precedence for summary rows.

1. PROC REPORT uses the default style attributes from the default style elements for summary rows (DataEmphasis).
2. The STYLE (SUMMARY)= option in the PROC REPORT statement overrides the default style attributes for the summary.
3. The style specified by the STYLE= option in the BREAK statement, applies to the summary cells.
4. The row style specified by a CALL DEFINE statement with the _ROW_ argument.
5. The style specified by a CALL DEFINE statement with the column-id _COL_, the column name, or the column number applies to all of the summary cells in the column.

Using a Format to Assign a Style Attribute Value

You can use a format to assign a style attribute value. For example, the following code assigns a red background color to cells in the Difference column for which the value is negative.

```
proc format;
value proffmt low-<0='red'
0-high='green';
run;

proc report data=sashelp.prdsale;
column country predict actual diff;
define country /group;
define diff /'Difference' computed format=dollar12.2
   style(column)=[backgroundcolor=proffmt.];

compute diff;
diff = predict.sum - actual.sum;
endcomp;
run;
```

Country	Predicted Sales	Actual Sales	Difference
CANADA	$233,019.00	$246,990.00	$-13,971.00
GERMANY	$231,554.00	$245,998.00	$-14,444.00
U.S.A.	$241,722.00	$237,349.00	$4,373.00

Controlling the Spacing between Rows

There is frequently a need to “shrink” a report to fit more rows on a page. Shrinking a report involves changing both the font size and the spacing between the rows. In order to give maximum flexibility to the programmer, ODS uses the font size that is specified for the REPORT location to calculate the spacing between the rows. Therefore, to shrink a table, change the font size for both the REPORT location and the COLUMN location. Here is an example:

```
proc report
data=libref.data_set-name
            style(report)=[fontsize=8pt]
            style(column)=[font=(Arial, 8pt)];
```

Printing a Report

Printing with ODS

Printing reports with the Output Delivery System is much simpler and provides more attractive output than the older methods of printing that are documented here. For best results, use an output destination in the ODS printer family or RTF. For details about these destinations and on using the ODS statements, see *SAS Output Delivery System: User's Guide*.

Printing from Noninteractive or Batch Mode

If you use noninteractive or batch mode, then SAS writes the output either to the display or to external files, depending on the operating environment and on the SAS options that you use. Refer to the SAS documentation for your operating environment for information about how these files are named and where they are stored.

You can print the output file directly or use PROC PRINTTO to redirect the output to another file. In either case, no form is used, but carriage-control characters are written if the destination is a print file.

Use operating environment commands to send the file to the printer.

Using PROC PRINTTO

PROC PRINTTO defines destinations for the SAS output and the SAS log. (See Chapter 49, "PRINTTO Procedure," on page 1857.)

PROC PRINTTO does not use a form, but it does write carriage-control characters if you are writing to a print file.

Note: You need two PROC PRINTTO steps. The first PROC PRINTTO step precedes the PROC REPORT step. It redirects the output to a file. The second PROC PRINTTO step follows the PROC REPORT step. It reestablishes the default destination and frees the output file. You cannot print the file until PROC PRINTTO frees it.

Storing and Reusing a Report Definition

The OUTREPT= option in the PROC REPORT statement stores a report definition in the specified catalog entry.

Note: A report definition might differ from the SAS program that creates the report. See the discussion of OUTREPT= on page 2087.

You can use a report definition to create an identically structured report for any SAS data set that contains variables with the same names as the ones that are used in the report definition. Use the REPORT= option in the PROC REPORT statement to load a report definition when you start PROC REPORT. For information, see "REPORT=*libref.catalog.entry*" on page 2091.

In-Database Processing for PROC REPORT

In-database processing has several advantages over processing within SAS. These advantages include increased security, reduced network traffic, and the potential for faster processing. Increased security is possible because sensitive data does not have to be extracted from the database management system (DBMS). Faster processing is possible because data is manipulated locally, on the DBMS, using high-speed secondary storage devices instead of being transported across a relatively slow network connection. The DBMS is used because it might have more processing resources at its disposal, and it might be capable of optimizing a query for execution in a highly parallel and scalable fashion.

When the DATA= input data set is stored as a table or view in a DBMS, the PROC REPORT procedure can use in-database processing to perform most of its work within the database. In-database processing can provide the advantages of faster processing and reduced data transfer between the database and SAS software.

In-database processing for PROC REPORT supports the following database management systems:

- Amazon Redshift
- Aster
- DB2
- Google BigQuery
- Greenplum
- Hadoop
- HAWQ
- Impala

- Microsoft SQL Server
- Netezza
- Oracle
- PostgreSQL
- SAP HANA
- Snowflake
- Teradata
- Vertica
- Yellowbrick

PROC REPORT performs in-database processing by using SQL implicit pass-through. The procedure generates SQL queries that are based on the statements and the PROC REPORT options that are used as well as the output statistics that are specified in the procedure. The database executes these SQL queries and the results of the query are then transmitted to PROC REPORT. To examine the generated SQL, set the SASTRACE= option.

If the SAS format definitions have not been deployed in the database, the in-database aggregation occurs on the raw values, and the relevant formats are applied by SAS as the results' set is merged into the PROC REPORT internal structures. For more information, see the section "Deploying and Using SAS Formats" in *SAS/ACCESS for Relational Databases: Reference*.

In-database processing will not occur if the PROC REPORT step contains variables with usage types DISPLAY or ORDER.

The following statistics are supported for in-database processing: N, NMISS, MIN, MAX, MEAN, RANGE, SUM, SUMWGT, CSS, USS, VAR, STD, STDERR, and CV.

Weighting for in-database processing is supported only for N, NMISS, MIN, MAX, RANGE, SUM, SUMWGT, and MEAN.

The SQLGENERATION system option or LIBNAME statement option controls whether and how in-database procedures are run inside the database. By default, the in-database procedures are run inside the database when possible. There are many data set options that prevent in-database processing. For a complete listing, refer to "In-Database Procedures" in *SAS/ACCESS for Relational Databases: Reference*.

For more information about in-database processing, see *SAS/ACCESS for Relational Databases: Reference*.

CAS Processing for PROC REPORT

If your input data set originates from SAS Cloud Analytic Services (CAS), some of the PROC REPORT analysis can be performed by the CAS server. Reports that require significant summarization of data can benefit from CAS processing. When run against a CAS table, PROC REPORT executes on the analytic server and uses

the appropriate statistical actions. For an overview about how procedures run in CAS, see Chapter 5, "CAS Processing of Base Procedures," on page 93.

The CAS LIBNAME statement option controls whether and how CAS procedures are run inside CAS. By default, the CAS procedures are run inside CAS when possible. However, there are many data set options that can prevent CAS processing.

When the DATA= input data set references an in-memory table or view in CAS, the REPORT procedure can use CAS actions to perform some of its work within the server. To reference an in-memory table or view, you must specify the CAS engine LIBNAME statement and specify the CAS engine libref option IN= or DATA=. By default, PROC REPORT uses CAS processing whenever a CAS engine libref is specified on the input.

The following example shows how to run SAS 9.4 PROC REPORT that uses CAS processing. The LIBNAME statement assigns a CAS engine libref named mycas that you use to connect to the CAS session casauto.

```
option casport=10935 cashost="cloud.example.com";
cas casauto ;

libname mycas cas;
data mycas.cars;
   set sashelp.cars;
run;

proc report data=mycas.cars;
title;
column ('Horsepower by Make and Drivetrain as a Percent of All
Horsepower'
origin drivetrain horsepower,(sum pctsum));
define origin / group;
define drivetrain / group;
define horsepower / '';
define sum / 'HP by Make and Drivetrain';
define pctsum / 'Percent of HP' format=percent6.;
rbreak after / summarize style=[font_style=italic];
run;
```

CAS processing does not occur if the PROC REPORT step contains variables with usage types DISPLAY or ORDER. If a DISPLAY or ORDER variable is found, all of the data is brought back to the client and PROC REPORT runs on the SAS client server.

The following statistics are supported for CAS processing:

CSS	RANGE
CV	STDERR
MAX	SUM
MEAN	SUMWGT
MIN	STD
N	USS
NMISS	VAR

Note: Weighting for CAS processing is supported only for N, NMISS, MIN, MAX, RANGE, SUM, SUMWGT, and MEAN.

The computations and processing are done in CAS. However, the rendering of the final table is done by the SAS client.

For information about how to use the CAS LIBNAME statement, see "CAS LIBNAME Statement" in *SAS Cloud Analytic Services: User's Guide*.

Substituting BY Line Values in a Text String

Starting with SAS 9.4M6, #BYLINE, #BYVAR, and #BYVAL substitutions are available in the following options:

- The CONTENTS= option in the PROC REPORT statement.
- The CAPTION= option in the PROC REPORT statement

To use the #BYVAR and #BYVAL substitutions, insert the item in the text string at the position where you want the substitution text to appear. Both #BYVAR and #BYVAL specifications must be followed by a delimiting character. The character can be either a space or other non-alphanumeric character, such as a quotation mark. If no delimiting character is provided, then the specification is ignored and its text remains intact and is displayed with the rest of the string. To allow a #BYVAR or #BYVAL substitution to be followed immediately by other text, with no delimiter, use a trailing dot (as with macro variables). The trailing dot is not displayed in the resolved text. If you want a period to be displayed as the last character in the resolved text, use two dots after the #BYVAR or #BYVAL substitution.

The substitution for #BYVAR or #BYVAL does not occur in the following cases:

- if you use a #BYVAR or #BYVAL specification for a variable that is not named in the BY statement. For example, you might use #BYVAL2 when there is only one BY-variable or #BYVAL(ABC) when ABC is non-existent or is not a BY-variable.
- if there is no BY statement

Results: REPORT Procedure

How PROC REPORT Builds a Report

Sequence of Events

This section explains the general process of building a report. For examples that illustrate this process, see "Report-Building Examples" on page 2160. The sequence of events is the same whether you use programming statements or the interactive report window environment.

To understand the process of building a report, you must understand the difference between report variables and temporary variables. **Report variables** are variables that are specified in the COLUMN statement. A report variable can come from the input data set or can be computed (that is, the DEFINE statement for that variable specifies the COMPUTED option). A report variable might or might not appear in a compute block. Variables that appear only in one or more compute blocks are **temporary variables**. Temporary variables do not appear in the report and are not written to the output data set (if one is requested).

PROC REPORT initializes report variables to missing at the beginning of each row of the report. The value for a **temporary variable** is initialized to missing before PROC REPORT begins to construct the rows of the report, and it remains missing until you specifically assign a value to it. PROC REPORT retains the value of a **temporary variable** from the execution of one compute block to another.

PROC REPORT constructs a report as follows:

1. It consolidates the data by group, order, and across variables. It calculates all statistics for the report, the statistics for detail rows as well as the statistics for summary lines in breaks. Statistics include those statistics that are computed for analysis variables. PROC REPORT calculates statistics for summary lines whether they appear in the report.
2. It initializes all temporary variables to missing.
3. It begins constructing the rows of the report.
   a. At the beginning of each row, it initializes all report variables to missing.
   b. It fills in values for report variables from left to right.

- Values for computed variables come from executing the statements in the corresponding compute blocks.
- Values for all other variables come from the data set or the summary statistics that were computed at the beginning of the report-building process.

c Whenever it comes to a break, PROC REPORT first constructs the break lines that are created with the BREAK or RBREAK statement or with options in the BREAK window.

d If there is a compute block attached to the break, PROC REPORT then executes the statements in the compute block. See "Construction of Summary Lines" on page 2159 for details.

Note: You can also use statistics with PROC REPORT as follows.

- Use group statistics in compute blocks for a break before the group variable.
- Use statistics for the whole report in a compute block at the beginning of the report.

This document references these statistics with the appropriate compound name. For information about referencing report items in a compute block, see "Four Ways to Reference Report Items in a Compute Block" on page 2063.

Note: You cannot use the LINE statement in conditional statements (IF-THEN, IF-THEN/ELSE, and SELECT) because it is not executed until PROC REPORT has executed all other statements in the compute block.

4 After each report row is completed, PROC REPORT sends the row to all of the ODS destinations that are currently open.

Construction of Summary Lines

PROC REPORT constructs a summary line for a break if either of the following conditions is true:

- You summarize numeric variables in the break.
- You use a compute block at the break. (You can attach a compute block to a break without using a BREAK or RBREAK statement or without selecting any options in the BREAK window.)

  For more information about using compute blocks, see "Using Compute Blocks" on page 2061 and "COMPUTE Statement" on page 2112.

The summary line that PROC REPORT constructs at this point is preliminary. If no compute block is attached to the break, then the preliminary summary line becomes the final summary line. However, if a compute block is attached to the break, then the statements in the compute block can alter the values in the preliminary summary line.

PROC REPORT prints the summary line only if you summarize numeric variables in the break.

Report-Building Examples

Building a Report That Uses Groups and a Report Summary

The report in "Report with Groups and a Report Summary" on page 2161 contains five columns:

- Sector and Department are group variables.
- Sales is an analysis variable that is used to calculate the Sum statistic.
- Profit is a computed variable whose value is based on the value of Department.
- The N statistic indicates how many observations each row represents.

At the end of the report a break summarizes the statistics and computed variables in the report and assigns to Sector the value of `TOTALS:`.

The following statements produce "Report with Groups and a Report Summary" on page 2161. The user-defined formats that are used are created by a PROC FORMAT step on page 2171.

```
libname proclib
'SAS-library';

options nodate pageno=1 linesize=64
        pagesize=60 fmtsearch=(proclib);

ods html close;
ods listing;
proc report data=grocery headline headskip;
    column sector department sales Profit N ;
    define sector / group format=$sctrfmt.;
    define department   / group format=$deptfmt.;
    define sales  / analysis sum
                    format=dollar9.2;
    define profit / computed format=dollar9.2;

    compute before;
    totprof = 0;
    endcomp;

    compute profit;
    if sector ne ' ' or department ne ' ' then do;
       if department='np1' or department='np2'
          then profit=0.4*sales.sum;
       else profit=0.25*sales.sum;
       totprof = totprof + profit;
       end;
    else
       profit = totprof;
    endcomp;
```

```
    rbreak after / dol dul summarize;
    compute after;
       sector='TOTALS:';
    endcomp;

    where sector contains 'n';
    title 'Report for Northeast and Northwest Sectors';
  run;
ods listing close;
```

Example Code 58.2 *Report with Groups and a Report Summary*

```
      Report for Northeast and Northwest Sectors          1

Sector     Department      Sales     Profit          N
-------------------------------------------------------

Northeast  Canned         $840.00    $336.00          2
           Meat/Dairy     $490.00    $122.50          2
           Paper          $290.00     $116.00         2
           Produce        $211.00     $52.75          2
Northwest  Canned       $1,070.00    $428.00          3
           Meat/Dairy   $1,055.00    $263.75          3
           Paper          $150.00     $60.00          3
           Produce        $179.00     $44.75          3
=========              =========  =========  =========
TOTALS:                $4,285.00  $1,423.75         20
=========              =========  =========  =========
```

A description of how PROC REPORT builds this report follows:

1 PROC REPORT starts building the report by consolidating the data (Sector and Department are group variables) and by calculating the statistics (Sales.sum and N) for each detail row and for the break at the end of the report.

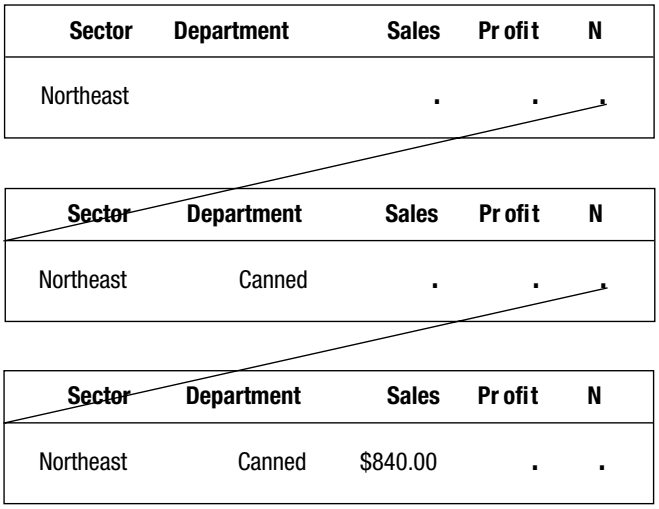
2 Now, PROC REPORT is ready to start building the first row of the report. This report does not contain a break at the beginning of the report or a break before any groups, so the first row of the report is a detail row. The procedure initializes all report variables to missing, as the following figure illustrates. Missing values for a character variable are represented by a blank, and missing values for a numeric variable are represented by a period.

Figure 58.11 *First Detail Row with Values Initialized*

Sector	Department	Sales	Profit	N
		.	.	.

3 The following figure illustrates the construction of the first three columns of the row. PROC REPORT fills in values for the row from left to right. Values come from the statistics that were computed at the beginning of the report-building process.

Figure 58.12 First Detail Row with Values Filled in from Left to Right



Sector	Department	Sales	Profit	N
Northeast		.	.	.

Sector	Department	Sales	Profit	N
Northeast	Canned	.	.	.

Sector	Department	Sales	Profit	N
Northeast	Canned	$840.00	.	.

4 The next column in the report contains the computed variable Profit. When it gets to this column, PROC REPORT executes the statements in the compute block that is attached to Profit. Nonperishable items (which have a value of **np1** or **np2**) return a profit of 40%; perishable items (which have a value of **p1** or **p2**) return a profit of 25%.

```
if department='np1' or department='np2'
   then profit=0.4*sales.sum;
else profit=0.25*sales.sum;
```

The row now looks like the following figure.

Note: The position of a computed variable is important. PROC REPORT assigns values to the columns in a row of a report from left to right. Consequently, you cannot base the calculation of a computed variable on any variable that appears to its right in the report.

Figure 58.13 A Computed Variable Added to the First Detail Row

Sector	Department	Sales	Profit	N
Northeast	Canned	$840.00	$336.00	.

5 The totprof variable is a temporary variable held in memory to keep a running total of the total profits. When each Sector and Department profits have been calculated, the value stored in variable totprof is then moved to Profit and reported in the TOTALS summary line.

```
totprof = totprof + profit;
       end;
    else
       profit = totprof;
```

6 Next, PROC REPORT fills in the value for the N statistic. The value comes from the statistics that are created at the beginning of the report-building process. The following figure illustrates the completed row.

Figure 58.14 First Complete Detail Row

Sector	Department	Sales	Profit	N
Northeast	Canned	$840.00	$336.00	2

7 The procedure writes the completed row to the report.

8 PROC REPORT repeats steps 2, 3, 4, 5, and 6 for each detail row in the report.

9 At the break at the end of the report, PROC REPORT constructs the break lines described by the RBREAK statement. These lines include double underlining, double overlining, and a preliminary version of the summary line. The statistics for the summary line were calculated earlier. (See step 1.) The value for the computed variable is calculated when PROC REPORT reaches the appropriate column, just as it is in detail rows. PROC REPORT uses these values to create the preliminary version of the summary line. (See the following figure.)

Figure 58.15 Preliminary Summary Line

Sector	Department	Sales	Profit	N
		$4,285.00	$1,423.75	20

10 If no compute block is attached to the break, then the preliminary version of the summary line is the same as the final version. However, in this example, a compute block is attached to the break. Therefore, PROC REPORT now executes the statements in that compute block. In this case, the compute block contains one statement:

```
sector='TOTALS:';
```

This statement replaces the value of Sector, which in the summary line is missing by default, with the word `TOTALS:`. After PROC REPORT executes the statement, it modifies the summary line to reflect this change to the value of Sector. The final version of the summary line appears in the following figure.

Figure 58.16 Final Summary Line

Sector	Department	Sales	Profit	N
TOTALS:		$4,285.00	$1,423.75	20

11 Finally, PROC REPORT writes all the break lines, with underlining, overlining, and the final summary line, to the report. See See "Report with Groups and a Report Summary" on page 2161.

Building a Report That Uses Temporary Variables

PROC REPORT initializes report variables to missing at the beginning of each row of the report. The value for a temporary variable is initialized to missing before PROC REPORT begins to construct the rows of the report, and it remains missing

until you specifically assign a value to it. PROC REPORT retains the value of a temporary variable from the execution of one compute block to another.

Because all compute blocks share the current values of all variables, you can initialize temporary variables at a break at the beginning of the report or at a break before a break variable. This report initializes the temporary variable Sctrtot at a break before Sector.

Note: PROC REPORT creates a preliminary summary line for a break before it executes the corresponding compute block. If the summary line contains computed variables, then the computations are based on the values of the contributing variables in the preliminary summary line. If you want to recalculate computed variables based on values that you set in the compute block, then you must do so explicitly in the compute block. This report illustrates this technique. If no compute block is attached to a break, then the preliminary summary line becomes the final summary line.

The report in "Report with Temporary Variables" on page 2166 contains five columns:

- Sector and Department are group variables.
- Sales is an analysis variable that is used twice in this report: once to calculate the Sum statistic, and once to calculate the Pctsum statistic.
- Sctrpct is a computed variable whose values are based on the values of Sales and a temporary variable, Sctrtot, which is the total sales for a sector.

At the beginning of the report, a customized report summary tells what the sales for all stores are. At a break before each group of observations for a department, a default summary summarizes the data for that sector. At the end of each group a break inserts a blank line.

The following statements produce "Report with Temporary Variables" on page 2166. The user-defined formats that are used are created by a PROC FORMAT step on page 2171.

Note: Calculations of the percentages do not multiply their results by 100 because PROC REPORT prints them with the PERCENT. format.

```
libname proclib
'SAS-library';

options nodate pageno=1 linesize=64
        pagesize=60 fmtsearch=(proclib);
ods html close;
ods listing;
proc report data=grocery noheader;
  column sector department sales
         Sctrpct sales=Salespct;

  define sector     / 'Sector' group
                      format=$sctrfmt.;
  define department / group format=$deptfmt.;
  define sales      / analysis sum
```

```
                    format=dollar9.2 ;
  define sctrpct    / computed
                    format=percent9.2 ;
  define salespct   / pctsum format=percent9.2;

  compute before;
     line ' ';
     line @16 'Total for all stores is '
          sales.sum dollar9.2;
     line ' ';
     line @29 'Sum of' @40 'Percent'
          @51 'Percent of';
     line @6 'Sector' @17 'Department'
          @29 'Sales'
          @40 'of Sector' @51 'All Stores';
     line @6 55*'=';
     line ' ';
  endcomp;

  break before sector / summarize ul;
  compute before sector;
     sctrtot=sales.sum;
     sctrpct=sales.sum/sctrtot;
  endcomp;

  compute sctrpct;
     sctrpct=sales.sum/sctrtot;
  endcomp;

  break after sector/skip;
  where sector contains 'n';
  title 'Report for Northeast and Northwest Sectors';
run;
ods listing close;
```

Example Code 58.3 *Report with Temporary Variables*

```
      Report for Northeast and Northwest Sectors          1


          Total for all stores is $4,285.00

                        Sum of     Percent    Percent of
Sector     Department   Sales      of Sector  All Stores
=======================================================

Northeast               $1,831.00   100.00%     42.73%
---------               ---------  ---------  ---------
Northeast  Canned          $840.00    45.88%     19.60%
           Meat/Dairy      $490.00    26.76%     11.44%
           Paper           $290.00    15.84%      6.77%
           Produce         $211.00    11.52%      4.92%

Northwest               $2,454.00   100.00%     57.27%
---------               ---------  ---------  ---------
Northwest  Canned        $1,070.00    43.60%     24.97%
           Meat/Dairy    $1,055.00    42.99%     24.62%
           Paper           $150.00     6.11%      3.50%
           Produce         $179.00     7.29%      4.18%
```

A description of how PROC REPORT builds this report follows:

1 PROC REPORT starts building the report by consolidating the data (Sector and Department are group variables) and by calculating the statistics (Sales.sum and Sales.pctsum) for each detail row, for the break at the beginning of the report, for the breaks before each group, and for the breaks after each group.

2 PROC REPORT initializes the temporary variable, Sctrtot, to missing. (See the following figure.)

Figure 58.17 *Initialized Temporary Variables*

Report Variables					Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
		.	.	.	.

3 Because this PROC REPORT step contains a COMPUTE BEFORE statement, the procedure constructs a preliminary summary line for the break at the beginning of the report. This preliminary summary line contains values for the statistics (Sales.sum and Sales.pctsum) and the computed variable (Sctrpct).

At this break, Sales.sum is the sales for all stores, and Sales.pctsum is the percentage those sales represent for all stores (100%). PROC REPORT takes the values for these statistics from the statistics that were computed at the beginning of the report-building process.

The value for Sctrpct comes from executing the statements in the corresponding compute block. Because the value of Sctrtot is missing, PROC REPORT cannot calculate a value for Sctrpct. Therefore, in the preliminary summary line (which is not printed in this case), this variable also has a missing value. (See the following figure.)

The statements in the COMPUTE BEFORE block do not alter any variables. Therefore, the final summary line is the same as the preliminary summary line.

Note: The COMPUTE BEFORE statement creates a break at the beginning of the report. You do not need to use an RBREAK statement.

Figure 58.18 *Preliminary and Final Summary Line for the Break at the Beginning of the Report*

	Report Variables				Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
		$4,285.00	.	100.00%	.

4 Because the program does not include an RBREAK statement with the SUMMARIZE option, PROC REPORT does not write the final summary line to the report. Instead, it uses LINE statements to write a customized summary that embeds the value of Sales.sum into a sentence and to write customized column headings. (The NOHEADER option in the PROC REPORT statement suppresses the default column headings, which would have appeared before the customized summary.)

5 Next, PROC REPORT constructs a preliminary summary line for the break before the first group of observations. (This break both uses the SUMMARIZE option in the BREAK statement with a compute block attached to it. Either of these conditions generates a summary line.) The preliminary summary line contains values for the break variable (Sector), the statistics (Sales.sum and Sales.pctsum), and the computed variable (Sctrpct). At this break, Sales.sum is the sales for one sector (the northeast sector). PROC REPORT takes the values for Sector, Sales.sum, and Sales.pctsum from the statistics that were computed at the beginning of the report-building process.

The value for Sctrpct comes from executing the statements in the corresponding compute blocks. Because the value of Sctrtot is still missing, PROC REPORT cannot calculate a value for Sctrpct. Therefore, in the preliminary summary line, Sctrpct has a missing value. (See the following figure.)

Figure 58.19 *Preliminary Summary Line for the Break before the First Group of Observations*

	Report Variables				Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
Northeast		$1,831.00	.	42.73%	.

6 PROC REPORT creates the final version of the summary line by executing the statements in the COMPUTE BEFORE SECTOR compute block. These statements execute once each time the value of Sector changes.

- The first statement assigns the value of Sales.sum, which in that part of the report represents total sales for one Sector, to the variable Sctrtot.

- The second statement completes the summary line by recalculating Sctrpct from the new value of Sctrtot. The following figure shows the final summary line.

Note: In this example, you must recalculate the value for Sctrpct in the final summary line. If you do not recalculate the value for Sctrpct, then it is missing because the value of Sctrtot is missing when the COMPUTE Sctrpct block executes.

Figure 58.20 *Final Summary Line for the Break before the First Group of Observations*

	Report Variables				Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
Northeast		$1,831.00	100.00%	42.73%	$1,831.00

7 Because the program contains a BREAK BEFORE statement with the SUMMARIZE option, PROC REPORT writes the final summary line to the report. The UL option in the BREAK statement underlines the summary line.

8 Now, PROC REPORT is ready to start building the first report row. It initializes all report variables to missing. Values for temporary variables do not change. The following figure illustrates the first detail row at this point.

Figure 58.21 *First Detail Row with Initialized Values*

	Report Variables				Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
		.	.	.	$1,831.00

9 The following figure illustrates the construction of the first three columns of the row. PROC REPORT fills in values for the row from left to right. The values come from the statistics that were computed at the beginning of the report-building process.

Figure 58.22 *Filling in Values from Left to Right*

	Report Variables				Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
Northeast		.	.	.	$1,831.00

	Report Variables				Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
Northeast	Canned	.	.	.	$1,831.00

	Report Variables				Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
Northeast	Canned	$840.00	.	.	$1,831.00

10 The next column in the report contains the computed variable Sctrpct. When it gets to this column, PROC REPORT executes the statement in the compute block attached to Sctrpct. This statement calculates the percentage of the sector's total sales that this department accounts for.

```
sctrpct=sales.sum/sctrtot;
```

The row now looks like the following figure.

Figure 58.23 *First Detail Row with the First Computed Variable Added*

	Report Variables				Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
Northeast	Canned	$840.00	45.88%	.	$1,831.00

11 The next column in the report contains the statistic Sales.pctsum. PROC REPORT gets this value from the statistics that are created at the beginning of the report-building process. The first detail row is now complete. (See the following figure.)

Figure 58.24 *First Complete Detail Row*

	Report Variables				Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
Northeast	Canned	$840.00	45.88%	19.60%	$1,831.00

12 PROC REPORT writes the detail row to the report. It repeats steps 8, 9, 10, 11, and 12 for each detail row in the group.

13 After writing the last detail row in the group to the report, PROC REPORT constructs the default group summary. Because no compute block is attached to this break and because the BREAK AFTER statement does not include the SUMMARIZE option, PROC REPORT does not construct a summary line. The only action at this break is that the SKIP option in the BREAK AFTER statement writes a blank line after the last detail row of the group.

14 Now the value of the break variable changes from `Northeast` to `Northwest`. PROC REPORT constructs a preliminary summary line for the break before this group of observations. As at the beginning of any row, PROC REPORT initializes all report variables to missing but retains the value of the temporary variable. Next, it completes the preliminary summary line with the appropriate values for the break variable (Sector), the statistics (Sales.sum and Sales.pctsum), and the computed variable (Sctrpct). At this break, Sales.sum is the sales for the Northwest sector. Because the COMPUTE BEFORE Sector block has not yet executed, the value of Sctrtot is still $1,831.00, the value for the Northeast sector. Thus, the value that PROC REPORT calculates for Sctrpct in this preliminary summary line is incorrect. (See the following figure.) The statements in the compute block for this break calculate the correct value. (See the following step.)

Figure 58.25 *Preliminary Summary Line for the Break before the Second Group of Observations*

		Report Variables			Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
Northwest		$2,454.00	134.00%	57.27%	$1,831.00

CAUTION

Synchronize values for computed variables in break lines to prevent incorrect results. If the PROC REPORT step does not recalculate Sctrpct in the compute block that is attached to the break, then the value in the final summary line is not synchronized with the other values in the summary line, and the report is incorrect.

15 PROC REPORT creates the final version of the summary line by executing the statements in the COMPUTE BEFORE Sector compute block. These statements execute once each time the value of Sector changes.

- The first statement assigns the value of Sales.sum, which in that part of the report represents sales for the Northwest sector, to the variable Sctrtot.
- The second statement completes the summary line by recalculating Sctrpct from the new, appropriate value of Sctrtot. The following figure shows the final summary line.

Figure 58.26 *Final Summary Line for the Break before the Second Group of Observations*

		Report Variables			Temporary Variable
Sector	Department	Sales.sum	Sctrpct	Sales.pctsum	Sctrtot
Northwest		$2,454.00	100.00%	57.27%	$2,454.00

Because the program contains a BREAK BEFORE statement with the SUMMARIZE option, PROC REPORT writes the final summary line to the report. The UL option in the BREAK statement underlines the summary line.

16 Now, PROC REPORT is ready to start building the first row for this group of observations. It repeats steps 8 through 16 until it has processed all observations in the input data set (stopping with step 14 for the last group of observations).

Examples: REPORT Procedure

Example 1: Selecting Variables and Creating a Summary Line for a Report

Features:

PROC REPORT statement options
COLUMN statement
RBREAK statement options
- AFTER
- STYLE=
- SUMMARIZE

LIBNAME statement
PROC FORMAT statement
DATA step
OPTIONS statement
FORMAT statement
WHERE statement
TITLE statement

Details

This example uses a permanent data set and permanent formats to create a report that contains the following:

- one row for every observation
- a default summary for the whole report

Program

```
libname proclib 'SAS-library';

data grocery;
   input Sector $ Manager $ Department $ Sales @@;
   datalines;
se 1 np1 50    se 1 p1 100   se 1 np2 120   se 1 p2 80
```

```
se 2 np1 40    se 2 p1 300   se 2 np2 220   se 2 p2 70
nw 3 np1 60    nw 3 p1 600   nw 3 np2 420   nw 3 p2 30
nw 4 np1 45    nw 4 p1 250   nw 4 np2 230   nw 4 p2 73
nw 9 np1 45    nw 9 p1 205   nw 9 np2 420   nw 9 p2 76
sw 5 np1 53    sw 5 p1 130   sw 5 np2 120   sw 5 p2 50
sw 6 np1 40    sw 6 p1 350   sw 6 np2 225   sw 6 p2 80
ne 7 np1 90    ne 7 p1 190   ne 7 np2 420   ne 7 p2 86
ne 8 np1 200   ne 8 p1 300   ne 8 np2 420   ne 8 p2 125
;

proc format library=proclib;
   value $sctrfmt 'se' = 'Southeast'
                  'ne' = 'Northeast'
                  'nw' = 'Northwest'
                  'sw' = 'Southwest';

   value $mgrfmt '1' = 'Smith'   '2' = 'Jones'
                 '3' = 'Reveiz'  '4' = 'Brown'
                 '5' = 'Taylor'  '6' = 'Adams'
                 '7' = 'Alomar'  '8' = 'Andrews'
                 '9' = 'Pelfrey';

   value $deptfmt 'np1' = 'Paper'
                  'np2' = 'Canned'
                  'p1'  = 'Meat/Dairy'
                  'p2'  = 'Produce';
run;

options fmtsearch=(proclib);

proc report data=grocery;

   column manager department sales;

   rbreak after / summarize style=[font_weight=bold];

   where sector='se';

   format manager $mgrfmt. department $deptfmt.
          sales dollar11.2;

   title 'Sales for the Southeast Sector';
   title2 "for &sysdate";
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Create the GROCERY data set. GROCERY contains one day's sales figures for eight stores in the Grocery Mart chain. Each observation contains one day's sales data for one department in one store.

```
data grocery;
   input Sector $ Manager $ Department $ Sales @@;
   datalines;
```

```
se 1 np1 50    se 1 p1 100   se 1 np2 120   se 1 p2 80
se 2 np1 40    se 2 p1 300   se 2 np2 220   se 2 p2 70
nw 3 np1 60    nw 3 p1 600   nw 3 np2 420   nw 3 p2 30
nw 4 np1 45    nw 4 p1 250   nw 4 np2 230   nw 4 p2 73
nw 9 np1 45    nw 9 p1 205   nw 9 np2 420   nw 9 p2 76
sw 5 np1 53    sw 5 p1 130   sw 5 np2 120   sw 5 p2 50
sw 6 np1 40    sw 6 p1 350   sw 6 np2 225   sw 6 p2 80
ne 7 np1 90    ne 7 p1 190   ne 7 np2 420   ne 7 p2 86
ne 8 np1 200   ne 8 p1 300   ne 8 np2 420   ne 8 p2 125
;
```

Create the $SCTRFMT., $MGRFMT., and $DEPTFMT. formats. PROC FORMAT creates permanent formats for Sector, Manager, and Department. The LIBRARY= option specifies a permanent storage location so that the formats are available in subsequent SAS sessions. These formats are used for examples throughout this section.

```
proc format library=proclib;
   value $sctrfmt 'se' = 'Southeast'
                  'ne' = 'Northeast'
                  'nw' = 'Northwest'
                  'sw' = 'Southwest';

   value $mgrfmt '1' = 'Smith'   '2' = 'Jones'
                 '3' = 'Reveiz'  '4' = 'Brown'
                 '5' = 'Taylor'  '6' = 'Adams'
                 '7' = 'Alomar'  '8' = 'Andrews'
                 '9' = 'Pelfrey';

   value $deptfmt 'np1' = 'Paper'
                  'np2' = 'Canned'
                  'p1'  = 'Meat/Dairy'
                  'p2'  = 'Produce';
run;
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Specify the report options. By default, REPORT procedure runs without the REPORT window and sends its output to the open output destinations.

```
proc report data=grocery;
```

Specify the report columns. The report contains a column for Manager, Department, and Sales. Because there is no DEFINE statement for any of these variables, PROC REPORT uses the character variables (Manager and Department) as display variables and the numeric variable (Sales) as an analysis variable that is used to calculate the sum statistic.

```
   column manager department sales;
```

Produce a report summary. The RBREAK statement produces a default summary at the end of the report. SUMMARIZE sums the value of Sales for all observations in the report. STYLE= is used to bold the summarized value.

```
   rbreak after / summarize style=[font_weight=bold];
```

Select the observations to process. The WHERE statement selects for the report only the observations for stores in the southeast sector.

```
where sector='se';
```

Format the report columns. The FORMAT statement assigns formats to use in the report. You can use the FORMAT statement only with data set variables.

```
format manager $mgrfmt. department $deptfmt.
       sales dollar11.2;
```

Specify the titles. SYSDATE is an automatic macro variable that returns the date on which the SAS job or SAS session began. The TITLE2 statement uses double rather than single quotation marks so that the macro variable resolves.

```
   title 'Sales for the Southeast Sector';
   title2 "for &sysdate";
run;
```

Output: HTML

Output 58.2 *Selecting Variables and Creating a Summary Line for a Report*

Sales for the Southeast Sector for 03MAY14

Manager	Department	Sales
Smith	Paper	$50.00
Smith	Meat/Dairy	$100.00
Smith	Canned	$120.00
Smith	Produce	$80.00
Jones	Paper	$40.00
Jones	Meat/Dairy	$300.00
Jones	Canned	$220.00
Jones	Produce	$70.00
		$980.00

Example 2: Ordering the Rows in a Report

Features: PROC REPORT statement options
COLUMN statement
DEFINE statement options

ANALYSIS
FORMAT=
ORDER
ORDER=
SUM

BREAK statement options
AFTER
SUMMARIZE
STYLE=

LIBNAME statement

OPTIONS statement

WHERE statement

TITLE statement

Data set: GROCERY

Format: $MGRFMT

Format: $DEPTFMT

Details

This example does the following:

- arranges the rows alphabetically by the formatted values of Manager and the internal values of Department (so that sales for the two departments that sell nonperishable goods precede sales for the two departments that sell perishable goods)
- controls the default column width and the spacing between columns
- creates a default summary of Sales for each manager
- creates a customized summary of Sales for the whole report

Program

```
libname proclib 'SAS-library';

options fmtsearch=(proclib);

proc report data=grocery;

   column manager department sales;

   define manager / order order=formatted format=$mgrfmt.;
   define department / order order=internal format=$deptfmt.;

   define sales / analysis sum format=dollar7.2;

   break after manager / summarize
                         style=[font_style=italic];
```

```
  where sector='se';

  title 'Sales for the Southeast Sector';
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Specify the report options. By default, PROC REPORT runs without the REPORT window and sends its output to the open output destinations.

```
proc report data=grocery;
```

Specify the report columns. The report contains a column for Manager, Department, and Sales.

```
  column manager department sales;
```

Define the sort order variables. The values of all variables with the ORDER option in the DEFINE statement determine the order of the rows in the report. In this report, PROC REPORT arranges the rows first by the value of Manager (because it is the first variable in the COLUMN statement) and then by the values of Department. ORDER= specifies the sort order for a variable. This report arranges the rows according to the formatted values of Manager and the internal values of Department (np1, np2, p1, and p2). FORMAT= specifies the formats to use in the report.

```
  define manager / order order=formatted format=$mgrfmt.;
  define department / order order=internal format=$deptfmt.;
```

Define the analysis variable. Sum calculates the sum statistic for all observations that are represented by the current row. In this report each row represents only one observation. Therefore, the Sum statistic is the same as the value of Sales for that observation in the input data set. Using Sales as an analysis variable in this report enables you to summarize the values for each group and at the end of the report.

```
  define sales / analysis sum format=dollar7.2;
```

Produce a report summary. This BREAK statement produces a default summary after the last row for each manager. PROC REPORT sums the values of Sales for each manager because Sales is an analysis variable that is used to calculate the Sum statistic. SKIP writes a blank line after the summary line.

```
  break after manager / summarize
                        style=[font_style=italic];
```

Select the observations to process. The WHERE statement selects for the report only the observations for stores in the southeast sector.

```
  where sector='se';
```

Specify the title.

```
  title 'Sales for the Southeast Sector';
run;
```

Output: HTML

Output 58.3 *Ordering the Rows in a Report*

Sales for the Southeast Sector

Manager	Department	Sales
Jones	Paper	$40.00
	Canned	$220.00
	Meat/Dairy	$300.00
	Produce	$70.00
Jones		*$630.00*
Smith	Paper	$50.00
	Canned	$120.00
	Meat/Dairy	$100.00
	Produce	$80.00
Smith		*$350.00*

Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable

Features:

PROC REPORT statement options

COLUMN statement
- with aliases

COMPUTE statement arguments
- AFTER

DEFINE statement options
- ORDER=
- ANALYSIS
- SUM
- FORMAT=
- MAX
- MIN
- NOPRINT

customizing column headings

LINE statement
quoted text
variable values and formats
writing a blank line

LIBNAME statement

OPTIONS statement

WHERE statement

TITLE statement

automatic macro variables
SYSDATE

Data set: GROCERY

Format: $MGRFMT

Format: $DEPTFMT

Details

The customized summary at the end of this report displays the minimum and maximum values of Sales over all departments for stores in the southeast sector. To determine these values, PROC REPORT needs the MIN and MAX statistic for Sales in every row of the report. However, to keep the report simple, the display of these statistics is suppressed.

Program

```
libname proclib 'SAS-library';

options fmtsearch=(proclib);

proc report data=grocery;

   column manager department sales
          sales=salesmin
          sales=salesmax;

   define manager / order
                    order=formatted
                    format=$mgrfmt.
                    'Manager';
   define department    / order
                    order=internal
                    format=$deptfmt.
                    'Department';

   define sales / analysis sum format=dollar7.2 'Sales';

   define salesmin / analysis min noprint;
   define salesmax / analysis max noprint;
```

```
compute after;
      line 'Departmental sales ranged from'
            salesmin dollar7.2  " " 'to' " " salesmax dollar7.2;
   endcomp;

   where sector='se';

   title 'Sales for the Southeast Sector';
   title2 "for &sysdate";
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Specify the report options. By default, PROC REPORT runs without the REPORT window and sends its output to the open output destinations.

```
proc report data=grocery;
```

Specify the report columns. The report contains columns for Manager and Department. It also contains three columns for Sales. The column specifications SALES=SALESMIN and SALES=SALESMAX create aliases for Sales. These aliases enable you to use a separate definition of Sales for each of the three columns.

```
column manager department sales
       sales=salesmin
       sales=salesmax;
```

Define the sort order variables. The values of all variables with the ORDER option in the DEFINE statement determine the order of the rows in the report. In this report, PROC REPORT arranges the rows first by the value of Manager (because it is the first variable in the COLUMN statement) and then by the values of Department. The ORDER= option specifies the sort order for a variable. This report arranges the values of Manager by their formatted values and arranges the values of Department by their internal values (np1, np2, p1, and p2). FORMAT= specifies the formats to use in the report. Text in quotation marks specifies column headings.

```
define manager / order
                 order=formatted
                 format=$mgrfmt.
                 'Manager';
define department    / order
                 order=internal
                 format=$deptfmt.
                 'Department';
```

Define the analysis variable. The value of an analysis variable in any row of a report is the value of the statistic that is associated with it (in this case Sum), calculated for all observations that are represented by that row. In a detail report

each row represents only one observation. Therefore, the Sum statistic is the same as the value of Sales for that observation in the input data set.

```
define sales / analysis sum format=dollar7.2 'Sales';
```

Define additional analysis variables for use in the summary. These DEFINE statements use aliases from the COLUMN statement to create separate columns for the MIN and MAX statistics for the analysis variable Sales. NOPRINT suppresses the printing of these statistics. Although PROC REPORT does not print these values in columns, it has access to them so that it can print them in the summary.

```
define salesmin / analysis min noprint;
define salesmax / analysis max noprint;
```

Produce a customized summary. This COMPUTE statement begins a compute block that executes at the end of the report. The line statement writes the text shown in the quotation marks, the value of Salesmin with the DOLLAR7.2 format, a space in quotation marks, the text in quotation marks “to”, a space, the value of Salesmax with the DOLLAR7.2 format. (Note that the program must reference the variables by their aliases.) The ENDCOMP statement ends the compute block.

```
compute after;
      line 'Departmental sales ranged from'
            salesmin dollar7.2  " " 'to' " " salesmax dollar7.2;
endcomp;
```

Select the observations to process. The WHERE statement selects for the report only the observations for stores in the southeast sector.

```
where sector='se';
```

Specify the titles. SYSDATE is an automatic macro variable that returns the date on which the SAS job or SAS session began. The TITLE2 statement uses double rather than single quotation marks so that the macro variable resolves.

```
title 'Sales for the Southeast Sector';
title2 "for &sysdate";
run;
```

Output: HTML

Output 58.4 *Using Aliases to Obtain Multiple Statistics for the Same Variable*

Sales for the Southeast Sector for 27MAY14

Manager	Department	Sales
Jones	Paper	$40.00
	Canned	$220.00
	Meat/Dairy	$300.00
	Produce	$70.00
Smith	Paper	$50.00
	Canned	$120.00
	Meat/Dairy	$100.00
	Produce	$80.00
Departmental sales ranged from $40.00 to $300.00		

Example 4: Displaying Multiple Statistics for One Variable

Features: PROC REPORT statement options
COLUMN statement
specifying statistics for stacked variables
DEFINE statement options
FORMAT=
GROUP
LIBNAME statement
OPTIONS statement
TITLE statement

Data set: GROCERY

Format: $MGRFMT

Details

The report in this example displays six statistics for the sales for each manager's store.

Program

```
libname proclib 'SAS-library';

options fmtsearch=(proclib);

proc report data=grocery;

column sector manager (Sum Min Max Range Mean Std),sales;

   define manager / group format=$mgrfmt.;
   define sector / group format=$sctrfmt.;
   define sales / format=dollar11.2 ;

   title 'Sales Statistics for All Sectors';
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Specify the report options.

```
proc report data=grocery;
```

Specify the report columns. This COLUMN statement creates a column for Sector, Manager, and each of the six statistics that are associated with Sales.

```
column sector manager (Sum Min Max Range Mean Std),sales;
```

Define the group variables and the analysis variable. In this report, Sector and Manager are group variables. Each detail row of the report consolidates the information for all observations with the same values of the group variables. FORMAT= specifies the formats to use in the report.

```
   define manager / group format=$mgrfmt.;
   define sector / group format=$sctrfmt.;
   define sales / format=dollar11.2 ;
```

Specify the title.

```
   title 'Sales Statistics for All Sectors';
run;
```

Output: HTML

Output 58.5 *Displaying Multiple Statistics for One Variable*

Sales Statistics for All Sectors

		Sum	Min	Max	Range	Mean	Std
Sector	**Manager**	**Sales**	**Sales**	**Sales**	**Sales**	**Sales**	**Sales**
Northeast	Alomar	$786.00	$86.00	$420.00	$334.00	$196.50	$156.57
	Andrews	$1,045.00	$125.00	$420.00	$295.00	$261.25	$127.83
Northwest	Brown	$598.00	$45.00	$250.00	$205.00	$149.50	$105.44
	Pelfrey	$746.00	$45.00	$420.00	$375.00	$186.50	$170.39
	Reveiz	$1,110.00	$30.00	$600.00	$570.00	$277.50	$278.61
Southeast	Jones	$630.00	$40.00	$300.00	$260.00	$157.50	$123.39
	Smith	$350.00	$50.00	$120.00	$70.00	$87.50	$29.86
Southwest	Adams	$695.00	$40.00	$350.00	$310.00	$173.75	$141.86
	Taylor	$353.00	$50.00	$130.00	$80.00	$88.25	$42.65

Example 5: Consolidating Multiple Observations into One Row of a Report

Features:

PROC REPORT statement options

COLUMN statement

DEFINE statement options
- ANALYSIS
- GROUP
- SUM
- FORMAT=

BREAK statement options
- AFTER
- SUMMARIZE
- SUPPRESS

CALL DEFINE statement

COMPUTE statement arguments
- AFTER

CALL DEFINE statement
LINE statement
    quoted text
    variable values
LIBNAME statement
OPTIONS statement
TITLE statement
WHERE statement

Data set: GROCERY
Format: $MGRFMT
Format: $DEPTFMT

Details

This example creates a summary report that does the following:

- consolidates information for each combination of Sector and Manager into one row of the report
- contains default summaries of sales for each sector
- contains a customized summary of sales for all sectors
- uses one format for sales in detail rows and a different format in summary rows
- uses customized column headings

Program

```
libname proclib 'SAS-library';

options fmtsearch=(proclib);

proc report data=grocery;

   column sector manager sales;

   define sector / group format=$sctrfmt.'Sector';
   define manager / group format=$mgrfmt.'Manager';
   define sales / analysis sum format=comma10.2 'Sales';

   break after sector / summarize
                        style=[font_style=italic]
                        suppress;

   compute after;
      line 'Combined sales for the northern sectors were '
           sales.sum dollar9.2 '.';
   endcomp;

   compute sales;
```

```
      if _break_ ne ' ' then
      call define(_col_,"format","dollar11.2");
   endcomp;

   where sector contains 'n';

   title 'Sales Figures for Northern Sectors';
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Specify the report options. By default, PROC REPORT runs without the REPORT window and sends its output to the open output destinations.

```
proc report data=grocery;
```

Specify the report columns. The report contains columns for Sector, Manager, and Sales.

```
   column sector manager sales;
```

Define the group and analysis variables. In this report, Sector and Manager are group variables. Sales is an analysis variable that is used to calculate the Sum statistic. Each detail row represents a set of observations that have a unique combination of formatted values for all group variables. The value of Sales in each detail row is the sum of Sales for all observations in the group. FORMAT= specifies the format to use in the report. Text in quotation marks in a DEFINE statement specifies the column heading.

```
   define sector / group format=$sctrfmt.'Sector';
   define manager / group format=$mgrfmt.'Manager';
   define sales / analysis sum format=comma10.2 'Sales';
```

Produce a report summary. This BREAK statement produces a default summary after the last row for each sector. SUMMARIZE writes the value of Sales in the summary line. The summary value is for each sector. It sums all managers in the sector sales. SUPPRESS prevents PROC REPORT from displaying the value of Sector in the summary line. The summary lines are italicized.

```
   break after sector / summarize
                        style=[font_style=italic]
                        suppress;
```

Produce a customized summary. This compute block creates a customized summary at the end of the report. The LINE statement writes the quoted text and the value of Sales.sum (with a format of DOLLAR9.2) in the summary. An ENDCOMP statement must end the compute block.

```
   compute after;
```

```
      line 'Combined sales for the northern sectors were '
           sales.sum dollar9.2 '.';
   endcomp;
```

Specify a format for the summary rows. In detail rows, PROC REPORT displays the value of Sales with the format that is specified in its definition (COMMA10.2). The compute block specifies an alternate format to use in the current column on summary rows. Summary rows are identified as a value other than a blank for _BREAK_.

```
   compute sales;
      if _break_ ne ' ' then
      call define(_col_,"format","dollar11.2");
   endcomp;
```

Select the observations to process. The WHERE statement selects for the report only the observations for stores in the northeast and northwest sectors. The TITLE statement specifies the title.

```
   where sector contains 'n';
```

Specify the title.

```
   title 'Sales Figures for Northern Sectors';
run;
```

Output: HTML

Output 58.6 *Consolidating Multiple Observations into One Row of a Report*

Sales Figures for Northern Sectors

Sector	Manager	Sales
Northeast	Alomar	786.00
	Andrews	1,045.00
		$1,831.00
Northwest	Brown	598.00
	Pelfrey	746.00
	Reveiz	1,110.00
		$2,454.00

Combined sales for the northern sectors were $4,285.00

Example 6: Creating a Column for Each Value of a Variable

Features:

PROC REPORT statement options
- SPLIT=

COLUMN statement
- stacking variables

DEFINE statement options
- GROUP
- ACROSS
- ANALYSIS
- COMPUTED
- SUM
- FORMAT=

COMPUTE statement arguments
- with a computed variable as *report-item*
- AFTER

LINE statement

ENDCOMP statement

LIBNAME statement

OPTIONS statement

TITLE statement

WHERE statement

Data set: GROCERY

Format: $SCTRFMT

Format: $MGRFMT

Format: $DEPTFMT

Details

The report in this example does the following:

- consolidates multiple observations into one row
- contains a column for each value of Department that is selected for the report (the departments that sell perishable items)
- contains a variable that is not in the input data set
- uses customized column headings, some of which contain blanks
- uses variable values in a customized summary

Program

```
libname proclib 'SAS-library';

options fmtsearch=(proclib);

proc report data=grocery split='*';

   column sector manager department,sales perish;

   define sector / group format=$sctrfmt. 'Sector' '';
   define manager / group format=$mgrfmt. 'Manager* ';

   define department / across format=$deptfmt. 'Department';

   define sales / analysis sum format=dollar11.2 ' ';

   define perish / computed format=dollar11.2
               'Perishable*Total';

   compute perish;
      perish=sum(_c3_, _c4_);
   endcomp;

   compute after;
            line  'Combined sales for meat and dairy : '
            _c3_ dollar11.2 '';
      line  'Combined sales for produce : '
            _c4_ dollar11.2 '';
      line  'Combined sales for all perishables: '
            _c5_ dollar11.2 '';
         endcomp;

   where sector contains 'n'
         and (department='p1' or department='p2');

   title 'Sales Figures for Perishables in Northern Sectors';
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Specify the report options. By default, PROC REPORT runs without the REPORT window and sends its output to the open output destinations. SPLIT= defines the split character as an asterisk (*) because the default split character (/) is part of the name of a department.

```
proc report data=grocery split='*';
```

Specify the report columns. Department and Sales are separated by a comma in the COLUMN statement, so they collectively determine the contents of the column

that they define. Each item generates a heading, but the heading for Sales is set to blank in its definition. Because Sales is an analysis variable, its values fill the cells that are created by these two variables.

```
column sector manager department,sales perish;

define sector / group format=$sctrfmt. 'Sector' '';
define manager / group format=$mgrfmt. 'Manager* ';
```

Define the across variable. PROC REPORT creates a column and a column heading for each formatted value of the across variable Department. PROC REPORT orders the columns by these values. PROC REPORT also generates a column heading that spans all these columns. Quoted text in the DEFINE statement for Department customizes this heading.

```
define department / across format=$deptfmt. 'Department';
```

Define the analysis variable. Sales is an analysis variable that is used to calculate the sum statistic. In each case, the value of Sales is the sum of Sales for all observations in one department in one group. (In this case, the value represents a single observation.)

```
define sales / analysis sum format=dollar11.2 ' ';
```

Define the computed variable. The COMPUTED option indicates that PROC REPORT must compute values for Perish. You compute the variable's values in a compute block that is associated with Perish.

```
define perish / computed format=dollar11.2
            'Perishable*Total';
```

Calculate values for the computed variable. This compute block computes the value of Perish from the values for the Meat/Dairy department and the Produce department. Because the variables Sales and Department collectively define these columns, there is no way to identify the values to PROC REPORT by name. Therefore, the assignment statement uses column numbers to unambiguously specify the values to use. Each time PROC REPORT needs a value for Perish, it sums the values in the third and fourth columns of that row of the report.

```
compute perish;
   perish=sum(_c3_, _c4_);
endcomp;
```

Produce a customized summary. This compute block creates a customized summary at the end of the report. LINE statements write the quoted text in the specified columns and the values of the variables _C3_, _C4_, and _C5_ with the DOLLAR11.2 format.

```
compute after;
         line  'Combined sales for meat and dairy : '
         _c3_ dollar11.2 '';
   line  'Combined sales for produce : '
         _c4_ dollar11.2 '';
   line  'Combined sales for all perishables: '
         _c5_ dollar11.2 '';
      endcomp;

where sector contains 'n'
      and (department='p1' or department='p2');
```

Specify the title.

```
   title 'Sales Figures for Perishables in Northern Sectors';
run;
```

Output: HTML

Output 58.7 *Creating a Column for Each Value of a Variable*

Sales Figures for Perishables in Northern Sectors

		Department		
		Meat/Dairy	Produce	
Sector	Manager			Perishable Total
Northeast	Alomar	$190.00	$86.00	$276.00
	Andrews	$300.00	$125.00	$425.00
Northwest	Brown	$250.00	$73.00	$323.00
	Pelfrey	$205.00	$76.00	$281.00
	Reveiz	$600.00	$30.00	$630.00

Combined sales for meat and dairy: $1,545.00
Combined sales for produce: $390.00
Combined sales for all perishables: $1,935.00

Example 7: Writing a Customized Summary on Each Page

Features:

PROC REPORT statement options

COLUMN statement

DEFINE statement options
- NOPRINT
- GROUP
- COMPUTED
- ANALYSIS

COMPUTE statement arguments
- BEFORE
- AFTER
- BEFORE _PAGE_
- STYLE=
- TEXT=

BREAK statement options
- PAGE
- SUMMARIZE
- AFTER
- STYLE=

LINE statement

LIBNAME statement

OPTIONS statement

TITLE statement

Data set: GROCERY

Format: $SCTRFMT

Format: $MGRFMT

Format: $DEPTFMT

Details

The report in this example displays a record of one day's sales for each store. The rows are arranged so that all the information about one store is together, and the information for each store begins on a new page. Some variables appear in columns. Others appear only in the page heading that identifies the sector and the store's manager.

The heading that appears at the top of each page is created with the _PAGE_ argument in the COMPUTE statement.

Profit is a computed variable based on the value of Sales and Department.

The text that appears at the bottom of the page depends on the total of Sales for the store. Only the first two pages of the report appear here.

Program

```
libname proclib 'SAS-library';

options fmtsearch=(proclib);

proc report data=grocery;

   title 'Sales for Individual Stores';

   column sector manager department sales Profit;

   define sector / group noprint;
   define manager / group noprint;
   define profit / computed format=dollar11.2;
   define sales / analysis sum format=dollar11.2;
   define department / group format=$deptfmt.;

   compute profit;
```

```
   if department='np1' or department='np2'
      then profit=0.4*sales.sum;
   else profit=0.25*sales.sum;
endcomp;

 compute before _page_ / style={just=left};
   line sector $sctrfmt. ' Sector';
   line 'Store managed by ' manager $mgrfmt.;
      endcomp;

break after manager / summarize style=[font_style=italic] page;

compute after manager;

   length text $ 35;

   if sales.sum lt 500 then
      text='Sales are below the target region.';
   else if sales.sum ge 500 and sales.sum lt 1000 then
      text='Sales are in the target region.';
   else if sales.sum ge 1000 then
      text='Sales exceeded goal!';
   line text $35.;
endcomp;
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Specify the report options. By default, PROC REPORT runs without the REPORT window and sends its output to the open output destinations.

```
proc report data=grocery;
```

Specify the title.

```
title 'Sales for Individual Stores';
```

Specify the report columns. The report contains a column for Sector, Manager, Department, Sales, and Profit, but the NOPRINT option suppresses the printing of the columns for Sector and Manager. The page heading (created later in the program) includes their values. To get these variable values into the page heading, Sector and Manager must be in the COLUMN statement.

```
column sector manager department sales Profit;
```

Define the group, computed, and analysis variables. In this report, Sector, Manager, and Department are group variables. Each detail row of the report consolidates the information for all observations with the same values of the group variables. Profit is a computed variable whose values are calculated in the next section of the program. FORMAT= specifies the formats to use in the report.

```
define sector / group noprint;
define manager / group noprint;
define profit / computed format=dollar11.2;
define sales / analysis sum format=dollar11.2;
define department / group format=$deptfmt.;
```

Calculate the computed variable. Profit is computed as a percentage of Sales. For nonperishable items, the profit is 40% of the sale price. For perishable items the profit is 25%. Notice that in the compute block, you must reference the variable Sales with a compound name (Sales.sum) that identifies both the variable and the statistic that you calculate with it.

```
compute profit;
   if department='np1' or department='np2'
      then profit=0.4*sales.sum;
   else profit=0.25*sales.sum;
endcomp;
```

Create a customized page heading. This compute block executes at the top of each page, after PROC REPORT writes the title. It writes the page heading for the current manager's store. The STYLE= option left-justifies the text in the LINE statements. The LINE statements write a variable value with the format specified immediately after the variable's name.

```
 compute before _page_ / style={just=left};
   line sector $sctrfmt. ' Sector';
   line 'Store managed by ' manager $mgrfmt.;
      endcomp;
```

Produce a report summary. This BREAK statement creates a default summary after the last row for each manager. SUMMARIZE writes the value of Sales (the only analysis or computed variable) in the summary line. The PAGE option starts a new page after each default summary so that the page heading that is created in the preceding compute block always pertains to the correct manager. The STYLE= option italicizes the summary information.

```
break after manager / summarize style=[font_style=italic] page;
```

Produce a customized summary. This compute block places conditional text in a customized summary that appears after the last detail row for each manager.

```
compute after manager;
```

Specify the length of the customized summary text. The LENGTH statement assigns a length of 35 to the temporary variable TEXT. In this particular case, the LENGTH statement is unnecessary because the longest version appears in the first IF/THEN statement. However, using the LENGTH statement ensures that even if the order of the conditional statements changes, TEXT is long enough to hold the longest version.

```
   length text $ 35;
```

Specify the conditional logic for the customized summary text. You cannot use the LINE statement in conditional statements (IF-THEN, IF-THEN/ELSE, and SELECT) because it does not take effect until PROC REPORT has executed all other statements in the compute block. These IF-THEN/ELSE statements assign a value to TEXT based on the value of Sales.sum in the summary row. A LINE statement writes that variable, whatever its value happens to be.

```
      if sales.sum lt 500 then
         text='Sales are below the target region.';
      else if sales.sum ge 500 and sales.sum lt 1000 then
         text='Sales are in the target region.';
      else if sales.sum ge 1000 then
         text='Sales exceeded goal!';
      line text $35.;
   endcomp;
   run;
```

Output: HTML

Output 58.8 *Writing a Customized Summary on Each Page*

Sales for Individual Stores

Northeast Sector
Store managed by Alomar

Department	Sales	Profit
Canned	$420.00	$168.00
Meat/Dairy	$190.00	$47.50
Paper	$90.00	$36.00
Produce	$86.00	$21.50
	$786.00	*$196.50*

Sales are in the target region.

Sales for Individual Stores

Northeast Sector
Store managed by Andrews

Department	Sales	Profit
Canned	$420.00	$168.00
Meat/Dairy	$300.00	$75.00
Paper	$200.00	$80.00
Produce	$125.00	$31.25
	$1,045.00	*$261.25*

Sales exceeded goal!

Example 8: Displaying a Calculated Percentage Column in a Report

Features:
PROC REPORT statement options
COLUMN statement arguments
- PCTSUM
- SUM

DEFINE statement options
- COMPUTED
- STYLE(COLUMN)=
- GROUP

COMPUTE statement options
- CHAR
- LENGTH=

RBREAK statement options
- SUMMARIZE
- STYLE=

LIBNAME statement

OPTIONS statement

TITLE statement

Data set: GROCERY

Format: $MGRFMT

Format: $DEPTFMT

Details

The summary report in this example shows the total sales for each store and the percentage that these sales represent of sales for all stores. Each of these columns has its own heading. A single heading also spans all the columns.

The report includes a computed character variable, COMMENT, that flags stores with an unusually high percentage of sales.

Program

```
libname proclib 'SAS-library';
options fmtsearch=(proclib);
proc report data=grocery;
```

```
   title;

   column ('Individual Store Sales as a Percent of All Sales'
            sector manager sales,(sum pctsum) comment);

   define manager / group
                    format=$mgrfmt.;
   define sector / group
                   format=$sctrfmt.;
   define sales / format=dollar11.2
                  '';
   define sum / format=dollar9.2
                'Total Sales';

   define pctsum / 'Percent of Sales' format=percent6.;
   define comment / computed style(column)=[cellwidth=2.5in];

   compute comment / char length=40;

      if sales.pctsum gt .15 and _break_ = ' '
      then comment='Sales substantially above expectations.';
      else comment=' ';
   endcomp;

   rbreak after / summarize style=[font_style=italic];
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Specify the report options. Specify the data set and other options.

```
proc report data=grocery;
   title;
```

Specify the report columns. The COLUMN statement uses the text in quotation marks as a spanning heading. The heading spans all the columns in the report because they are all included in the pair of parentheses that contains the heading. The COLUMN statement associates two statistics with Sales: Sum and Pctsum. The Sum statistic sums the values of Sales for all observations that are included in a row of the report. The Pctsum statistic shows what percentage of Sales sum is for all observations in the report.

```
   column ('Individual Store Sales as a Percent of All Sales'
            sector manager sales,(sum pctsum) comment);
```

Define the group and analysis columns. In this report, Sector and Manager are group variables. Each detail row represents a set of observations that have a unique combination of formatted values for all group variables. Sales is, by default, an analysis variable that is used to calculate the Sum statistic. However, because

statistics are associated with Sales in the column statement, those statistics override the default. FORMAT= specifies the formats to use in the report. Text between quotation marks specifies the column heading.

```
define manager / group
                  format=$mgrfmt.;
define sector / group
                 format=$sctrfmt.;
define sales / format=dollar11.2
               '';
define sum / format=dollar9.2
             'Total Sales';
```

Define the percentage and computed columns. The DEFINE statement for Pctsum specifies a column heading and a format. The PERCENT. format presents the value of Pctsum as a percentage rather than a decimal. The DEFINE statement for COMMENT defines a computed variable and assigns it a column.

```
define pctsum / 'Percent of Sales' format=percent6.;
define comment / computed style(column)=[cellwidth=2.5in];
```

Calculate the computed variable. Options in the COMPUTE statement define COMMENT as a character variable with a length of 40.

```
compute comment / char length=40;
```

Specify the conditional logic for the computed variable. For every store where sales exceed 15% of the sales for all stores, the compute block creates a comment that says **`Sales substantially above expectations`**. Of course, on the summary row for the report, the value of Pctsum is 100. However, it is inappropriate to flag this row as having exceptional sales. The automatic variable _BREAK_ distinguishes detail rows from summary rows. In a detail row, the value of _BREAK_ is blank. The THEN statement executes only on detail rows where the value of Pctsum exceeds 0.15.

```
    if sales.pctsum gt .15 and _break_ = ' '
    then comment='Sales substantially above expectations.';
    else comment=' ';
endcomp;
```

Produce the report summary. This RBREAK statement creates a default summary at the end of the report. SUMMARIZE writes the values of Sales.sum and Sales.pctsum in the summary line. STYLE= italicizes the summary line.

```
    rbreak after / summarize style=[font_style=italic];
run;
```

Output: HTML

Output 58.9 *Calculating Percentages*

Individual Store Sales as a Percent of All Sales				
Sector	**Manager**	**Total Sales**	**Percent of Sales**	**comment**
Northeast	Alomar	$786.00	12%	
	Andrews	$1,045.00	17%	Sales substantially above expectations.
Northwest	Brown	$598.00	9%	
	Pelfrey	$746.00	12%	
	Reveiz	$1,110.00	18%	Sales substantially above expectations.
Southeast	Jones	$630.00	10%	
	Smith	$350.00	6%	
Southwest	Adams	$695.00	11%	
	Taylor	$353.00	6%	
		$6,313.00	*100%*	

Example 9: How PROC REPORT Handles Missing Values

Features:

PROC REPORT statement options
- MISSING

COLUMN statement
- with the N statistic

DEFINE statement options
- STYLE(COLUMN)=
- GROUP

RBREAK statement options
- AFTER
- SUMMARIZE
- STYLE=

LIBNAME statement

OPTIONS statement

TITLE statement

Format: $MGRFMT

Details

This example illustrates how PROC REPORT handles missing values for group (or order or across) variables with and without the MISSING option. The differences in the reports are apparent if you compare the values of N for each row and compare the totals in the default summary at the end of the report.

Program – Data Set with No Missing Values

```
libname proclib 'SAS-library';

options fmtsearch=(proclib);

data grocmiss;
   input Sector $ Manager $ Department $ Sales @@;
datalines;
se 1 np1 50    .  1 p1 100   se . np2 120   se 1 p2 80
se 2 np1 40    se 2 p1 300   se 2 np2 220   se 2 p2 70
nw 3 np1 60    nw 3 p1 600   .  3 np2 420   nw 3 p2 30
nw 4 np1 45    nw 4 p1 250   nw 4 np2 230   nw 4 p2 73
nw 9 np1 45    nw 9 p1 205   nw 9 np2 420   nw 9 p2 76
sw 5 np1 53    sw 5 p1 130   sw 5 np2 120   sw 5 p2 50
.  . np1 40    sw 6 p1 350   sw 6 np2 225   sw 6 p2 80
ne 7 np1 90    ne . p1 190   ne 7 np2 420   ne 7 p2 86
ne 8 np1 200   ne 8 p1 300   ne 8 np2 420   ne 8 p2 125
;

proc report data=grocmiss;

   column sector manager N sales;

   define sector / group format=$sctrfmt.;
   define manager / group format=$mgrfmt.;
   define sales / format=dollar9.2;

   rbreak after / summarize style=[fontstyle=italic];

   title 'Summary Report for All Sectors and Managers';
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Create the GROCMISS data set. GROCMISS is identical to GROCERY except that it contains some observations with missing values for Sector, Manager, or both.

```
data grocmiss;
   input Sector $ Manager $ Department $ Sales @@;
datalines;
se 1 np1 50    .  1 p1 100   se . np2 120   se 1 p2 80
se 2 np1 40    se 2 p1 300   se 2 np2 220   se 2 p2 70
nw 3 np1 60    nw 3 p1 600   .  3 np2 420   nw 3 p2 30
nw 4 np1 45    nw 4 p1 250   nw 4 np2 230   nw 4 p2 73
nw 9 np1 45    nw 9 p1 205   nw 9 np2 420   nw 9 p2 76
sw 5 np1 53    sw 5 p1 130   sw 5 np2 120   sw 5 p2 50
.  . np1 40    sw 6 p1 350   sw 6 np2 225   sw 6 p2 80
ne 7 np1 90    ne . p1 190   ne 7 np2 420   ne 7 p2 86
ne 8 np1 200   ne 8 p1 300   ne 8 np2 420   ne 8 p2 125
;
```

Specify the report options. By default, PROC REPORT runs without the REPORT window and sends its output to the open output destinations.

```
proc report data=grocmiss;
```

Specify the report columns. The report contains columns for Sector, Manager, the N statistic, and Sales.

```
   column sector manager N sales;
```

Define the group and analysis variables. In this report, Sector and Manager are group variables. Sales is, by default, an analysis variable that is used to calculate the Sum statistic. Each detail row represents a set of observations that have a unique combination of formatted values for all group variables. The value of Sales in each detail row is the sum of Sales for all observations in the group. In this PROC REPORT step, the procedure does not include observations with a missing value for the group variable. FORMAT= specifies formats to use in the report.

```
   define sector / group format=$sctrfmt.;
   define manager / group format=$mgrfmt.;
   define sales / format=dollar9.2;
```

Produce a report summary. This RBREAK statement creates a default summary at the end of the report. SUMMARIZE writes the values of N and Sales.sum in the summary line. STYLE= italicizes the summary line.

```
   rbreak after / summarize style=[fontstyle=italic];
```

Specify the title.

```
   title 'Summary Report for All Sectors and Managers';
run;
```

OUTPUT: HTML

Output 58.10 *Output with No Missing Values*

Summary Report for All Sectors and Managers

Sector	Manager	N	Sales
Northeast	Alomar	3	$596.00
	Andrews	4	$1,045.00
Northwest	Brown	4	$598.00
	Pelfrey	4	$746.00
	Reveiz	3	$690.00
Southeast	Jones	4	$630.00
	Smith	2	$130.00
Southwest	Adams	3	$655.00
	Taylor	4	$353.00
		31	*$5,443.00*

Program – Data Set with Missing Values

Include the missing values. The MISSING option in the second PROC REPORT step includes the observations with missing values for the group variable.

```
proc report data=grocmiss missing;
   column sector manager N sales;
   define sector / group format=$sctrfmt.;
   define manager / group format=$mgrfmt.;
   define sales / format=dollar9.2;
   rbreak after / summarize style=[fontstyle=italic];
run;
```

OUTPUT: HTML

Output 58.11 *Output with Missing Values*

Summary Report for All Sectors and Managers

Sector	Manager	N	Sales
		1	$40.00
	Reveiz	1	$420.00
	Smith	1	$100.00
Northeast		1	$190.00
	Alomar	3	$596.00
	Andrews	4	$1,045.00
Northwest	Brown	4	$598.00
	Pelfrey	4	$746.00
	Reveiz	3	$690.00
Southeast		1	$120.00
	Jones	4	$630.00
	Smith	2	$130.00
Southwest	Adams	3	$655.00
	Taylor	4	$353.00
		36	*$6,313.00*

Example 10: Creating an Output Data Set and Storing Computed Variables

Features:

PROC REPORT statement options
- OUT=

COLUMN

DEFINE statement options
- GROUP
- COMPUTED
- ANALYSIS
- SUM

COMPUTE

Data set options

WHERE=
LIBNAME statement
OPTIONS statement
TITLE

Data set: GROCERY

Format: $MGRFMT

Details

This example uses WHERE processing as it builds an output data set. This technique enables you to do WHERE processing after you have consolidated multiple observations into a single row.

Note: This technique is needed because you cannot subset on the results of analysis variables. You cannot subset on a value calculated by PROC REPORT.

The first PROC REPORT step creates a report in which each row represents all the observations from the input data set for a single manager. The second PROC REPORT step builds a report from the output data set.

Program to Create Output Data Set

```
libname proclib 'SAS-library';

options fmtsearch=(proclib);

proc report data=grocery
            out=profit( where=(sales gt 1000 and _break_='') );
   column manager sales manager_pct;

   define manager / group;
   define manager_pct / computed;
   compute before;
      total_sales = sales.sum;
   endcomp;
   compute manager_pct;
      manager_pct = sales.sum /total_sales;
   endcomp;
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Specify the report options and columns. By default, PROC REPORT runs without the REPORT window and sends its output to the open output destinations. OUT= creates the output data set PROFIT. The output data set contains a variable for each column in the report (Manager, Sales, and the computed column manager_pct) as well as for the variable _BREAK_, which is not used in this example. Each observation in the data set represents a row of the report. Because Manager is a group variable and Sales is an analysis variable that is used to calculate the Sum statistic, each row in the report (and therefore each observation in the output data set) represents multiple observations from the input data set. In particular, each value of Sales in the output data set is the total of all values of Sales for that manager. The WHERE= data set option in the OUT= option filters those rows as PROC REPORT creates the output data set. Only those observations with sales that exceed $1,000 become observations in the output data set.

```
proc report data=grocery
            out=profit( where=(sales gt 1000 and _break_='') );
   column manager sales manager_pct;
```

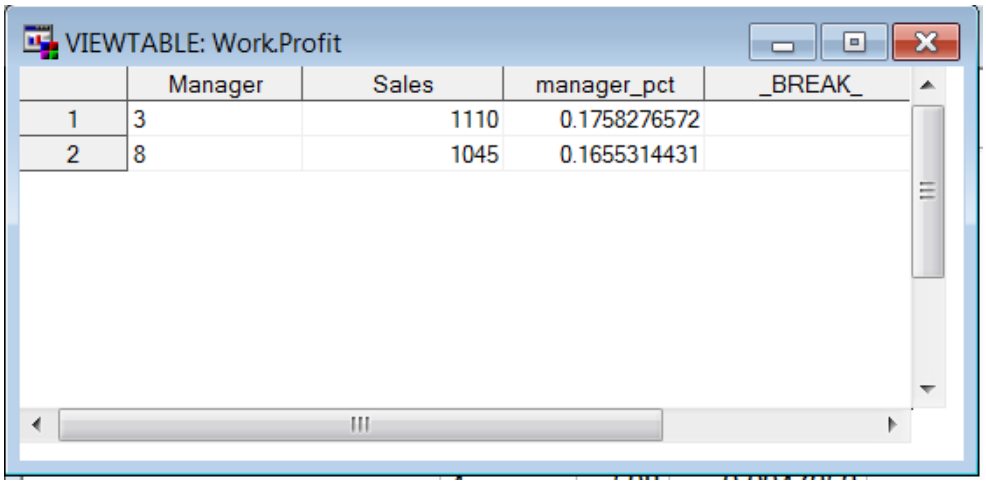
Define the group and analysis variables and compute the values for the percent of sales. The overall sum is placed in a temporary variable, total_sales, and the values for the percent of sales is computed.

```
   define manager / group;
   define manager_pct / computed;
   compute before;
      total_sales = sales.sum;
   endcomp;
   compute manager_pct;
      manager_pct = sales.sum /total_sales;
   endcomp;
run;
```

OUTPUT: HTML

Here is the data set created by PROC REPORT. It is used as the input set in the next PROC REPORT step.

Output 58.12 *The Output Data Set PROFIT*



	Manager	Sales	manager_pct	_BREAK_
1	3	1110	0.1758276572	
2	8	1045	0.1655314431	

Program That Uses the Output Data Set

Specify the report options and columns, define the group and analysis columns, and specify the titles. DATA= specifies the output data set from the first PROC REPORT step as the input data set for this report. The TITLE statements specify a title for the report.

```
proc report data=profit;
   column manager sales manager_pct;
   define manager / group format=$mgrfmt.;
   define sales / analysis sum format=dollar11.2;
   define manager_pct /'Percent of Total Sales' format=percent8.2;
   title 'Managers with Daily Sales';
   title2 'of over';
   title3 'One Thousand Dollars';
run;
```

OUTPUT: HTML

Output 58.13 *Report Based on the Output Data Set*

Managers with Daily Sales
of over
One Thousand Dollars

Manager	Sales	Percent of Total Sales
Andrews	$1,045.00	16.55%
Reveiz	$1,110.00	17.58%

Example 11: Using a Format to Create Groups

Features:
PROC REPORT statement
DEFINE statement options
- GROUP
- ORDER
- ACROSS
- ANALYSIS
- SUM
- STYLE=

COMPUTE statement options
- AFTER
- STYLE=

LINE statement
FORMAT procedure
LIBNAME statement
OPTIONS statement
TITLE

Data set: GROCERY

Format: $MGRFMT

Details

This example shows how to use formats to control the number of groups that PROC REPORT creates. The program creates a format for Department that classifies the four departments as one of two types: perishable or nonperishable. Consequently, when Department is an across variable, PROC REPORT creates only two columns instead of four. The column heading is the formatted value of the variable.

Program

```
libname proclib 'SAS-library';

options fmtsearch=(proclib);

proc format;
   value $perish 'p1','p2'='Perishable'
                 'np1','np2'='Nonperishable';
run;

proc report data=grocery;
```

```
   column manager department,sales sales;

   define manager / group order=formatted
                    format=$mgrfmt.;
   define department / across order=formatted
                format=$perish. '';

   define sales / analysis sum
                  format=dollar9.2 style=[cellwidth=13];

   compute after / style=[font_style=italic];
      line 'Total sales for these stores were: '
            sales.sum dollar9.2;
   endcomp;

title 'Sales Summary for All Stores';
run;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Create the $PERISH. format. PROC FORMAT creates a format for Department. This variable has four different values in the data set, but the format has only two values.

```
proc format;
   value $perish 'p1','p2'='Perishable'
                 'np1','np2'='Nonperishable';
run;
```

Specify the report options. By default, the REPORT procedure runs without the REPORT window and sends its output to the open output destinations.

```
proc report data=grocery;
```

Specify the report columns. Department and Sales are separated by a comma in the COLUMN statement, so they collectively determine the contents of the column that they define. Because Sales is an analysis variable, its values fill the cells that are created by these two variables. The report also contains a column for Manager and a column for Sales by itself (which is the sales for all departments).

```
   column manager department,sales sales;
```

Define the group and across variables. Manager is a group variable. Each detail row of the report consolidates the information for all observations with the same value of Manager. Department is an across variable. PROC REPORT creates a column and a column heading for each formatted value of Department. ORDER=FORMATTED

arranges the values of Manager and Department alphabetically according to their formatted values. FORMAT= specifies the formats to use. The empty quotation marks in the definition of Department specify a blank column heading, so no heading spans all the departments. However, PROC REPORT uses the formatted values of Department to create a column heading for each individual department.

```
define manager / group order=formatted
                 format=$mgrfmt.;
define department / across order=formatted
             format=$perish. '';
```

Define the analysis variable. Sales is an analysis variable that is used to calculate the Sum statistic. Sales appears twice in the COLUMN statement, and the same definition applies to both occurrences. FORMAT= specifies the format to use in the report. STYLE= specifies the width of the column. Notice that the column headings for the columns that both Department and Sales create are a combination of the heading for Department and the (default) heading for Sales.

```
define sales / analysis sum
               format=dollar9.2 style=[cellwidth=13];
```

Produce a customized summary. This COMPUTE statement begins a compute block that produces a customized summary at the end of the report. The LINE statement places the quoted text and the value of Sales.sum (with the DOLLAR9.2 format) in the summary. The STYLE= option italicizes the total sales. An ENDCOMP statement must end the compute block.

```
compute after / style=[font_style=italic];
   line 'Total sales for these stores were: '
         sales.sum dollar9.2;
endcomp;
```

Specify the title.

```
title 'Sales Summary for All Stores';
run;
```

Output: HTML

Output 58.14 *Using a Format to Create Groups*

Sales Summary for All Stores

	Nonperishable	Perishable	
Manager	**Sales**	**Sales**	**Sales**
Adams	$265.00	$430.00	$695.00
Alomar	$510.00	$276.00	$786.00
Andrews	$620.00	$425.00	$1,045.00
Brown	$275.00	$323.00	$598.00
Jones	$260.00	$370.00	$630.00
Pelfrey	$465.00	$281.00	$746.00
Reveiz	$480.00	$630.00	$1,110.00
Smith	$170.00	$180.00	$350.00
Taylor	$173.00	$180.00	$353.00
Total sales for these stores were: $6,313.00			

Example 12: Using Multilabel Formats

Features:

PROC REPORT statement

COLUMN statement

DEFINE statement options
- FORMAT=
- GROUP
- MLF
- ORDER=
- PRELOADFMT
- MEAN

FORMAT procedure option
- MULTILABEL
- NOTSORTED

LIBNAME statement

OPTIONS statement

TITLE statement

WHERE statement

Details

This example uses a multilabel format to create a report that does the following:

- shows how to specify a multilabel format in the VALUE statement of PROC FORMAT
- shows how to activate multilabel format processing using the MLF option with the DEFINE statement
- shows how using NOTSORTED and PRELOADFMT use the sort order shown in PROC FORMAT.

Program

```
proc format;
  value agelfmt (multilabel notsorted)
     11='11'
     12='12'
     13='13'
     14='14'
     15='15'
     16='16'
     11-12='11 or 12'
     13-14='13 or 14'
     15-16='15 or 16'
     low-13='13 and below'
     14-high='14 and above' ;
run;

ods html file="example.html";

title "GROUP Variable with MLF Option";

proc report data=sashelp.class;

   col age ('Mean' height weight);

   define age / group mlf format=agelfmt. 'Age Group' order=data
preloadfmt;
   define height / mean format=6.2 'Height (in.)';
   define weight / mean format=6.2 'Weight (lbs.)';
run;
```

Program Description

Create the AGE1FMT. format. The FORMAT procedure creates a multilabel format for ages by using the MULTILABEL option. A multilabel format is one in which multiple labels can be assigned to the same value. Each value is represented in the

table for each range in which it occurs. Use the NOTSORTED to ensure that the sort order is kept.

```
proc format;
  value agelfmt (multilabel notsorted)
     11='11'
     12='12'
     13='13'
     14='14'
     15='15'
     16='16'
     11-12='11 or 12'
     13-14='13 or 14'
     15-16='15 or 16'
     low-13='13 and below'
     14-high='14 and above' ;
run;
```

Specify the ODS HTML output filename.

```
ods html file="example.html";
```

Specify a title.

```
title "GROUP Variable with MLF Option";
```

Specify the report options. By default, the REPORT procedure runs without the REPORT window and sends its output to the open output destination.

```
proc report data=sashelp.class;
```

Specify the report columns. The report contains a column for Age, Height, and Weight. The Mean of the Height and Weight are calculated.

```
   col age ('Mean' height weight);
```

Define the variables. AGE is a group variable. The AGE variable uses the MLF option to activate multilabel format processing. MLF should be used only with group and across variables. FORMAT= specifies that the multilabel format, AGE1FMT. is used. The ORDER=DATA option along with the NOTSORTED option on PROC FORMAT, keeps the desired sort order. Each detail row of the report consolidates the information for all observations with the same values of the group variables. The mean is calculated for the HEIGHT and WEIGHT column values. PRELOADFMT option specifies that the format is preloaded for the variable.

```
   define age / group mlf format=agelfmt. 'Age Group' order=data
preloadfmt;
   define height / mean format=6.2 'Height (in.)';
   define weight / mean format=6.2 'Weight (lbs.)';
run;
```

Output: HTML

Output 58.15 *Using Multilabel Formats*

GROUP Variable with MLF Option

	Mean	
Age Group	Height (in.)	Weight (lbs.)
11	54.40	67.75
12	59.44	94.40
13	61.43	88.67
14	64.90	101.88
15	65.63	117.38
16	72.00	150.00
11 or 12	58.00	86.79
13 or 14	63.41	96.21
15 or 16	66.90	123.90
13 and below	59.03	87.35
14 and above	66.01	114.11

Example 13: Specifying Style Elements for ODS Output in Multiple Statements

Features:

PROC REPORT statement optionsSTYLE= option
    STYLE=

DEFINE statement options
    ORDER
    STYLE=

BREAK statement options
    AFTER
    SUMMARIZE

COMPUTE statement options
    AFTER
    STYLE=

CALL DEFINE
    STYLE=

LINE statement

FORMAT procedure

LIBNAME statement
OPTIONS statement
TITLE statement
WHERE statement
ODS PDF statement
ODS RTF statement

Data set: GROCERY
Format: $MGRFMT
Format: $DEPTFMT

Details

This example creates HTML, PDF, and RTF files and sets the style elements for each location in the report in the PROC REPORT statement. It then overrides some of these settings by specifying style elements in other statements. For more information, see “Style Elements and Style Attributes for Table Regions ” on page 2149.

Program

```
libname proclib 'SAS-library';

options fmtsearch=(proclib);

ods pdf file='external-PDF-file';
ods rtf file='external-RTF-file';

proc report data=grocery

style(report)=[cellspacing=5 borderwidth=10 bordercolor=blue]

style(header)=[color=yellow
               fontstyle=italic fontsize=6]

style(column)=[color=moderate brown
               fontfamily=helvetica fontsize=4]

style(lines)=[color=white backgroundcolor=black
              fontstyle=italic fontweight=bold fontsize=5]

style(summary)=[color=cx3e3d73 backgroundcolor=cxaeadd9
                fontfamily=helvetica fontsize=3 textalign=r];

   column manager department sales;

   define manager / order
                    order=formatted
                    format=$mgrfmt.
                    'Manager'

                    style(header)=[color=white
```

```
                                    backgroundcolor=black];
   define department / order
                       order=internal
                       format=$deptfmt.
                       'Department'
                       style(column)=[fontstyle=italic];
   break after manager / summarize;
   compute after manager
           / style=[fontstyle=roman fontsize=3 fontweight=bold
             backgroundcolor=white color=black];
      line 'Subtotal for ' manager $mgrfmt. 'is '
           sales.sum dollar7.2 '.';
   endcomp;
   compute sales;
      if sales.sum>100 and _break_=' ' then
      call define(_col_, "style",
                  "style=[backgroundcolor=yellow
                          fontfamily=helvetica
                          fontweight=bold]");
   endcomp;
   compute after;
       line 'Total for all departments is: '
            sales.sum dollar7.2 '.';
   endcomp;
   where sector='se';
   title 'Sales for the Southeast Sector';
run;
ods pdf close;
ods rtf close;
```

Program Description

Declare the PROCLIB library. The PROCLIB library is used to store user-created formats.

```
libname proclib 'SAS-library';
```

Specify the format search library. The SAS system option FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options fmtsearch=(proclib);
```

Specify the ODS output filenames. By opening multiple ODS destinations, you can produce multiple output files in a single execution. HTML output is produced by default. The ODS PDF statement produces output in Portable Document Format (PDF). The ODS RTF statement produces output in Rich Text Format (RTF). The output from PROC REPORT goes to each of these files.

```
ods pdf file='external-PDF-file';
ods rtf file='external-RTF-file';
```

Specify the report options. By default, PROC REPORT runs without the REPORT window. In this case, SAS writes the output to the traditional procedure output, the HTML body file, and the RTF and PDF files.

```
proc report data=grocery
```

Specify the style attributes for the report. This STYLE= option sets the style element for the structural part of the report. Because no style element is specified, PROC REPORT uses all the style attributes of the default style element for this location except for the ones that are specified here.

```
style(report)=[cellspacing=5 borderwidth=10 bordercolor=blue]
```

Specify the style attributes for the column headings. This STYLE= option sets the style element for all column headings. Because no style element is specified, PROC REPORT uses all the style attributes of the default style element for this location except for the ones that are specified here.

```
style(header)=[color=yellow
               fontstyle=italic fontsize=6]
```

Specify the style attributes for the report columns. This STYLE= option sets the style element for all the cells in all the columns. Because no style element is specified, PROC REPORT uses all the style attributes of the default style element for this location except for the ones that are specified here.

```
style(column)=[color=moderate brown
               fontfamily=helvetica fontsize=4]
```

Specify the style attributes for the compute block lines. This STYLE= option sets the style element for all the LINE statements in all compute blocks. Because no style element is specified, PROC REPORT uses all the style attributes of the default style element for this location except for the ones that are specified here.

```
style(lines)=[color=white backgroundcolor=black
              fontstyle=italic fontweight=bold fontsize=5]
```

Specify the style attributes for the report summaries. This STYLE= option sets the style element for all the default summary lines. Because no style element is specified, PROC REPORT uses all the style attributes of the default style element for this location except for the ones that are specified here.

```
style(summary)=[color=cx3e3d73 backgroundcolor=cxaeadd9
                fontfamily=helvetica fontsize=3 textalign=r];
```

Specify the report columns. The report contains columns for Manager, Department, and Sales.

```
column manager department sales;
```

Define the first sort order variable. In this report Manager is an order variable. PROC REPORT arranges the rows first by the value of Manager (because it is the first variable in the COLUMN statement). ORDER= specifies that values of Manager are arranged according to their formatted values. FORMAT= specifies the format to use for this variable. Text in quotation marks specifies the column headings.

```
define manager / order
                 order=formatted
                 format=$mgrfmt.
                 'Manager'
```

Specify the style attributes for the first sort order variable column heading. The STYLE= option sets the foreground and background colors of the column heading for the Manager column heading.

```
style(header)=[color=white
              backgroundcolor=black];
```

Define the second sort order variable. In this report Department is an order variable. PROC REPORT arranges the rows first by the value of Manager (because it is the first variable in the COLUMN statement), then by the value of Department. ORDER= specifies that values of Department are arranged according to their internal values. FORMAT= specifies the format to use for this variable. Text in quotation marks specifies the column heading.

```
define department / order
                    order=internal
                    format=$deptfmt.
                    'Department'
```

Specify the style attributes for the second sort order variable column. The STYLE= option sets the font of the cells in the column Department to italic. The style attributes for the cells match the ones that were established for the COLUMN location in the PROC REPORT statement.

```
style(column)=[fontstyle=italic];
```

Produce a report summary. The BREAK statement produces a default summary after the last row for each manager. SUMMARIZE writes the values of Sales (the only analysis or computed variable in the report) in the summary line. PROC REPORT sums the values of Sales for each manager because Sales is an analysis variable that is used to calculate the Sum statistic.

```
break after manager / summarize;
```

Produce a customized summary. The COMPUTE statement begins a compute block that produces a customized summary at the end of the report. This STYLE= option specifies the style element to use for the text that is created by the LINE statement in this compute block. This style element switches the foreground and background colors that were specified for the LINES location in the PROC REPORT statement. It also changes the font style, the font weight, and the font size.

```
compute after manager
        / style=[fontstyle=roman fontsize=3 fontweight=bold
          backgroundcolor=white color=black];
```

Specify the text for the customized summary. The LINE statement places the quoted text and the values of Manager and Sales.sum (with the formats $MGRFMT. and DOLLAR7.2) in the summary. An ENDCOMP statement must end the compute block.

```
   line 'Subtotal for ' manager $mgrfmt. 'is '
        sales.sum dollar7.2 '.';
endcomp;
```

Produce a customized background for the analysis column. This compute block specifies a background color and a bold font for all cells in the Sales column that contain values of 100 or greater and that are not summary lines.

```
compute sales;
   if sales.sum>100 and _break_=' ' then
```

```
    call define(_col_, "style",
                "style=[backgroundcolor=yellow
                        fontfamily=helvetica
                        fontweight=bold]");
endcomp;
```

Produce a customized end-of-report summary. This COMPUTE statement begins a compute block that executes at the end of the report. The LINE statement writes the quoted text and the value of Sales.sum (with the DOLLAR7.2 format). An ENDCOMP statement must end the compute block.

```
compute after;
    line 'Total for all departments is: '
         sales.sum dollar7.2 '.';
endcomp;
```

Select the observations to process. The WHERE statement selects for the report only the observations for stores in the southeast sector.

```
where sector='se';
```

Specify the title.

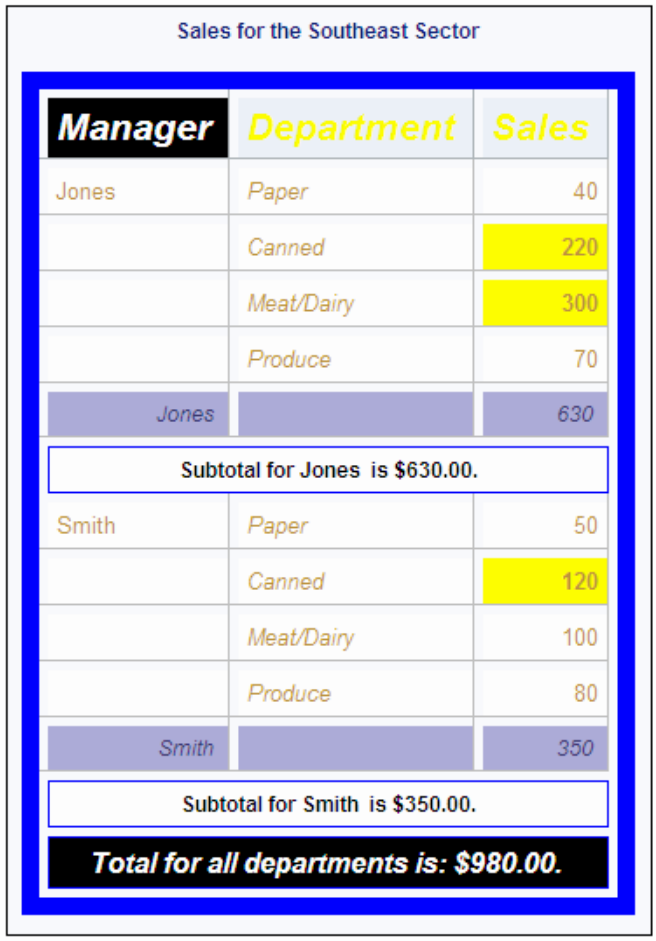
```
title 'Sales for the Southeast Sector';
run;
```

Close the ODS destinations.

```
ods pdf close;
ods rtf close;
```

Output: HTML

Output 58.16 *Style Elements for ODS HTML Output in Multiple Statements*

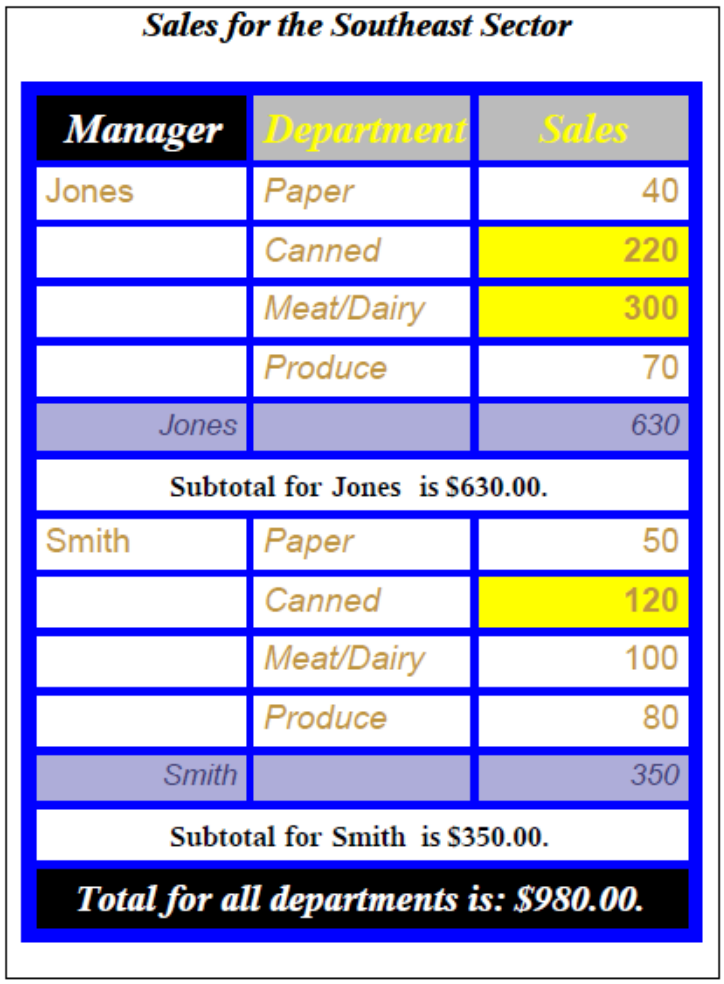


Sales for the Southeast Sector

Manager	Department	Sales
Jones	Paper	40
	Canned	220
	Meat/Dairy	300
	Produce	70
Jones		630
Subtotal for Jones is $630.00.		
Smith	Paper	50
	Canned	120
	Meat/Dairy	100
	Produce	80
Smith		350
Subtotal for Smith is $350.00.		
Total for all departments is: $980.00.		

Output: PDF

Output 58.17 *Style Elements for ODS PDF Output in Multiple Statements*

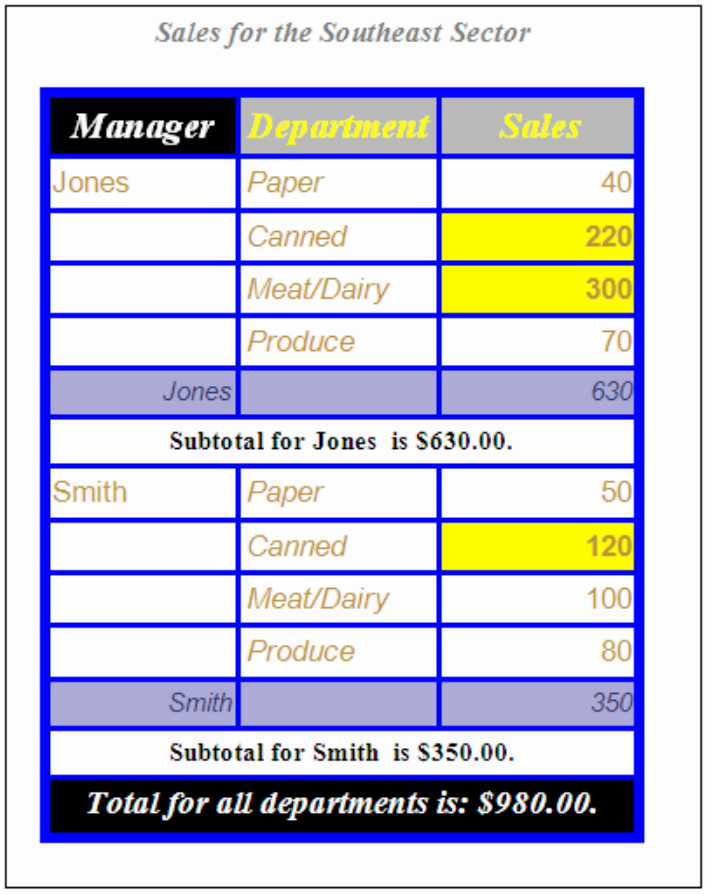


Sales for the Southeast Sector

Manager	Department	Sales
Jones	Paper	40
	Canned	220
	Meat/Dairy	300
	Produce	70
Jones		630
Subtotal for Jones is $630.00.		
Smith	Paper	50
	Canned	120
	Meat/Dairy	100
	Produce	80
Smith		350
Subtotal for Smith is $350.00.		
Total for all departments is: $980.00.		

Output: RTF

Output 58.18 *Style Elements for ODS RTF Output in Multiple Statements*



Sales for the Southeast Sector

Manager	Department	Sales
Jones	Paper	40
	Canned	220
	Meat/Dairy	300
	Produce	70
Jones		630
Subtotal for Jones is $630.00.		
Smith	Paper	50
	Canned	120
	Meat/Dairy	100
	Produce	80
Smith		350
Subtotal for Smith is $350.00.		
Total for all departments is: $980.00.		

Example 14: Using the CELLWIDTH= Style Attribute with PROC REPORT

Features:

PROC REPORT statement options
STYLE=

COLUMN statement

DEFINE statement options
STYLE(COLUMN)=

TITLE statement

Details

This example uses PROC REPORT to create a table and uses ODS style attributes. This example

- sets the cell width of the total report
- defines the cell width for the columns in the ODS output.

Note: CELLWIDTH= and WIDTH= are aliases.

Refer to "Style Attributes Tables" in *SAS Output Delivery System: Advanced Topics* for details.

Note: The DEFINE statement WIDTH= option changes the width only for tables output in LISTING output.

Program

```
proc report data=sashelp.class;
   col name age sex;
   define name / style(column)=[cellwidth=1in];
define age / style(column)=[cellwidth=.5in];
define sex / style(column)=[cellwidth=.5in];
title "Using the CELLWIDTH= Style with PROC REPORT";
run;
```

Program Description

Specify the cell width for all the columns in the ODS output. By default, the REPORT procedure runs without the REPORT window and sends its output to the open output destination. ODS HTML is the output destination used as the default in this example.

```
proc report data=sashelp.class;
```

Specify the Columns to be used.

```
   col name age sex;
```

Define the column widths using the CELLWIDTH= style attribute. Define the dimensions of the NAME, AGE, and SEX column using the STYLE= option.

```
   define name / style(column)=[cellwidth=1in];
define age / style(column)=[cellwidth=.5in];
```

```
define sex / style(column)=[cellwidth=.5in];
```

Specify a table title. Provide a table name and run the SAS program.

```
title "Using the CELLWIDTH= Style with PROC REPORT";
run;
```

Output: HTML

Output 58.19 *Using the CELLWIDTH= Style Attributes with PROC REPORT*

Using CELLWIDTH= Style with PROC REPORT

Name	Age	Sex
Alfred	14	M
Alice	13	F
Barbara	13	F
Carol	14	F
Henry	14	M
James	12	M
Jane	12	F
Janet	15	F
Jeffrey	13	M
John	12	M
Joyce	11	F
Judy	14	F
Louise	12	F
Mary	15	F
Philip	16	M
Robert	12	M
Ronald	15	M
Thomas	11	M
William	15	M

Example 15: Using STYLE/MERGE in PROC REPORT CALL DEFINE Statement

Features:

PROC REPORT statement
COLUMN statement
COMPUTE statement
CALL DEFINE statement options
    STYLE
    STYLE/MERGE
TITLE statement

Details

This example uses PROC REPORT to create a table that uses the STYLE/MERGE option in the CALL DEFINE statement.

Program

```
proc report data=sashelp.class;
col name sex age height weight;
define name--weight / display;
   compute sex;
    if sex = 'M' then
        call define('name', "style", "style=[background=cyan]");
    endcomp;
   compute age;
    if age > 13 then
        call define('name', "style/merge", "style=[color=red]");
    endcomp;
title "Using STYLE/MERGE Style with PROC REPORT";
run;
```

Program Description

Specify the cell width for all the columns in the ODS output. By default, the REPORT procedure runs without the REPORT window and sends its output to the

open output destination. ODS HTML is the output destination used as the default in this example.

```
proc report data=sashelp.class;
```

Specify the Columns to be used.

```
col name sex age height weight;
```

Display all of the Columns.

```
define name--weight / display;
```

Apply style attributes. Apply the cyan color to the background of the names that are males.

```
compute sex;
 if sex = 'M' then
     call define('name', "style", "style=[background=cyan]");
 endcomp;
```

Merge style attributes. Apply the color red to the names that are over the age 13. That name color is merged with cells that have the cyan background color.

```
compute age;
 if age > 13 then
     call define('name', "style/merge", "style=[color=red]");
 endcomp;
```

Specify a table title. Provide a table name and run the SAS program.

```
title "Using STYLE/MERGE Style with PROC REPORT";
run;
```

Output: HTML

Output 58.20 *Using STYLE/MERGE*

Using STYLE/MERGE

Name	Sex	Age	Height	Weight
Alfred	M	14	69	112.5
Alice	F	13	56.5	84
Barbara	F	13	65.3	98
Carol	F	14	62.8	102.5
Henry	M	14	63.5	102.5
James	M	12	57.3	83
Jane	F	12	59.8	84.5
Janet	F	15	62.5	112.5
Jeffrey	M	13	62.5	84
John	M	12	59	99.5
Joyce	F	11	51.3	50.5
Judy	F	14	64.3	90
Louise	F	12	56.3	77
Mary	F	15	66.5	112
Philip	M	16	72	150
Robert	M	12	64.8	128
Ronald	M	15	67	133
Thomas	M	11	57.5	85
William	M	15	66.5	112

Example 16: Using STYLE/REPLACE in PROC REPORT CALL DEFINE Statement

Features:
- PROC REPORT statement
- COLUMN statement
- COMPUTE statement
- CALL DEFINE statement options
  - STYLE

STYLE/REPLACE
TITLE statement

Details

This example uses PROC REPORT to create a table that uses the STYLE/REPLACE option in the CALL DEFINE statement.

Program

```
proc report data=sashelp.class;
col name sex age height weight;
define name--weight / display;
   compute sex;
    if sex = 'M' then
        call define('name', "style", "style=[background=cyan]");
    endcomp;
   compute age;
    if age > 13 then
        call define('name', "style/replace", "style=[color=red]");
    endcomp;
title "Using STYLE/REPLACE";
run;
```

Program Description

Specify the cell width for all the columns in the ODS output. By default, the REPORT procedure runs without the REPORT window and sends its output to the open output destination. ODS HTML is the output destination used as the default in this example.

```
proc report data=sashelp.class;
```

Specify the Columns to be used.

```
col name sex age height weight;
```

Display all of the Columns.

```
define name--weight / display;
```

Apply style attributes. Apply the cyan color to the background of the names that are males.

```
   compute sex;
    if sex = 'M' then
```

```
        call define('name', "style", "style=[background=cyan]");
    endcomp;
```

Replace style attributes. Apply the color red to the names that are over the age 13. For the names that are over the age of 13, the red name color replaces the background color cyan.

```
    compute age;
     if age > 13 then
        call define('name', "style/replace", "style=[color=red]");
     endcomp;
```

Specify a table title. Provide a table name and run the SAS program.

```
title "Using STYLE/REPLACE";
run;
```

Output: HTML

Output 58.21 *Using STYLE/REPLACE*

Using STYLE/REPLACE

Name	Sex	Age	Height	Weight
Alfred	M	14	69	112.5
Alice	F	13	56.5	84
Barbara	F	13	65.3	98
Carol	F	14	62.8	102.5
Henry	M	14	63.5	102.5
James	M	12	57.3	83
Jane	F	12	59.8	84.5
Janet	F	15	62.5	112.5
Jeffrey	M	13	62.5	84
John	M	12	59	99.5
Joyce	F	11	51.3	50.5
Judy	F	14	64.3	90
Louise	F	12	56.3	77
Mary	F	15	66.5	112
Philip	M	16	72	150
Robert	M	12	64.8	128
Ronald	M	15	67	133
Thomas	M	11	57.5	85
William	M	15	66.5	112

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REPORT Procedure Windows

Overview of REPORT Procedure Windows

The interactive report window environment in PROC REPORT provides essentially the same functionality as the statements, with one major exception: you cannot use the Output Delivery System from the interactive report window environment.

Dictionary

BREAK Window

Controls PROC REPORT's actions at a change in the value of a group or order variable or at the top or bottom of a report.

Details

Path

Edit ⇨ Summarize information

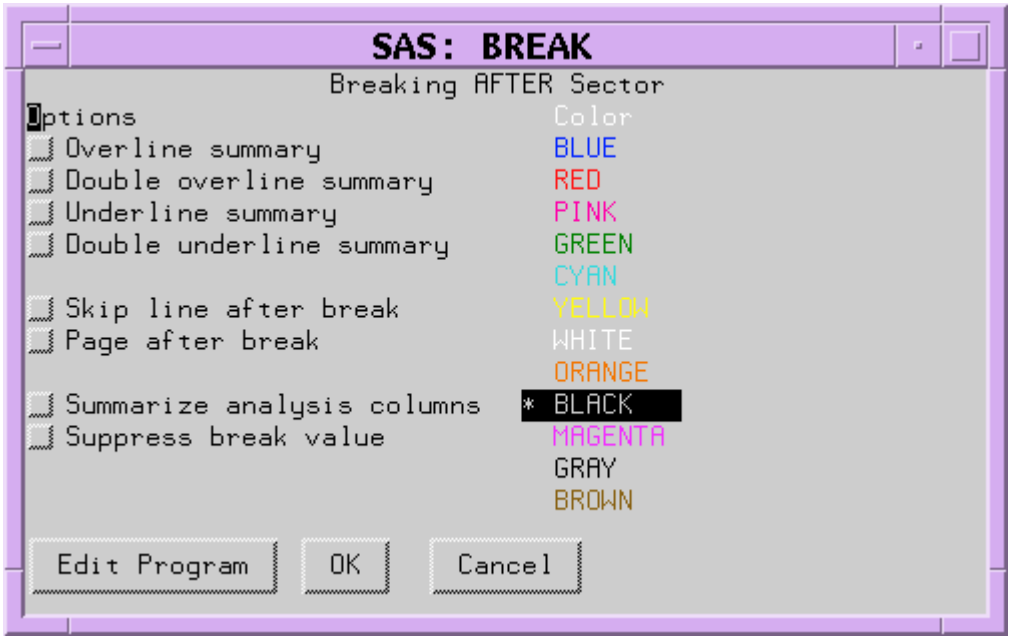
After you select **Summarize information**, PROC REPORT offers you four choices for the location of the break:

- **Before Item**
- **After Item**
- **At the top**
- **At the bottom**

After you select a location, the BREAK window appears.

Note: To create a break before or after detail lines (when the value of a group or order variable changes), you must select a variable before you open the BREAK window.

Description



Note: For information about changing the formatting characters that are used by the line drawing options in this window, see the discussion of "FORMCHAR <(*position(s)*)>='*formatting-character(s)*' " on page 2081

Options

Overline summary
uses the second formatting character to overline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default hyphen (-)

Interaction If you specify options to overline and to double overline, then PROC REPORT overlines.

Double overline summary
uses the 13th formatting character to overline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default equal sign (=)

Interaction If you specify options to overline and to double overline, then PROC REPORT overlines.

Underline summary
uses the second formatting character to underline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default hyphen (-)

Interaction If you specify options to underline and to double underline, then PROC REPORT underlines.

Double underline summary
uses the 13th formatting character to underline each value

- that appears in the summary line
- that would appear in the summary line if you specified the SUMMARIZE option

Default equal sign (=)

Interaction If you specify options to underline and to double underline, then PROC REPORT underlines.

Skip line after break
writes a blank line for the last break line.

This option has no effect if you use it in a break at the end of a report.

Page after break
starts a new page after the last break line. This option has no effect in a break at the end of a report.

Interaction If you use this option in a break on a variable and you create a break at the end of the report, then the summary for the whole report is on a separate page.

Summarize analysis columns
writes a summary line in each group of break lines. A summary line contains values for

- statistics
- analysis variables
- computed variables

A summary line between sets of observations also contains

- the break variable (which you can suppress with **Suppress break value**)
- other group or order variables to the left of the break variable.

The following table shows how PROC REPORT calculates the value for each type of report item in a summary line created by the BREAK window:

Report Item	Resulting Value
The break variable	The current value of the variable (or a missing value if you select `suppress break value`)
A group or order variable to the left of the break variable	The current value of the variable
A group or order variable to the right of the break variable, or a display variable anywhere in the report	Missing*
A statistic	The value of the statistic over all observations in the set
An analysis variable	The value of the statistic specified as the usage option in the item's definition. PROC REPORT calculates the value of the statistic over all observations in the set. The default usage is SUM.
A computed variable	The results of the calculations based on the code in the corresponding compute block. (See the "COMPUTE Statement" on page 2112 statement.)

*If you reference a variable with a missing value in a customized summary line, then PROC REPORT displays that variable as a blank (for character variables) or a period (for numeric variables).

Suppress break value
suppresses printing of

- the value of the break variable in the summary line
- any underlining and overlining in the break lines in the column containing the break variable

If you select **Suppress break value**, then the value of the break variable is unavailable for use in customized break lines unless you assign it a value in the compute block that is associated with the break.

Color

From the list of colors, select the one to use in the REPORT window for the column heading and the values of the item that you are defining. The default is the color of **Foreground** in the SASCOLOR window. (For more information, see the online Help for the **SASCOLOR** window.)

Note: Not all operating environments and devices support all colors, and in some operating environments and devices, one color might map to another color. For example, if the DEFINITION window displays the word BROWN in yellow characters, then selecting BROWN results in a yellow item.

Buttons

Edit Program
opens the COMPUTE window and enables you to associate a compute block with a location in the report.

OK
applies the information in the BREAK window to the report and closes the window.

Cancel
closes the BREAK window without applying information to the report.

COMPUTE Window

Attaches a compute block to a report item or to a location in the report. Use the SAS Text Editor commands to manipulate text in this window.

Details

Path

From **Edit Program** in the COMPUTED VAR, DEFINITION, or BREAK window.

Description

For information about the SAS language features that you can use in the COMPUTE window, see "The Contents of Compute Blocks" on page 2062.

COMPUTED VAR Window

Adds a variable that is not in the input data set to the report.

Details

Path

Select a column. Then select **Edit** ⇨ **Add Item** ⇨ **Computed Column**.

After you select **Computed Column**, PROC REPORT prompts you for the location of the computed column relative to the column that you have selected. After you select a location, the COMPUTED VAR window appears.

Description

Enter the name of the variable at the prompt. If it is a character variable, then select the **Character data** check box and, if you want, enter a value in the **Length** field. The length can be any integer between 1 and 200. If you leave the field blank, then PROC REPORT assigns a length of 8 to the variable.

After you enter the name of the variable, select **Edit Program** to open the COMPUTE window. Use programming statements in the COMPUTE window to define the computed variable. After closing the COMPUTE and COMPUTED VAR windows, open the DEFINITION window to describe how to display the computed variable.

Note: The position of a computed variable is important. PROC REPORT assigns values to the columns in a row of a report from left to right. Consequently, you cannot base the calculation of a computed variable on any variable that appears to its right in the report.

DATA COLUMNS Window

Lists all variables in the input data set so that you can add one or more data set variables to the report.

Details

Path

Select a report item. Then select **Edit** ⇨ **Add Item** ⇨ **Data Column**.

After you select **Data column**, PROC REPORT prompts you for the location of the computed column relative to the column that you have selected. After you select a location, the DATA COLUMNS window appears.

Description

Select one or more variables to add to the report. When you select the first variable, it moves to the top of the list in the window. If you select multiple variables, then subsequent selections move to the bottom of the list of selected variables. An asterisk (*) identifies each selected variable. The order of selected variables from top to bottom determines their order in the report from left to right.

DATA SELECTION Window

Loads a data set into the current report definition.

Details

Path

File ⇨ Open Data Set

Description

The first list box in the DATA SELECTION window lists all the librefs defined for your SAS session. The second one lists all the SAS data sets in the selected library.

Note: You must use data that is compatible with the current report definition. The data set that you load must contain variables whose names are the same as the variable names in the current report definition.

Buttons

OK
loads the selected data set into the current report definition.

Cancel
closes the DATA SELECTION window without loading new data.

DEFINITION Window

Displays the characteristics associated with an item in the report and lets you change them.

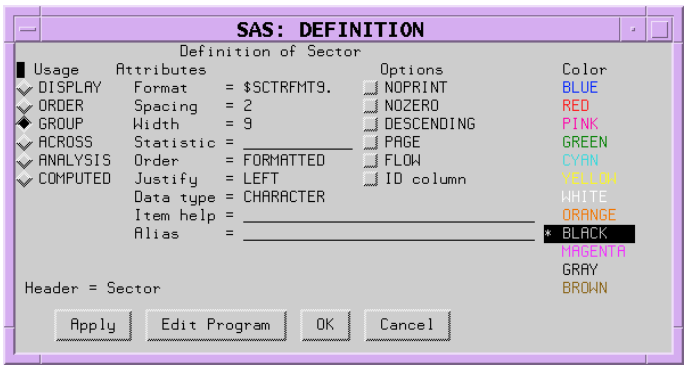
Details

Path

Select a report item. Then select **Edit** ⇨ **Define**.

Note: Alternatively, double-click on the selected item. (Not all operating environments support this method of opening the DEFINITION window.)

Description



Usage

For an explanation of each type of usage, see “Laying Out a Report ” on page 2054.

DISPLAY
: defines the selected item as a display variable. DISPLAY is the default for character variables.

ORDER
: defines the selected item as an order variable.

GROUP
: defines the selected item as a group variable.

ACROSS
: defines the selected item as an across variable.

ANALYSIS
: defines the selected item as an analysis variable. You must specify a statistic (see the discussion of the Statistic= attribute on page 2238) for an analysis variable. ANALYSIS is the default for numeric variables.

COMPUTED
: defines the selected item as a computed variable. Computed variables are variables that you define for the report. They are not in the input data set, and PROC REPORT does not add them to the input data set. However, computed variables are included in an output data set if you create one.

  In the interactive report window environment, you add a computed variable to a report from the COMPUTED VAR window.

Attributes

Format=
assigns a SAS or user-defined format to the item. This format applies to the selected item as PROC REPORT displays it; the format does not alter the format that is associated with a variable in the data set. For data set variables, PROC REPORT honors the first of these formats that it finds:

- the format that is assigned with FORMAT= in the DEFINITION window
- the format that is assigned in a FORMAT statement when you start PROC REPORT
- the format that is associated with the variable in the data set

If none of these formats is present, then PROC REPORT uses BEST*w*. for numeric variables and $*w*. for character variables. The value of *w* is the default column width. For character variables in the input data set, the default column width is the variable's length. For numeric variables in the input data set and for computed variables (both numeric and character), the default column width is the value of the COLWIDTH= attribute in the ROPTIONS window.

If you are unsure what format to use, then type a question mark (?) in the format field in the DEFINITION window to access the FORMATS window.

Spacing=
defines the number of blank characters to leave between the column being defined and the column immediately to its left. For each column, the sum of its width and the blank characters between it and the column to its left cannot exceed the line size.

Default 2

Interactions When PROC REPORT's CENTER option is in effect, PROC REPORT ignores spacing that precedes the leftmost variable in the report.

SPACING= in an item definition overrides the value of SPACING= in the PROC REPORT statement or the ROPTIONS window.

Width=
defines the width of the column in which PROC REPORT displays the selected item.

Default A column width that is just large enough to handle the format. If there is no format, then PROC REPORT uses the value of COLWIDTH=.

Range 1 to the value of the SAS system option LINESIZE=

Note When you stack items in the same column in a report, the width of the item that is at the bottom of the stack determines the width of the column.

Statistic=
associates a statistic with an analysis variable. You must associate a statistic with every analysis variable in its definition. PROC REPORT uses the statistic that you specify to calculate values for the analysis variable for the

observations represented by each cell of the report. You cannot use *statistic* in the definition of any other type of variable.

Note: PROC REPORT uses the name of the analysis variable as the default heading for the column. You can customize the column heading with the **Header** field of the DEFINITION window.

You can use the following values for *statistic*:

Descriptive statistic keywords	
CSS	PCTSUM
CV	RANGE
MAX	STD
MEAN	STDERR
MIN	SUM
N	SUMWGT
NMISS	USS
PCTN	VAR
Quantile statistic keywords	
MEDIAN | P50	Q3 | P75
P1	P90
P5	P95
P10	P99
Q1 | P25	QRANGE
Hypothesis testing keyword	
PRT|PROBT	T

Explanations of the keywords, the formulas that are used to calculate them, and the data requirements are discussed in Appendix 1, "SAS Elementary Statistics Procedures," on page 2699.

Default SUM

Requirement To compute standard error and the Student's *t*-test you must use the default value of VARDEF=, which is DF.

See For definitions of these statistics, see "Keywords and Formulas" on page 2700.

Order=

orders the values of a GROUP, ORDER, or ACROSS variable according to the specified order, where

DATA
orders values according to their order in the input data set.

FORMATTED
orders values by their formatted (external) values. By default, the order is ascending.

FREQ
orders values by ascending frequency count.

INTERNAL
orders values by their unformatted values, which yields the same order that PROC SORT would yield. This order is operating environment-dependent. This sort sequence is particularly useful for displaying dates chronologically.

Default FORMATTED

Interaction DESCENDING in the item's definition reverses the sort sequence for an item.

Note The default value for the ORDER= option in PROC REPORT is not the same as the default value in other SAS procedures. In other SAS procedures, the default is ORDER=INTERNAL. The default for the option in PROC REPORT might change in a future release to be consistent with other procedures. Therefore, in production jobs where it is important to order report items by their formatted values, specify ORDER=FORMATTED even though it is currently the default. Doing so ensures that PROC REPORT will continue to produce the reports that you expect even if the default changes.

Justify=

You can justify the placement of the column heading and of the values of the item that you are defining within a column in one of three ways:

LEFT
left-justifies the formatted values of the item that you are defining within the column width and left-justifies the column heading over the values. If the format width is the same as the width of the column, then LEFT has no effect on the placement of values.

RIGHT
right-justifies the formatted values of the item that you are defining within the column width and right-justifies the column heading over the values. If the format width is the same as the width of the column, then RIGHT has no effect on the placement of values.

CENTER
centers the formatted values of the item that you are defining within the column width and centers the column heading over the values. This option has no effect on the setting of the SAS system option CENTER.

When justifying values, PROC REPORT justifies the field width defined by the format of the item within the column. Thus, numbers are always aligned.

Data type=
shows you if the report item is numeric or character. You cannot change this field.

Item Help=
references a HELP or CBT entry that contains Help information for the selected item. Use PROC BUILD in SAS/AF software to create a HELP or CBT entry for a report item. All HELP and CBT entries for a report must be in the same catalog, and you must specify that catalog with the HELP= option in the PROC REPORT statement or from the **User Help** fields in the ROPTIONS window.

To access a Help entry from the report, select the item and issue the HELP command. PROC REPORT first searches for and displays an entry named *entry-name*.CBT. If no such entry exists, then PROC REPORT searches for *entry-name*.HELP. If neither a CBT nor a HELP entry for the selected item exists, then the opening frame of the Help for PROC REPORT is displayed.

Alias=
By entering a name in the **Alias** field, you create an alias for the report item that you are defining. Aliases let you distinguish between different uses of the same report item. When you refer in a compute block to a report item that has an alias, you must use the alias. (See "Example 3: Using Aliases to Obtain Multiple Statistics for the Same Variable" on page 2177.)

Options

NOPRINT
suppresses the display of the item that you are defining. Use this option

- if you do not want to show the item in the report but you need to use the values in it to calculate other values that you use in the report.
- to establish the order of rows in the report.
- if you do not want to use the item as a column but want to have access to its values in summaries. (See "Example 7: Writing a Customized Summary on Each Page" on page 2190.)

Interactions Even though the columns that you define with NOPRINT do not appear in the report, you must count them when you are referencing columns by number. (See "Four Ways to Reference Report Items in a Compute Block" on page 2063 .)

SHOWALL in the PROC REPORT statement or the ROPTIONS window overrides all occurrences of NOPRINT.

NOZERO
suppresses the display of the item that you are defining if its values are all zero or missing.

Interactions Even though the columns that you define with NOZERO do not appear in the report, you must count them when you are referencing columns by number. (See "Four Ways to Reference Report Items in a Compute Block" on page 2063.)

SHOWALL in the PROC REPORT statement or the ROPTIONS window overrides all occurrences of NOZERO.

DESCENDING
reverses the order in which PROC REPORT displays rows or values of a group, order, or across variable.

PAGE
inserts a page break just before printing the first column containing values of the selected item.

Interaction PAGE is ignored if you use WRAP in the PROC REPORT statement or in the ROPTIONS window.

FLOW
wraps the value of a character variable in its column. The FLOW option honors the split character. If the text contains no split character, then PROC REPORT tries to split text at a blank.

ID column
specifies that the item that you are defining is an ID variable. An ID variable and all columns to its left appear at the left of every page of a report. ID ensures that you can identify each row of the report when the report contains more columns than will fit on one page.

Color

From the list of colors, select the one to use in the REPORT window for the column heading and the values of the item that you are defining. The default is the color of **Foreground** in the SASCOLOR window. (For more information, see the online Help for the SASCOLOR window.)

Note: Not all operating environments and devices support all colors, and in some operating environments and devices, one color might map to another color. For example, if the DEFINITION window displays the word BROWN in yellow characters, then selecting BROWN results in a yellow item.

Buttons

Apply
applies the information in the open window to the report and keeps the window open.

Edit Program
opens the COMPUTE window and enables you to associate a compute block with the variable that you are defining.

OK
applies the information in the DEFINITION window to the report and closes the window.

Cancel
closes the DEFINITION window without applying changes made with **APPLY**.

DISPLAY PAGE Window

Displays a particular page of the report.

Details

Path

View ⇨ Display Page

Description

You can access the last page of the report by entering a large number for the page number. When you are on the last page of the report, PROC REPORT sends a note to the message line of the REPORT window.

EXPLORE Window

Lets you experiment with your data.

Restriction: You cannot open the EXPLORE window unless your report contains at least one group or order variable.

Details

Path

Edit ⇨ Explore Data

Description

In the EXPLORE window, you can

- subset the data with list boxes
- suppress the display of a column with the **Remove Column** check box
- change the order of the columns with **Rotate columns**

Note: The results of your manipulations in the EXPLORE window appear in the REPORT window but are not saved in report definitions.

Window Features

list boxes
: The EXPLORE window contains three list boxes. These boxes contain the value **All levels** as well as actual values for the first three group or order variables in your report. The values reflect any WHERE clause processing that is in effect. For example, if you use a WHERE clause to subset the data so that it includes only the northeast and northwest sectors, then the only values that appear in the list box for Sector are **All levels**, **Northeast**, and **Northwest**. Selecting **All levels** in this case displays rows of the report for only the northeast and northwest sectors. To see data for all the sectors, you must clear the WHERE clause before you open the EXPLORE window.

  Selecting values in the list boxes restricts the display in the REPORT window to the values that you select. If you select incompatible values, then PROC REPORT returns an error.

Remove Column
: Above each list box in the EXPLORE window is a check box labeled **Remove Column**. Selecting this check box and applying the change removes the column from the REPORT window. You can easily restore the column by clearing the check box and applying that change.

Buttons

OK
: applies the information in the EXPLORE window to the report and closes the window.

Apply
: applies the information in the EXPLORE window to the report and keeps the window open.

Rotate columns
: changes the order of the variables displayed in the list boxes. Each variable that can move one column to the left does; the leftmost variable moves to the third column.

Cancel
: closes the EXPLORE window without applying changes made with **APPLY**.

FORMATS Window

Displays a list of formats and provides a sample of each one.

Details

Path

From the DEFINE window, type a question mark (?) in the **Format** field and select any of the Buttons except **Cancel**, or press Enter.

Description

When you select a format in the FORMATS window, a sample of that format appears in the **Sample:** field. Select the format that you want to use for the variable that you are defining.

Buttons

OK
writes the format that you have selected into the **Format** field in the DEFINITION window and closes the FORMATS window. To see the format in the report, select **Apply** in the DEFINITION window.

Cancel
closes the FORMATS window without writing a format into the **Format** field.

LOAD REPORT Window

Loads a stored report definition.

Details

Path

File ⇨ Open Report

Description

The first list box in the LOAD REPORT window lists all the librefs that are defined for your SAS session. The second list box lists all the catalogs that are in the

selected library. The third list box lists descriptions of all the stored report definitions (entry types of REPT) that are in the selected catalog. If there is no description for an entry, then the list box contains the entry's name.

Buttons

OK
loads the current data into the selected report definition.

Cancel
closes the LOAD REPORT window without loading a new report definition.

Note: Issuing the END command in the REPORT window returns you to the previous report definition (with the current data).

MESSAGES Window

Automatically opens to display notes, warnings, and errors returned by PROC REPORT.

Details

You must close the MESSAGES window by selecting **OK** before you can continue to use PROC REPORT.

PROFILE Window

Customizes some features of the PROC REPORT environment by creating a report profile.

Details

Path

Tools ⇨ Report Profile

Description

The PROFILE window creates a report profile that

- specifies the SAS library, catalog, and entry that define alternative menus to use in the REPORT and COMPUTE windows. Use PROC PMENU to create catalog

entries of type PMENU that define these menus. PMENU entries for both windows must be in the same catalog.

- sets defaults for WINDOWS, PROMPT, and COMMAND. PROC REPORT uses the default option whenever you start the procedure unless you specifically override the option in the PROC REPORT statement.

Specify the catalog that contains the profile to use with the PROFILE= option in the PROC REPORT statement. (See the discussion of "PROFILE=*libref.catalog*" on page 2088.)

Buttons

OK
stores your profile in a file that is called SASUSER.PROFILE.REPORT.PROFILE.

Note: Use PROC CATALOG or the EXPLORER window to copy the profile to another location.

Cancel
closes the window without storing the profile.

PROMPTER Window

Prompts you for information as you add items to a report.

Details

Path

Specify the PROMPT option when you start PROC REPORT or select PROMPT from the ROPTIONS window. The PROMPTER window appears the next time you add an item to the report.

Description

The prompter guides you through parts of the windows that are most commonly used to build a report. As the content of the PROMPTER window changes, the title of the window changes to the name of the window that you would use to perform a task if you were not using the prompter. The title change is to help you begin to associate the windows with their functions and to learn what window to use if you later decide to change something.

If you start PROC REPORT with prompting, then the first window gives you a chance to limit the number of observations that are used during prompting. When you exit the prompter, PROC REPORT removes the limit.

Buttons

OK
applies the information in the open window to the report and continues the prompting process.

Note: When you select **OK** from the last prompt window, PROC REPORT removes any limit on the number of observations that it is working with.

Apply
applies the information in the open window to the report and keeps the window open.

Backup
returns you to the previous PROMPTER window.

Exit Prompter
closes the PROMPTER window without applying any more changes to the report. If you have limited the number of observations to use during prompting, then PROC REPORT removes the limit.

REPORT Window

Is the surface on which the report appears.

Details

Path

Use WINDOWS or PROMPT in the PROC REPORT statement.

Description

You cannot write directly in any part of the REPORT window except column headings. To change other aspects of the report, you select a report item (for example, a column heading) as the target of the next command and issue the command. To select an item, use a mouse or cursor keys to position the cursor over it. Then click the mouse button or press Enter. To execute a command, make a selection from the menu bar at the top of the REPORT window. PROC REPORT displays the effect of a command immediately unless the DEFER option is on.

Note: Issuing the END command in the REPORT window returns you to the previous report definition with the current data. If there is no previous report definition, then END closes the REPORT window.

Note: In the REPORT window, there is no Save As option from the File menu to save your report to a file. Instead:

1. From the REPORT window, select Save Data Set. In the dialog box, enter a SAS library and filename in which to save this data set.
2. From the Program Editor window, execute a PROC PRINT.
3. In the File menu, select Save As to save the generated output to a file.

ROPTIONS Window

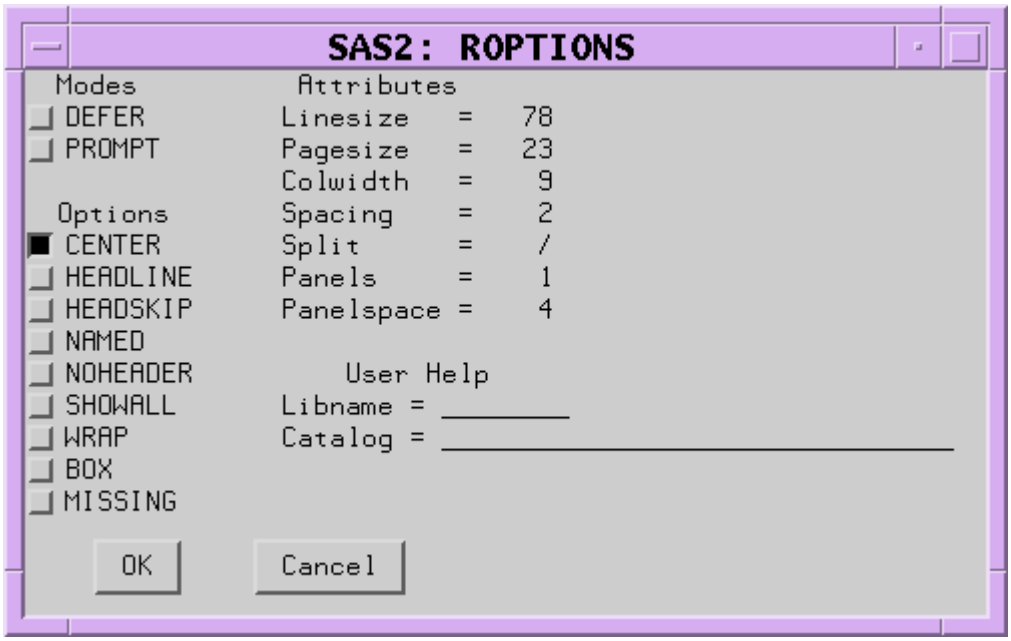
Displays choices that control the layout and display of the entire report and identifies the SAS library and catalog containing CBT or HELP entries for items in the report.

Details

Path

Tools ⇨ **Options** ⇨ **Report**

Description



Modes

DEFER
stores the information for changes and makes the changes all at once when you turn DEFER mode off or select **View** ⇨ **Refresh**.

DEFER is particularly useful when you know that you need to make several changes to the report but do not want to see the intermediate reports.

By default, PROC REPORT redisplays the report in the REPORT window each time you redefine the report by adding or deleting an item, by changing information in the DEFINITION window, or by changing information in the BREAK window.

PROMPT
opens the PROMPTER window the next time you add an item to the report.

Options

CENTER
centers the report and summary text (customized break lines). If CENTER is not selected, then the report is left-justified.

PROC REPORT honors the first of these centering specifications that it finds:

- the CENTER or NOCENTER option in the PROC REPORT statement or the CENTER toggle in the ROPTIONS window
- the CENTER or NOCENTER option stored in the report definition loaded with REPORT= in the PROC REPORT statement
- the SAS system option CENTER or NOCENTER

When PROC REPORT's CENTER option is in effect, PROC REPORT ignores spacing that precedes the leftmost variable in the report.

HEADLINE
underlines all column headings and the spaces between them at the top of each page of the report.

HEADLINE underlines with the second formatting character. (See the discussion of "FORMCHAR <(*position(s)*)>='*formatting-character(s)*' " on page 2081.)

Default hyphen (-)

Tip In traditional (monospace) SAS output, you can underline column headings without underlining the spaces between them, by using `'--'` as the last line of each column heading instead of using HEADLINE.

HEADSKIP
writes a blank line beneath all column headings (or beneath the underlining that the HEADLINE option writes) at the top of each page of the report.

NAMED
writes *name*= in front of each value in the report, where *name* is the column heading for the value.

Interaction When you use NAMED, PROC REPORT automatically uses NOHEADER.

Tip Use NAMED in conjunction with WRAP to produce a report that wraps all columns for a single row of the report onto consecutive lines rather than placing columns of a wide report on separate pages.

NOHEADER
suppresses column headings, including headings that span multiple columns.

Once you suppress the display of column headings in the interactive report window environment, you cannot select any report items.

SHOWALL
overrides the parts of a definition that suppress the display of a column (NOPRINT and NOZERO). You define a report item with a DEFINE statement or in the DEFINITION window.

WRAP
displays one value from each column of the report, on consecutive lines if necessary, before displaying another value from the first column. By default, PROC REPORT displays values for only as many columns as it can fit on one page. It fills a page with values for these columns before starting to display values for the remaining columns on the next page.

Interaction When WRAP is in effect, PROC REPORT ignores PAGE in any item definitions.

Tip Typically, you use WRAP in conjunction with NAMED to avoid wrapping column headings.

BOX
uses formatting characters to add line-drawing characters to the report. These characters

- surround each page of the report
- separate column headings from the body of the report
- separate rows and columns from each other

Interaction You cannot use BOX if you use WRAP in the PROC REPORT statement or ROPTIONS window or if you use FLOW in any item's definition.

See For information about formatting characters, see the discussion of "FORMCHAR <(*position(s)*)>='*formatting-character(s)*' " on page 2081.

MISSING
considers missing values as valid values for group, order, or across variables. Special missing values that are used to represent numeric values (the letters A through Z and the underscore (_) character) are each considered as a different value. A group for each missing value appears in the report. If you omit the

MISSING option, then PROC REPORT does not include observations with a missing value for one or more group, order, or across variables in the report.

Attributes

LINESIZE=
specifies the line size for a report. PROC REPORT honors the first of these line-size specifications that it finds:

- LS= in the PROC REPORT statement or LINESIZE= in the ROPTIONS window
- the LS= setting stored in the report definition loaded with REPORT= in the PROC REPORT statement
- the SAS system option LINESIZE=

Range 64-256 (integer)

Tip If the line size is greater than the width of the REPORT window, then use SAS interactive report window environment commands RIGHT and LEFT to display portions of the report that are not currently in the display.

PAGESIZE=
specifies the page size for a report. PROC REPORT honors the first of these page size specifications that it finds:

- PS= in the PROC REPORT statement or PAGESIZE= in the ROPTIONS window
- the PS= setting stored in the report definition loaded with REPORT= in the PROC REPORT statement
- the SAS system option PAGESIZE=

Range 15-32,767 (integer)

COLWIDTH=
specifies the default number of characters for columns containing computed variables or numeric data set variables.

When setting the width for a column, PROC REPORT first looks at WIDTH= in the definition for that column. If WIDTH= is not present, then PROC REPORT uses a column width large enough to accommodate the format for the item. (For information about formats, see the discussion of "Format=" on page 2238.) If no format is associated with the item, then the column width depends on variable type:

Variable	Resulting Column Width
Character variable in the input data set	Length of the variable
Numeric variable in the input data set	Value of the COLWIDTH= option

Variable	Resulting Column Width
Computed variable (numeric or character)	Value of the COLWIDTH= option

Default 9

Range 1 to the line size

SPACING=*space-between-columns*
specifies the number of blank characters between columns. For each column, the sum of its width and the blank characters between it and the column to its left cannot exceed the line size.

Default 2

Interactions PROC REPORT separates all columns in the report by the number of blank characters specified by SPACING= in the PROC REPORT statement or the ROPTIONS window unless you use SPACING= in the definition of a particular item to change the spacing to the left of that item.

When CENTER is in effect, PROC REPORT ignores spacing that precedes the leftmost variable in the report.

SPLIT='*character*'
specifies the split character. PROC REPORT breaks a column heading when it reaches that character and continues the heading on the next line. The split character itself is not part of the column heading although each occurrence of the split character counts toward the 40-character maximum for a label.

Default slash (/)

Interaction The FLOW option in the DEFINE statement honors the split character.

Tip If you are typing over a heading (rather than entering one from the PROMPTER or DEFINITION window), then you do not see the effect of the split character until you refresh the screen by adding or deleting an item, by changing the contents of a DEFINITION or BREAK window, or by selecting**View** ⇨ **Refresh**.

PANELS=*number-of-panels*
specifies the number of panels on each page of the report. If the width of a report is less than half of the line size, then you can display the data in multiple sets of columns so that rows that would otherwise appear on multiple pages appear on the same page. Each set of columns is a *panel*. A familiar example of this type of report is a telephone book, which contains multiple panels of names and telephone numbers on a single page.

When PROC REPORT writes a multipanel report, it fills one panel before beginning the next.

The number of panels that fits on a page depends on the

- width of the panel
- space between panels
- line size

Default 1

Tip If *number-of-panels* is larger than the number of panels that can fit on the page, then PROC REPORT creates as many panels as it can. Let PROC REPORT put your data in the maximum number of panels that can fit on the page by specifying a large number of panels (for example, 99).

See For information about specifying the space between panels see the discussion of PSPACE=. For information about setting the line size, see the discussion of "LINESIZE=" on page 2252.

PSPACE=*space-between-panels*
specifies the number of blank characters between panels. PROC REPORT separates all panels in the report by the same number of blank characters. For each panel, the sum of its width and the number of blank characters separating it from the panel to its left cannot exceed the line size.

Default 4

User Help
identifies the library and catalog containing user-defined Help for the report. This Help can be in CBT or HELP catalog entries. You can write a CBT or HELP entry for each item in the report with the BUILD procedure in SAS/AF software. You must store all such entries for a report in the same catalog.

Specify the entry name for Help for a particular report item in the DEFINITION window for that report item or in a DEFINE statement.

SAVE DATA SET Window

Lets you specify an output data set in which to store the data from the current report.

Details

Path

File ⇨ Save Data Set

Description

To specify an output data set, enter the name of the SAS library and the name of the data set (called **member** in the window) that you want to create in the Save Data Set window.

Buttons

OK
creates the output data set and closes the Save Data Set window.

Cancel
closes the Save Data Set window without creating an output data set.

SAVE DEFINITION Window

Saves a report definition for subsequent use with the same data set or with a similar data set.

Details

Path

File ⇨ Save Report

Description

The SAVE DEFINITION window prompts you for the complete name of the catalog entry in which to store the definition of the current report and for an optional description of the report. This description shows up in the LOAD REPORT window and helps you select the appropriate report.

SAS stores the report definition as a catalog entry of type REPT. You can use a report definition to create an identically structured report for any SAS data set that contains variables with the same names as those variables that are used in the report definition.

Buttons

OK
creates the report definition and closes the SAVE DEFINITION window.

Cancel
closes the SAVE DEFINITION window without creating a report definition.

SOURCE Window

Lists the PROC REPORT statements that build the current report.

Details

Path

Tools ⇨ Report Statements

STATISTICS Window

Displays statistics that are available in PROC REPORT.

Details

Path

Edit ⇨ Add item ⇨ Statistic

After you select **Statistic**, PROC REPORT prompts you for the location of the statistic relative to the column that you have selected. After you select a location, the STATISTICS window appears.

Description

Select the statistics that you want to include in your report and close the window. When you select the first statistic, it moves to the top of the list in the window. If you select multiple statistics, then subsequent selections move to the bottom of the list of selected statistics. An asterisk (*) indicates each selected statistic. The order of selected statistics from top to bottom determines their order in the report from left to right.

Note: If you double-click on a statistic, then PROC REPORT immediately adds it to the report. The STATISTICS window remains open.

To compute standard error and the Student's *t* test, you must use the default value of VARDEF=, which is DF.

To add all selected statistics to the report, select **File** ⇨ **Accept Selection**. Selecting **File** ⇨ **Close** closes the STATISTICS window without adding the selected statistics to the report.

WHERE Window

Selects observations from the data set that meet the conditions that you specify.

Details

Path

Subset ⇨ **Where**

Description

Enter a *where-expression* in the **Enter WHERE clause** field. A *where-expression* is an arithmetic or logical expression that generally consists of a sequence of operands and operators. For information about constructing a *where-expression*, see the documentation of the "WHERE" in *SAS DATA Step Statements: Reference*.

Note: You can clear all *where-expressions* by leaving the **Enter WHERE clause** field empty and by selecting **OK**.

Buttons

OK
applies the *where-expression* to the report and closes the WHERE window.

Cancel
closes the WHERE window without altering the report.

WHERE ALSO Window

Selects observations from the data set that meet the conditions that you specify and any other conditions that are already in effect.

Details

Path

Subset ⇨ Where Also

Description

Enter a *where-expression* in the **Enter where also clause** field. A *where-expression* is an arithmetic or logical expression that generally consists of a sequence of operands and operators. For information about constructing a *where-expression*, see the documentation of the "WHERE" in *SAS DATA Step Statements: Reference*.

Buttons

OK
adds the *where-expression* to any other *where-expressions* that are already in effect and applies them all to the report. It also closes the WHERE ALSO window.

Cancel
closes the WHERE ALSO window without altering the report.

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S3 Procedure

Overview: S3 Procedure

What Does the S3 Procedure Do?

Use the S3 procedure to perform object management for objects in Amazon S3. For example, you can create buckets and add files to S3. Common object types for use with SAS are files and directories.

Note:

The S3 procedure is not supported on z/OS platforms.

Before you can use the S3 procedure, you need an Amazon Web Service (AWS) key ID and secret. When using temporary credentials, you also need a security token. For more information, see the Amazon S3 documentation.

When the data that you add to or retrieve from S3 is larger than 5 MB, the procedure creates additional threads. These threads enable parallel processing for faster transfer speeds.

Concepts: S3 Procedure

Support for IMDS

Beginning in SAS 9.4M8, support has been added for EC2 Instance Metadata Service version 2 (IMDSv2). IMDSv1 continues to be supported. When deployed to Amazon EKS, SAS uses IMDS to obtain an IAM role that enables you to access S3 resources.

SAS first attempts to use IMDSv2 to obtain a session token. If using IMDSv2 fails, then IMDSv1 is used.

Specify the following options in your Amazon environment:

- When you set http-tokens to required, you must use IMDSv2. If http-tokens is set to optional, then either IMDSv1 or IMDSv2 can be used.

- Set the http_put_response_hop_limit to 2 when you use IMDSv2.

PROC S3 Configuration

Overview of PROC S3 Configuration

The S3 procedure reads configuration and security information from configuration files, options in the PROC S3 statement, or from an Amazon EC2 instance role. When configuration files are used, these configuration files can be either AWS Command-Line Interface (CLI) configuration files or a local PROC S3 configuration file. PROC S3 reads both types of configuration files when it runs.

Options that are specified in AWS CLI configuration files override options that are specified in the PROC S3 configuration file. Options that you specify in the S3 procedure override options that are set in configuration files.

AWS CLI Configuration Files

Unless you specify otherwise, PROC S3 reads AWS CLI configuration files from their default locations in your home directory and uses the default profile. The AWS CLI configuration files are called config and credentials. You can specify an alternative location for the config file with the AWSCONFIG= option. You can specify an alternative location for the credentials file with the AWSCREDENTIALS= option.

The config file contains multiple sets of options called *profiles*. Specify which configuration profile to use with the PROFILE= option in the PROC S3 statement.

PROC S3 Configuration File

You can create a local PROC S3 configuration file to use for connection options. The default PROC S3 configuration file is tks3.conf on Windows or .tks3.conf on UNIX. It is located in your home directory. If the local configuration file with the default name exists, the S3 procedure reads it automatically. If the PROC S3 configuration file uses a different name or is in a different location, specify its name and path with the CONFIG= option in the PROC S3 statement.

Note: If an option is specified in the AWS CLI configuration file as well as in the local PROC S3 configuration file, then the value in the AWS CLI configuration file takes precedence.

The PROC S3 configuration file contains case-sensitive name-value pairs that you specify as name=value. Do not enclose values in quotation marks. The file can contain one or more sets of the following name-value pairs:

region
specifies the AWS region to connect to. See the Region argument for the list of valid region values.

keyId
specifies the AWS access key ID. This value is a 20-character, alphanumeric string.

secret
specifies the AWS secret access key. This value is a 40-character string.

Note: See "Securing the PROC S3 Configuration File" for information about restricting access to this information.

sessionToken
specifies the session token. Specify this value if you are using temporary AWS security credentials.

Note: See "Securing the PROC S3 Configuration File" for information about restricting access to this information.

ssl
specifies whether SSL or TLS should be used for connections. Specify *true* or *yes* to use SSL or TLS. Any other value deactivates SSL or TLS.

Here is a sample PROC S3 configuration file:

```
ssl=yes
keyID=AKFKI8OMEVIM3XJHKEUQ
secret=wb89GergI/3xejxudQugFj5Wi4iqlFJhGpLvYVv
region=usstd
```

Securing the PROC S3 Configuration File

Because the secret and sessionToken values are confidential, use your operating system to restrict access to the file. For example, in UNIX you might issue this command to restrict access to just yourself:

```
chmod 700 /u/$user/.tks3.conf
```

In Microsoft Windows, use the file properties to restrict access to the PROC S3 configuration file. You can access the file properties by right-clicking the file, selecting **Properties**, and then selecting the **Security** tab.

Defining Custom Regions

You can define custom regions in addition to the predefined list of regions that is supplied with the S3 environment. One way to manage custom regions is by using the REGION statement with PROC S3. If you define custom regions with PROC S3, the region definition lasts for the duration of your SAS session. You need to redefine the region in subsequent SAS sessions.

Note: Support for custom regions was added to PROC S3 for SAS Viya in a July 2021 update to SAS Viya 3.5. Support for custom regions was added to PROC S3 for SAS 9 in SAS 9.4M8.

Another way to manage custom regions is with the TKS3_CUSTOM_REGION environment variable. You can define this environment variable in the Autoexec file or by using SAS Environment Manager. In this way, the custom region definition is automatically used when you start a subsequent SAS session.

Here is the syntax to set the TKS3_CUSTOM_REGION environment variable:

TKS3_CUSTOM_REGION=<'>*region-name*<'>,*HTTP-host*,*HTTP-port*,*SSL-HTTP-port*,*SSLRequired*,*SSLAllowed*

region-name
specifies the custom region name. Enclose the name in quotation marks if it contains spaces or special characters.

HTTP-host
specifies the host name of the server for the region.

HTTP-port
specifies the port number of the server when communicating without SSL. Use 0 to use the default port number for the HTTP protocol.

SSL-HTTP-port
specifies the port number of the server when communicating with SSL. Use 0 to use the default port number for the HTTPS protocol.

SSLRequired
specifies whether all communications with the S3 environment must use SSL. Values are TRUE or FALSE.

SSLAllowed
specifies whether communications with the S3 environment can use SSL. Values are TRUE or FALSE.

Interaction This value is ignored if the *SSLRequired* value is TRUE.

Here is a sample setting for this environment variable that uses a BackBlaze B2 server.

```
TKS3_CUSTOM_REGION=us-west-002,s3.us-west-002.backblazeb2.com,0,0,TRUE,TRUE
```

In Linux, define multiple regions by separating sets of values with a colon (:). In Windows, separate sets of values with a semicolon (;).

Using Server-Side Encryption with AWS Data

Manage Encryption Keys with the ENCKEY Statement

Use the ENCKEY statement to name and manage encryption keys. Use the ADD option to add a new name and encryption key. You can then call the named encryption key when you transfer data between the Amazon S3 environment and SAS using the GET, GETDIR, PUT, and PUTDIR statements. You can also request a list of currently registered encryption keys with the ENCKEY statement LIST option or delete a previously registered encryption key with the REMOVE option.

You can specify an encryption key in three forms: an Amazon Key Management Service (KMS) key, a customer-supplied server-side encryption key (SSE-C) key represented as a character string, or an SSE-C key represented by a hexadecimal value.

You can specify a KMS key from the Amazon S3 environment. This type of key works with AWS server-side encryption and is managed in the S3 environment as part of the IAM service.

For SSE-C encryption keys, you can specify the key as a 32-byte character string or as a 64-digit hexadecimal value. User-specified keys are then used by the S3 environment to encrypt data using the AES256 encryption algorithm.

As a best practice, manage encryption keys in a separate SAS program. You can then use the %INCLUDE statement to read in your named encryptions and work with the encryption key names. For an example, see “Example 3: Manage Encryptions with S3 Data” on page 2284.

Use Encryption Keys with SAS/ACCESS

After you add an encryption key, you can use that key with SAS/ACCESS Interface to Amazon Redshift. In a LIBNAME statement, use the BL_ENCKEY= option to call an encryption key by the name that you assigned with the ENCKEY statement. This enables encryption during bulk loading or unloading between the Amazon Redshift environment and SAS. Alternatively, you can specify the BL_ENCKEY= data set option when referring to a specific Amazon Redshift data set, such as in a DATA step or in a call to PROC SQL.

Note: Only IAM:KMS keys are supported for SAS/ACCESS Interface to Amazon Redshift.

For more information, see "Encryption with Amazon Redshift" in *SAS/ACCESS for Relational Databases: Reference*.

Transfer Acceleration

Transfer acceleration is a special mode that is used to load or write data. In this mode, an alternative host enables faster data transfer. For more information, see your AWS documentation.

The GET, GETDIR, PUT, and PUTDIR statements take advantage of this faster data transfer method when transfer acceleration is enabled.

Syntax: S3 Procedure

```
PROC S3 <options>;
   BUCKET "bucket-name";
   COPY <SRCKEY="key-name"> "source-s3-location" <ENCKEY="key-name">
     "destination-s3-location";
   CREATE "bucket-name";
   DELETE "s3-location";
   DESTROY "bucket-name";
   ENCKEY <ADD> | <REPLACE> NAME="key-name" ID="key-ID"
     <CONTEXT="key-context">;
   GET <ENCKEY="key-name"> "s3-location" "local-file-path";
   GETACCEL "bucket-name";
   GETDIR <ENCKEY="key-name"> "s3-location" "local-path";
   INFO <ENCKEY="key-name"> "s3-location";
   LIST <OUT=libref.file><_SHORT_> "s3-location";
   MKDIR "s3-location";
   PUT <ENCKEY="key-name"> "local-path" "s3-location";
   PUTDIR <ENCKEY="key-name"> "local-path" "s3-location";
   REGION <ADD HOST="AWS-server" NAME="region-name" <PORT=port-value>
     <REPLACE> <SSLALLOWED><SSLPORT=SSL-port> <SSLREQUIRED>> |
     <LIST> | <REMOVE NAME="region-name">;
   RMDIR "s3-location";
RUN;
```

Statement	Task	Example
PROC S3	Specifies the connection parameters to S3.	Ex. 1, Ex. 2, Ex. 3, Ex. 4
BUCKET	Specifies whether to enable transfer acceleration for a bucket.	
COPY	Copies an S3 object to an S3 destination.	Ex. 2, Ex. 3
CREATE	Creates an S3 bucket.	Ex. 1
DELETE	Deletes an S3 location or object.	Ex. 2
DESTROY	Deletes an S3 bucket.	
ENCKEY	Enables you to work with encryption keys.	Ex. 3
GET	Retrieves an S3 object.	Ex. 3
GETACCEL	Retrieves the transfer acceleration status for a bucket.	
GETDIR	Retrieves the contents of an S3 directory.	Ex. 3
INFO	Lists information about an S3 location or object.	
LIST	Lists the contents of an S3 location.	Ex. 1
MKDIR	Specifies a directory to create in an S3 location.	Ex. 2
PUT	Specifies a local object to write to an S3 location.	Ex. 1, Ex. 3
PUTDIR	Specifies a local directory to write to an S3 location.	Ex. 3
REGION	Enables you to add, list, or remove custom regions.	Ex. 4
RMDIR	Deletes a directory from an S3 location.	

PROC S3 Statement

Specifies the connection parameters for connecting to AWS S3.

Examples:

"Example 1: Create a Bucket and Add a File" on page 2281
"Example 2: Manage the Contents of a Bucket" on page 2282
"Example 3: Manage Encryptions with S3 Data" on page 2284
"Example 4: Define a Custom Region with PROC S3" on page 2288

Syntax

PROC S3 <AWSCONFIG="*AWS-CLI-file-path*"> <CONFIG="*local-configuration-file-path*"> <PROFILE="*configuration-profile-name*"> <AWSCREDENTIALS="*AWS-credentials-file-path*"> <ROLENAME="*IAM-role-name*" | ROLEARN="*IAM-role-ARN*> <KEYID="*AWS-key-ID*"> <SECRET="*AWS-secret*"> <SESSION="*session-token*"> <SSL | NOSSL> <REGION=*AWS-region*>;

Optional Arguments

AWSCONFIG="*AWS-CLI-file-path*"
specifies the path of the AWS CLI configuration file, called config. This file contains connection parameters to access AWS S3. If a value is specified in the AWS CLI configuration file and in the PROC S3 configuration file, the value in the AWS CLI file takes precedence.

Note: Support for this option was added in SAS 9.4M5.

AWSCREDENTIALS="*AWS-credentials-file-path*"
specifies the path of the AWS credentials file. This file contains the credentials that are used to access AWS S3.

Note: Support for this option was added in SAS Viya 3.4.

CONFIG="*local-configuration-file-path*"
specifies the path and filename of the PROC S3 configuration file that contains connection parameters to access AWS S3. If you specify this option, then the specified configuration file is read instead of the default PROC S3 configuration file in the default location.

The default PROC S3 configuration file is file .tks3.conf in your home directory in UNIX or file tks3.conf in your home directory in Windows. You do not need to specify the CONFIG= option if your configuration file is in the default location.

For more information, see "PROC S3 Configuration File" on page 2261.

KEYID="*AWS-key-ID*"
specifies the AWS access key ID. This value is a 20-character, alphanumeric string. A sample key ID value is AKIAIOSFODNN7EXAMPLE.

PROFILE="*profile-name*"
specifies the profile to use in the AWS CLI file config. Sets of options are grouped into profiles. If you do not specify the PROFILE= option, PROC S3 uses the default profile.

Note: Support for this option was added in SAS 9.4M5.

REGION=*AWS-region*
specifies the AWS region to connect to. Here are the valid region values.

You might need to activate a region for your account if it does not appear in your list of regions. See your AWS documentation for more information.

Table 60.1 PROC S3 Region Values

PROC S3 Region Value	Description	Corresponding AWS S3 Region
afcapetown	Africa (Cape Town)	af-south-1
aphongkong	Asia Pacific (Hong Kong)	ap-east-1
aphyderabad	Asia Pacific (Hyderabad)	ap-south-2
apindia	Asia Pacific (India)	ap-south-1
apjakarta	Asia Pacific (Jakarta)	ap-southeast-3
aposaka[1]	Asia Pacific (Osaka)	ap-northeast-3
apseoul	Asia Pacific (Seoul)	ap-northeast-2
apsingapore	Asia Pacific (Singapore)	ap-southeast-1
apsydney	Asia Pacific (Sydney)	ap-southeast-2
aptokyo	Asia Pacific (Tokyo)	ap-northeast-1
cacentral	Canada (Central)	ca-central-1
cnbeijing	China (Beijing)	cn-north-1
cnningxia	China (Ningxia)	cn-northwest-1
eufrankfurt	EU (Frankfurt)	eu-central-1
euireland	EU (Ireland)	eu-west-1
eulondon	EU (London)	eu-west-2
eumilan	EU (Milan)	eu-south-1
euparis	EU (Paris)	eu-west-3
euspain	EU (Spain)	eu-south-2
eustockholm	EU (Stockholm)	eu-north-1
euzurich	EU (Zurich)	eu-central-2
fips	US Government Cloud (FIPS)	fips-us-gov-west-1

PROC S3 Region Value	Description	Corresponding AWS S3 Region
fipseast	US Government Cloud (FIPS)	fips-us-gov-east-1
mebahrain	Middle East (Bahrain)	me-south-1
meuae	Middle East (UAE)	me-central-1
sa	South America (Sao Paulo)	sa-east-1
useast	US East (Virginia)	us-east-1
useastoh	US East (Ohio)	us-east-2
usgov	US Government Cloud	us-gov-west-1
usgoveast	US East Government Cloud	us-gov-east-1
uswest	US West (Oregon)	us-west-2
uswestca	US West (California)	us-west-1

1 Contact your AWS sales representative to get access to the Asia Pacific (Osaka) region.

ROLENAME="*IAM-role-name*"
specifies an IAM role name that enables you to get access credentials to S3 via the AssumeRole IAM operation.

Interaction Specify either the ROLENAME= option or the ROLEARN= option. Do not specify both.

Note Support for this option was added in SAS 9.4M7.

Example
```
proc s3 rolename="s3AccessRole" <additional-options>;
```

ROLEARN="*IAM-role-ARN*"
specifies an Amazon Resource Name (ARN) that identifies an IAM role. The associated IAM role enables you to get access credentials to S3 via the AssumeRole IAM operation.

Interaction Specify either the ROLEARN= option or the ROLENAME= option. Do not specify both.

Note Support for this option was added in SAS 9.4M7.

Example
```
proc s3 rolearn="arn:aws:iam::123456789012:role/s3AccessRole"
       <additional-options>;
```

SECRET="*AWS-secret*"
specifies the AWS secret access key. This value is a 40-character string. A sample secret access value is wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY.

SESSION="*session-token*"
specifies the AWS session token. Use this value if you are using temporary AWS security credentials.

For more information, see "PROC S3 Configuration" on page 2261.

Note Support for this option was added in the May 2021 update for SAS 9.4M7 and SAS Viya 3.5.

SSL | NOSSL
SSL specifies that SSL or TLS should be enabled during data transfer. NOSSL specifies that SSL or TLS should be disabled during data transfer.

You can use the SSL value to override an `ssl=no` setting in the PROC S3 configuration file. If there is no value specified for SSL in the PROC S3 statement or in a PROC S3 configuration file, then SSL or TLS is used during data transfer by default.

Interaction: If you specify NOSSL in the PROC S3 statement, then enabling server-side encryption with the ENCKEY statement fails.

BUCKET Statement

Sets the acceleration transfer mode for the specified bucket.

Note: Support for this statement was added in SAS 9.4M5.

Syntax

BUCKET *"bucket-name"* ACCELERATE | NOACCELERATE;

Required Arguments

bucket-name
specifies the name of the S3 bucket for which you are setting transfer acceleration mode. For more information, see "Transfer Acceleration" on page 2265.

ACCELERATE
enables transfer acceleration for the specified bucket.

NOACCELERATE
disables transfer acceleration for the specified bucket.

COPY Statement

Copies an object from an S3 source location to an S3 destination.

See: "Example 2: Manage the Contents of a Bucket" on page 2282

Syntax

COPY <SRCKEY="*key-name*"> "*source-s3-location*" <ENCKEY="*key-name*"> "*destination-s3-location*";

Required Arguments

source-s3-location
specifies the S3 location of the object to be copied. Fully qualify the S3 location from the bucket name to the object name.

destination-s3-location
specifies the S3 location to which an object should be copied. Fully qualify the S3 location from the bucket name to the object name.

Optional Arguments

ENCKEY="*key-name*"
specifies an encryption key name that identifies the encryption for the created object. The name must match an encryption key name that you specified in an ENCKEY statement.

The ENCKEY= option defaults to no encryption. You can use the value _*DEFAULT*_ to use the default encryption key. Your default encryption key is automatically created.

SRCKEY="*key-name*"
specifies the encryption of the source object. The name must match an encryption key name that you specified in an ENCKEY statement.

Note: This value is not applied to the created object if the ENCKEY= option is not specified.

CREATE Statement

Creates a bucket.

See: "Example 1: Create a Bucket and Add a File" on page 2281

Syntax

CREATE "*bucket-name*";

Required Argument

bucket-name
specifies the name of the S3 bucket that you are creating. The name of the S3 bucket that you create must be unique across S3.

DELETE Statement

Deletes an S3 location or object.

See: "Example 2: Manage the Contents of a Bucket" on page 2282

Syntax

DELETE "*s3-location*";

Required Argument

s3-location
specifies the S3 location that you are deleting. Fully qualify the S3 location from the bucket name to the object name.

DESTROY Statement

Deletes an S3 bucket.

Syntax

DESTROY "*bucket-name*";

Required Argument

bucket-name
specifies the name of an S3 bucket that you are deleting. The bucket that you specify must exist in S3 and must be empty.

ENCKEY Statement

Specifies the encryption key for an S3 location.

Note: Support for this statement was added in SAS 9.4M6.

See: "Example 3: Manage Encryptions with S3 Data" on page 2284

Syntax

Form 1: **ENCKEY** ADD | REPLACE NAME="*key-name*"ID="*key-ID*" <CONTEXT="*key-context*">;

Form 2: **ENCKEY** ADD | REPLACE NAME="*key-name*" KEY="*key-string*" <ALGORITHM="*S3-encryption-algorithm*"> <CONTEXT="*key-context*">;

Form 3: **ENCKEY** ADD | REPLACE NAME="*key-name*" HEXKEY="*hexadecimal-value*" <ALGORITHM="*S3-encryption-algorithm*"> <CONTEXT="*key-context*">;

Form 4: **ENCKEY** LIST <NAME="*key-name*">;

Form 5: **ENCKEY** REMOVE NAME="*key-name*";

Arguments

ADD
indicates that you are adding an encryption key.

Requirement: Specify the HEXKEY=, ID=, or KEY= options with ADD, depending on the type of key that you are using.

ALGORITHM="*S3-encryption-algorithm*"
specifies the S3 encryption algorithm that is used in the S3 location.

The only value that is currently supported is AES256. This value is the default when you do not specify the ALGORITHM= option.

CONTEXT="*key-context*"
specifies the key context for the encryption key.

HEXKEY="*hexadecimal-value*"
specifies an encryption key in the form of a 64-digit hexadecimal value.

ID="*key-ID*"
specifies the key ID for the encryption key.

KEY="*key-string*"
specifies an encryption key as a 32-byte character string.

LIST
requests a list of defined encryption keys.

NAME="*key-name*"
specifies the encryption key name. This is a user-friendly name that you can use to refer to an encryption key. The value is case insensitive.

NAME= is required with the ADD, REPLACE, or REMOVE options. When used with the LIST option, NAME= is optional.

REMOVE
removes an encryption key from the list of defined keys.

Requirement: Specify the NAME= option with REMOVE.

REPLACE
specifies that the existing encryption key should be replaced. If not set, any attempt to redefine an encryption key fails.

Requirement: Specify the HEXKEY=, ID=, or KEY= options with REPLACE, depending on the type of key that you are using.

Details

The ENCKEY statement is used to support server-side encryption in an AWS S3 environment.

- Use Form 1 of the ENCKEY statement to add or replace an IAM:KMS encryption key.
- Use Form 2 of the ENCKEY statement to add or replace an encryption key in the form of a string. The string must be 32 bytes long.
- Use Form 3 of the ENCKEY statement to add or replace an encryption key expressed as hexadecimal characters. Do not use the “0x” prefix when you specify the hexadecimal key string. The hexadecimal string should be 64 digits long.
- Use Form 4 of the ENCKEY statement to view the list of defined encryption keys.
- Use Form 5 of the ENCKEY statement to remove an encryption key.

Note: If you specify the NOSSL option in the PROC S3 statement, then using encryption with the ENCKEY statement fails.

You must specify one of these options in the ENCKEY statement: ADD, LIST, REMOVE, or REPLACE.

Encryption keys are specified for the duration of your SAS session.

The encryption key *_DEFAULT_* cannot be modified. The *_DEFAULT_* encryption key is defined by the AWS environment.

For more information, see Protecting Data Using Server-Side Encryption in your AWS documentation.

GET Statement

Retrieves an S3 object.

Note: This statement uses transfer acceleration when it is available. For more information, see “Transfer Acceleration” on page 2265.

Syntax

GET <ENCKEY="*key-name*"> "*s3-location*" "*local-file-path*";

Required Arguments

s3-location
specifies the name of an S3 object to retrieve. Fully qualify the location from the bucket name to the object name.

local-file-path
specifies a local file in which to store the object. Examples are **`C:\public\filename`** for Windows or **`/u/$USER/filename`** for UNIX.

Optional Argument

ENCKEY="*key-name*"
specifies an encryption key name that identifies the encryption to use during data retrieval. The name must match an encryption key name that you specified in an ENCKEY statement. The name must also correspond to the encryption key that was used when the object was created in the S3 environment. Otherwise, S3 returns an error.

GETACCEL Statement

Retrieves the transfer acceleration status for a bucket.

Note: Support for this statement was added in SAS 9.4M5.

Syntax

GETACCEL "*bucket-name*";

Required Argument

bucket-name
specifies the name of an S3 bucket for which you want the transfer acceleration status. For more information, see "Transfer Acceleration" on page 2265.

GETDIR Statement

Retrieves the contents of an S3 directory.

Note: This statement uses transfer acceleration when it is available. For more information, see "Transfer Acceleration" on page 2265.

Syntax

GETDIR <ENCKEY="*key-name*"> "*s3-location*" "*local-path*";

Required Arguments

s3-location
specifies the name of an S3 directory to retrieve. Fully qualify the location from the bucket name to the directory.

local-path
specifies a directory that is local to the SAS client. Examples are `C:\public` for Windows or `/u/$USER/` for UNIX.

Optional Argument

ENCKEY="*key-name*"
specifies an encryption key name that identifies the encryption to use during data retrieval. The name must match an encryption key name that you specified in an ENCKEY statement.

Note: Encryption fails if any files in the source location do not use the specified encryption key.

INFO Statement

Requests information in the SAS log about an S3 location.

Note: Information about a file includes the region, path, and the date and time at which the file was last modified.

Syntax

INFO <ENCKEY="*key-name*"> "*s3-location*";

Required Argument

s3-location
specifies a fully qualified path from the bucket name to the object name.

Optional Argument

ENCKEY="*key-name*"
specifies an encryption key name. The name must match an encryption key name that you specified in an ENCKEY statement.

Note: The ENCKEY= option is required if any objects in the S3 location are encrypted.

LIST Statement

Requests information in the SAS log about the contents of an S3 location.

Syntax

LIST <_SHORT_> "*s3-location*" <OUT=*filename* >;

Required Argument

s3-location
specifies a fully qualified path from the bucket name to the object name. The object that you specify is typically a container, such as a bucket or a directory.

Optional Arguments

SHORT
specifies that you want a list of object names only.

OUT=*filename*
specifies an output file for the output of the LIST statement.

Provide the filename as *libname.file* or as a *fileref*.

Note Support for this option was added in SAS 9.4M7 and SAS Viya 3.5.

Example
```
list "/myS3location" out=sasuser.list;
```

MKDIR Statement

Specifies a directory to create in an S3 location.

See: "Example 2: Manage the Contents of a Bucket" on page 2282

Syntax

MKDIR *"s3-location"*;

Required Argument

s3-location
specifies a fully qualified path from the bucket name to the directory name that you want to create.

PUT Statement

Specifies a local object to write to an S3 location.

Note: This statement uses transfer acceleration when it is available. For more information, see "Transfer Acceleration" on page 2265.

Syntax

PUT <ENCKEY=*"key-name"*> *"local-path"* *"s3-location"*;

Required Arguments

local-path
specifies a file or directory that is local to the SAS client.

s3-location
specifies a location in S3. Fully qualify the path from the bucket name to the object name.

Optional Argument

ENCKEY=*"key-name"*
specifies an encryption key name that identifies the encryption to use when storing data in S3. The name must match an encryption key name that you specified in an ENCKEY statement.

Example To specify your default encryption key:

```
put enckey=_default_ "/home/demouser/s3/foo.txt" "/mybucket/foo.txt";
```

PUTDIR Statement

Specifies a local directory to write to an S3 location.

Note: This statement uses transfer acceleration when it is available. For more information, see "Transfer Acceleration" on page 2265.

Syntax

PUTDIR <ENCKEY="*key-name*"> "*local-path*" "*s3-location*";

Required Arguments

local-path
specifies a directory that is local to the SAS client.

s3-location
specifies a location in S3. Fully qualify the path from the bucket name to the object name.

Optional Argument

ENCKEY="*key-name*"
specifies an encryption key name that identifies the encryption to use when writing to S3. The name must match an encryption key name that you specified in an ENCKEY statement.

Note: All files in the S3 location are encrypted with the specified encryption key.

REGION Statement

Enables you to add, list, or remove custom regions.

Notes: Support for this statement in SAS Viya 3.5 starts in July 2021.
Support for this statement in SAS 9 starts in SAS 9.4M8.

See: "Example 4: Define a Custom Region with PROC S3" on page 2288

Syntax

Form 1: **REGION** ADD HOST="*AWS-server*" NAME="*region-name*" <PORT=*port-value*> <REPLACE> <SSLALLOWED><SSLPORT=*SSL-port*> <SSLREQUIRED> ;

Form 2: **REGION** LIST;

Form 3: **REGION** REMOVE NAME="*region-name*";

Arguments

ADD
specifies that you are adding a custom region for the S3 environment.

HOST="*AWS-server*"
specifies the server that PROC S3 connects to on AWS.

Note Support for the HOST= option was added in the August 2021 update for SAS Viya 3.5.

Example
```
host="myhost.amazonaws.com"
```

LIST
requests a list of all defined S3 regions.

NAME="*region-name*"
specifies the name of the region that you are adding or removing.

PORT=*port-value*
specifies the HTTP port value to use to connect to S3 without SSL.

If you do not specify a port value, the default value is used.

REMOVE
specifies to remove the region that you identify with the NAME= option.

Restriction You cannot remove any of the predefined S3 regions. See the PROC S3 statement REGION= argument for the list of predefined region values.

REPLACE
indicates that a custom region should be added and should overwrite a region of the same name, if it exists.

Restriction You cannot replace any of the predefined regions for S3. See the REGION= argument for the list of predefined region values.

SSLALLOWED
indicates that SSL is allowed when communicating with the S3 environment.

Interaction This value is ignored if SSLREQUIRED is specified.

SSLPORT=*SSL-port*
specifies the HTTP port value to use to connect to S3 with SSL.

If you do not specify a port value, the default value is used.

SSLREQUIRED
indicates that all communications with the S3 environment must be made using SSL.

RMDIR Statement

Specifies a directory to delete from an S3 location.

Syntax

RMDIR "*s3-location*";

Required Argument

s3-location
specifies a directory in S3. Fully qualify the path from the bucket name to the directory name. The directory that you specify must be empty.

Examples: S3 Procedure

Example 1: Create a Bucket and Add a File

Features: PROC S3 statement, CONFIG= option
CREATE statement
PUT statement
LIST statement

Details

This example uses the CREATE statement in PROC S3 to create a bucket in S3. Next, the example shows how to add a file to the bucket and then list the contents of the bucket.

Program

```
proc s3 config="/u/marti/.tks3.conf";
   create "/myBucket";
   put "/u/marti/project/licj.csv" "/myBucket/licj.csv";
   list "/myBucket";
run;
```

Program Description

Execute the PROC S3 statement and specify the location of the PROC S3 configuration file. Connect to S3 with connection options that are contained in the .tks3.conf file in the specified directory.

```
proc s3 config="/u/marti/.tks3.conf";
```

Create a bucket in S3. Use the CREATE statement to create the bucket *myBucket*.

```
   create "/myBucket";
```

Store a copy of a local file in the new S3 bucket. Execute the PUT statement to copy the local file licj.csv into a file of the same name in the S3 bucket *myBucket*.

```
   put "/u/marti/project/licj.csv" "/myBucket/licj.csv";
```

List the contents of the S3 bucket. Use the LIST statement to see a list of the contents of *myBucket*.

```
   list "/myBucket";
run;
```

If the file licj.csv is the only file in the bucket, then the following message is printed to the SAS log.

Output 60.1 *List of Bucket Contents*

```
licj.csv    2791403 2015-06-05T19:27:35.000Z
```

Example 2: Manage the Contents of a Bucket

Features:

PROC S3 statement

MKDIR statement

COPY statement

DELETE statement

Details

This example shows how to create a directory in a bucket and how to copy and delete files.

Program

```
proc s3;
   mkdir "/myBucket/csv";
   copy "/myBucket/licj.csv" "/myBucket/csv/licj.csv";
   delete "/myBucket/licj.csv";
run;
```

Program Description

Connect to S3 using the default configuration file. Use the PROC S3 statement to connect to S3 with connection options that are specified in the .tks3.conf file in your home directory. This is the default configuration file location.

```
proc s3;
```

Create a new directory. Use the MKDIR statement to create a directory, csv, in the *myBucket*. A note is printed to the SAS log.

```
   mkdir "/myBucket/csv";
```

Copy a file into the new directory. Use the COPY statement to copy a file, licj.csv, from *myBucket* into the `csv` directory.

```
   copy "/myBucket/licj.csv" "/myBucket/csv/licj.csv";
```

Delete the original copy of the file. Use the DELETE statement to delete the original copy of the licj.csv file from *myBucket*. Only the copy of the file in `/myBucket/csv` remains.

```
   delete "/myBucket/licj.csv";
run;
```

Output 60.2 *Managing Data in a Bucket*

```
NOTE: Created directory /myBucket/csv.

NOTE: Deleted object /myBucket/licj.csv.
```

Example 3: Manage Encryptions with S3 Data

Features:
PROC S3 statement
COPY statement
ENCKEY statement
GET statement
GETDIR statement
PUT statement
PUTDIR statement

Details

This example shows how to work with encryption keys. As a best practice, manage encryption keys in a separate SAS program that you include into another SAS program that interacts with the AWS environment. In this example, the program that manages encryption keys is called keys.sas. All encryptions use the default AES256 encryption algorithm that is supported by the S3 environment.

PROGRAM: Keys.sas

```
/* keys.sas */
proc s3;

   /* IAM:KMS keys */
   enckey add name="foo" id="98v27390-1si1-8sc9-38k0-k893j354nw5g";
   enckey add name="bar" id="22f87852-0ak1-5xy2-01j1-l852g809gx4q";


   /* SSE-C keys (user-specified) as character string */
   enckey add name="foo2" key="ke-sj-eb-ok-qk-zi-nb-lu-fh-wi-zi";
   enckey add name="bar2" key="wl-tk-64-rk-i0-zn-wk-7c-s8-a8-jk";


   /* SSE-C (user-specified) keys as hex data */
   enckey replace name="foo2"

hexkey="e1d2e3bb4a5f6079889706b3c4d1e2f999f2c3bb4c5f6079888706f6a4b3e2d
a";
   enckey replace name="bar2"

hexkey="9892940203456892093758029375728394010928374674839201837583920192
2";

run;
```

Program Description

Add an IAM:KMS encryption key. Use the ENCKEY statement with the ADD option to add two encryption keys named foo and bar. You supply the ID= value that is defined by the IAM service in the AWS environment. Use the NAME= option to provide a user-friendly identifier for the encryption key.

```
/* keys.sas */
proc s3;

   /* IAM:KMS keys */
   enckey add name="foo" id="98v27390-1si1-8sc9-38k0-k893j354nw5g";
   enckey add name="bar" id="22f87852-0ak1-5xy2-01j1-l852g809gx4q";
```

Add an SSE-C key with a character string. You can use the ENCKEY statement and the ADD option to add a user-specified encryption key. Specify a 32-byte character string as the KEY= value and provide a user-friendly value for NAME=.

```
   /* SSE-C keys (user-specified) as character string */
   enckey add name="foo2" key="ke-sj-eb-ok-qk-zi-nb-lu-fh-wi-zi";
   enckey add name="bar2" key="wl-tk-64-rk-i0-zn-wk-7c-s8-a8-jk";
```

Replace existing encryption keys with a user-defined hexadecimal key. Use the REPLACE option with the NAME= option to identify an encryption key that you want to replace. You can specify an encryption key with a 64-digit hexadecimal value with the HEXKEY= option.

```
   /* SSE-C (user-specified) keys as hex data */
   enckey replace name="foo2"

hexkey="e1d2e3bb4a5f6079889706b3c4d1e2f999f2c3bb4c5f6079888706f6a4b3e2d
a";
   enckey replace name="bar2"

hexkey="9892940203456892093758029375728394010928374674839201837583920192
2";

run;
```

```
1          /* keys.sas */
2          proc s3;
3          /* IAM:KMS keys */
4          enckey add name="foo" id="98v27390-1si1-8sc9-38k0-k893j354nw5g";
5          enckey add name="bar" id="22f87852-0ak1-5xy2-01j1-l852g809gx4q";
6          /* user-defined keys as character string */
7          enckey add name="foo2" key="ke-sj-eb-ok-qk-zi-nb-lu-fh-wi-zi";
8          enckey add name="bar2" key="wl-tk-64-rk-i0-zn-wk-7c-s8-a8-jk";
9          /* user-defined keys as hex data */
10         enckey replace name="foo2"
11
hexkey="e1d2e3bb4a5f6079889706b3c4d1e2f999f2c3bb4c5f6079888706f6a4b3e2da";
12         enckey replace name="bar2"
13
hexkey="98929402034568920937580293757283940109283746748392018375839201 92";
14         run;

NOTE:  Created the S3 encryption key "foo".
NOTE:  Created the S3 encryption key "bar".
NOTE:  Created the S3 encryption key "foo2".
NOTE:  Created the S3 encryption key "bar2".
NOTE:  The value for S3 encryption key "foo2" was redefined.
NOTE:  The value for S3 encryption key "bar2" was redefined.
NOTE: PROCEDURE S3 used (Total process time):
      real time           3.02 seconds
      cpu time            0.01 seconds


NOTE: SAS Institute Inc., SAS Campus Drive, Cary, NC USA 27513-2414
NOTE: The SAS System used:
      real time           3.34 seconds
      cpu time            0.11 seconds
```

Program: S3data.sas

```
/* s3data.sas */
%include "keys.sas";


proc s3;
  enckey list;


  put enckey="foo" "/home/demouser/s3/foo.txt" "/mybucket/foo.txt";
  copy srckey="foo" "/mybucket/foo.txt" enckey="bar" "/mybucket/
bar.txt";
  get enckey="foo" "/mybucket/foo.txt" "/home/demouser/foo-get.txt";


  putdir enckey="foo2" "/home/demouser/s3" "/mybucket/enctest";

  getdir enckey="foo2" "/mybucket/enctest" "/home/demouser/enctest";

run;
```

Program Description

In a separate program, s3data.sas, you can specify the encryptions to use while you work with data from an S3 environment.

Include encryption key definitions so that they are accessible to the s3data.sas program. Use the %INCLUDE statement to retrieve encryption key definitions and their associated names.

```
/* s3data.sas */
%include "keys.sas";
```

List available encryption keys. Use the LIST option with the ENCKEY statement to see the currently defined encryption keys.

```
proc s3;
  enckey list;
```

Manipulate the encryptions for files. The PUT statement uses the foo encryption key from keys.sas to encrypt the local foo.txt file that is copied to an S3 bucket called Mybucket. The COPY statement copies the foo.txt file in Mybucket to a file called bar.txt that is encrypted using the bar encryption key. The GET statement copies the file foo.txt from Mybucket to your local directory and renames the file foo-get.txt. The file is encrypted using the foo encryption key.

```
  put enckey="foo" "/home/demouser/s3/foo.txt" "/mybucket/foo.txt";
  copy srckey="foo" "/mybucket/foo.txt" enckey="bar" "/mybucket/
bar.txt";
  get enckey="foo" "/mybucket/foo.txt" "/home/demouser/foo-get.txt";
```

Create a subdirectory in an S3 bucket and encrypt it. Use the PUTDIR statement to create a subdirectory, Enctest, in Mybucket. This location is a copy of your local directory `/home/demouser/s3`. The Enctest location is encrypted using the foo2 encryption key. In keys.sas, the foo2 encryption key is represented by a hexadecimal value, because that encryption key replaced the original encryption key for foo2.

```
  putdir enckey="foo2" "/home/demouser/s3" "/mybucket/enctest";
```

Create a decrypted local directory that is a copy of an encrypted S3 location. Use the GETDIR statement to create a decrypted copy of an S3 location, Enctest. The encryption key name is provided to enable decryption of the data. Data is encrypted by default during data transfer. The new local directory is `/home/demouser/enctest`.

```
  getdir enckey="foo2" "/mybucket/enctest" "/home/demouser/enctest";

run;
```

```
1          /* s3data.sas */
2          %include "keys.sas";

NOTE:  Created the S3 encryption key "foo".
NOTE:  Created the S3 encryption key "bar".
NOTE:  Created the S3 encryption key "foo2".
NOTE:  Created the S3 encryption key "bar2".
NOTE:  The value for S3 encryption key "foo2" was redefined.
NOTE:  The value for S3 encryption key "bar2" was redefined.
NOTE: PROCEDURE S3 used (Total process time):
      real time           3.02 seconds
      cpu time            0.01 seconds


17         proc s3;
18         enckey list;
19         put enckey="foo" "/home/demouser/foo.txt" "/mybucket/foo.txt";
20         copy srckey="foo" "/mybucket/foo.txt" enckey="bar" "/mybucket/bar.txt";
21         get enckey="foo" "/mybucket/foo.txt" "/home/demouser/foo-get.txt";
22         putdir enckey="foo2" "/home/demouser/s3" "/mybucket/enctest";
23         getdir enckey="foo2" "/mybucket/enctest" "/home/demouser";
24         run;

Defined S3 Encryption Keys
Name      Type       Details
_DEFAULT_ KMS
bar       KMS        22f87852-0ak1-5xy2-01j1-l852g809gx4q
bar2      SSE-C      HEX AES256
foo       KMS        98v27390-1si1-8sc9-38k0-k893j354nw5g
foo2      SSE-C      HEX AES256
NOTE: Writing directory /home/demouser/s3 to S3 path /mybucket/enctest
NOTE:  Put: /home/demouser/s3/s3data.sas -> /mybucket/enctest/s3data.sas
NOTE:  Put: /home/demouser/s3/foo.txt -> /mybucket/enctest/foo.txt
NOTE:  Put: /home/demouser/s3/keys.log -> /mybucket/enctest/keys.doc.log
NOTE:  Put: /home/demouser/s3/keys.sas -> /mybucket/enctest/keys.sas
NOTE: Writing contents of S3 path /mybucket/enctest to local path /home/demouser
NOTE: PROCEDURE S3 used (Total process time):
      real time           5.53 seconds
      cpu time            2.35 seconds


NOTE: SAS Institute Inc., SAS Campus Drive, Cary, NC USA 27513-2414
NOTE: The SAS System used:
      real time           8.82 seconds
      cpu time            2.47 seconds
```

Example 4: Define a Custom Region with PROC S3

Features: REGION statement

Details

This example shows how to define a custom region using PROC S3.

Program

```
proc s3;

   region add host="s3.us-west-004.backblazeb2.com"
      name="us-west-002"
      sslrequired replace;
run;
```

Program Description

Connect to S3 using the default configuration file. Use the PROC S3 statement to connect to S3 with connection options that are specified in the .tks3.conf file in your home directory. This is the default configuration file location.

```
proc s3;
```

Define a new custom region. Use the REGION statement to create a custom region, us-west-002. The SSLREQUIRED argument indicates that SSL is required when communicating with the S3 environment. The REPLACE argument specifies that if the custom region is already defined, then the definition should be overwritten.

```
   region add host="s3.us-west-004.backblazeb2.com"
      name="us-west-002"
      sslrequired replace;
run;
```

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SCAPROC Procedure

Overview: SCAPROC Procedure

What Does the SCAPROC Procedure Do?

The SCAPROC procedure implements the SAS Code Analyzer, which captures information about input, output, and the use of macro symbols from a SAS job while it is running. The SAS Code Analyzer can write this information and the information that is in the original SAS file to a file that you specify. The SCAPROC procedure can also generate a grid-enabled job that can concurrently run independent pieces of the job. You can issue the SCAPROC procedure on your operating system's command line or in SAS code in the SAS Editor window.

The following command runs your SAS job with the SAS Code Analyzer from your operating system's command line:

```
sas yourjob.sas -initstmt "proc scaproc;  record 'yourjob.txt' ; run;"
```

sas
is the command used at your site to start SAS.

yourjob.sas
is the name of the SAS job that you want to analyze.

yourjob.txt
is the name of the file that will contain a copy of your SAS code. The file will also contain the comments that are inserted to show input and output information, macro symbol usage, and other aspects of your job. For information about issuing PROC SCAPROC in SAS code, see the examples.

Special Considerations

Some tasks of grid-enabled jobs can have dependencies on previous tasks. PROC SCAPROC combines and reorders these tasks based on their dependencies to the preceding tasks. Combining the tasks and submitting them in the same work unit enables faster processing of the tasks. The NOOPTIMIZE argument of the GRID option disables the combining and reordering of tasks of grid-enabled jobs.

For the GRID statement to work, your site has to license SAS Grid Manager or SAS/CONNECT. SAS Grid Manager enables your generated grid job to run on a grid of distributed machines. SAS/CONNECT enables your generated grid job to run on parallel SAS sessions on one symmetric multiprocessing (SMP) machine.

Concepts: SCAPROC Procedure

Handling Global Statements

You can mark a set of statements that you want to submit to each remote session in the generated grid job. Include an `/* SCAPROC GLOBAL BEGIN */` comment on the line before the set of statements, and include an `/* SCAPROC GLOBAL END */` comment on the line after the statements. PROC SCAPROC submits the statements in the marked session to each of the remote sessions before any of the job's steps are submitted.

In the following example, PROC SCAPROC submits the statements between the /* SCAPROC GLOBAL BEGIN */ and /* SCAPROC GLOBAL END */ comments with each of the PROC SUMMARY statements.

```
/* SCAPROC GLOBAL BEGIN */;
    libname one "SAS-library-1";
    libname two "SAS-library-1";
   %let year=2018;
/* SCAPROC GLOBAL END */;

Proc summary data=one.sales;
   where year=&year
   class month;
   var sales;
   output out=sasuser.sales;
run;
Proc summary data=two.expenses;
   where year=&year
   class month;
   var expenses;
   output out=sasuser.expenses;
run;
```

You can include any SAS statement that is valid with the generated grid job. You can use text that is all uppercase, all lowercase, or mixed case.

Syntax: SCAPROC Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

PROC SCAPROC;

RECORD *filespec* <ATTR> <OPENTIMES> <INTCON> <EXPANDMACROS> <GRID *filespec* <RESOURCE *"resource name"*> <INHERITLIB> <NOOPTIMIZE> >;

WRITE;

Statement	Task	Example
PROC SCAPROC	Implement the SAS Code Analyzer	Ex. 1, Ex. 2
RECORD	Specify a filename or a fileref to contain the output of the SAS Code Analyzer	Ex. 1, Ex. 2
WRITE	Output information to the record file	Ex. 1

PROC SCAPROC Statement

Specifies that SAS will run the SAS Code Analyzer with your SAS job.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Examples: "Example 1: Specifying a Record File" on page 2300
"Example 2: Specifying the Grid Job Generator" on page 2301

Syntax

PROC SCAPROC;

RECORD Statement

Specifies a filename or a fileref to contain the output of the SAS Code Analyzer.

Examples: "Example 1: Specifying a Record File" on page 2300
"Example 2: Specifying the Grid Job Generator" on page 2301

Syntax

RECORD *filespec* <ATTR> <OPENTIMES> <INTCON> <EXPANDMACROS> <GRID *filespec* <RESOURCE *"resource name"*> <INHERITLIB> <NOOPTIMIZE> >;

Required Argument

filespec
specifies a physical filename in quotation marks, or a fileref, that indicates a file to contain the output of the SAS Code Analyzer. The output is the original SAS source and comments that contain information about the job. For more information about the output comments, see "Results" on page 2296.

Optional Arguments

ATTR
writes additional information about the variables in the input data sets and views.

OPENTIMES
writes the open time, size, and physical filename of the input data sets.

INTCON
outputs information about table integrity constraints.

EXPANDMACROS
expands macro invocations into separate tasks.

GRID

filespec
specifies a physical filename in quotation marks, or a fileref, that points to a file that will contain the output of the Grid Job Generator.

RESOURCE "*resource name*"
specifies the resource to use in the `grdsvs_enable` function call. The default is SASApp.

INHERITLIB
adds INHERITLIB=(USER) to the SIGNON statements in the grid-enabled job. By default, the user library (if one is specified) is assigned in each remote session.

Note: INHERITLIB should be used only when the USER library is not globally accessible to all remote sessions.

NOOPTIMIZE
disables the combining and reordering of tasks for grid-enabled jobs.

WRITE Statement

Specifies output information to the record file.

Example: "Example 1: Specifying a Record File" on page 2300

Syntax

WRITE;

Without Arguments

The WRITE statement specifies that the SAS Code Analyzer writes information to the record file, if a file has been specified with the RECORD statement. The Grid Job Generator will also run at this time if it has been specified. Termination of SAS also causes the SAS Code Analyzer to write information to the specified record file.

Results: SCAPROC Procedure

Results

The following list contains explanations of the comments that the SAS Code Analyzer writes to the record file that you specify with PROC SCAPROC. The output comments are bounded by **/*** and ***/** comment tags in the record file. That format is represented here to enhance clarity when the user reads a record file.

`/* JOBSPLIT: DATASET INPUT|OUTPUT|UPDATE SEQ|MULTI` *name* `*/`
specifies that a data set was opened for reading, writing, or updating.

INPUT
specifies that SAS read the data set.

OUTPUT
specifies that SAS wrote the data set.

UPDATE
specifies that SAS updated the data set.

SEQ
specifies that SAS opened the data set for sequential access.

MULTI
specifies that SAS opened the data set for multipass access.

name
specifies the name of the data set.

`/* JOBSPLIT: CATALOG INPUT|OUTPUT|UPDATE` *name* `*/`
specifies that a catalog was opened for reading, writing, or updating.

INPUT
specifies that SAS read the catalog.

OUTPUT
specifies that SAS wrote the catalog.

UPDATE
specifies that SAS updated the catalog.

name
specifies the name of the catalog.

`/* JOBSPLIT: FILE INPUT|OUTPUT|UPDATE` *name* `*/`
specifies that an external file was opened for reading, writing, or updating.

INPUT
specifies that SAS read the file.

OUTPUT
specifies that SAS wrote the file.

UPDATE
specifies that SAS updated the file.

name
specifies the name of the file.

`/* JOBSPLIT: ITEMSTOR INPUT|OUTPUT|UPDATE name */`
specifies that an ITEMSTOR was opened for reading, writing, or updating.

INPUT
specifies that SAS read the ITEMSTOR.

OUTPUT
specifies that SAS wrote the ITEMSTOR.

UPDATE
specifies that SAS updated the ITEMSTOR.

name
specifies the name of the ITEMSTOR.

`/* JOBSPLIT: OPENTIME name DATE:date PHYS:phys SIZE:size */`
specifies that a data set was opened for input. SAS writes the OPENTIME and the SIZE of the file.

name
specifies the name of the data set.

DATE
specifies the date and time that the data set was opened. The value that is returned for DATE is not the creation time of the file.

PHYS
specifies the complete physical name of the data set that was opened.

SIZE
specifies the size of the data set in bytes.

`/* JOBSPLIT: ATTR name INPUT|OUTPUT VARIABLE:variable name TYPE:CHARACTER|NUMERIC LENGTH:length LABEL:label FORMAT:format INFORMAT:informat */`
specifies that when a data set is closed, SAS reopens it and writes the attributes of each variable. One ATTR line is produced for each variable.

name
specifies the name of the data set.

INPUT
specifies that SAS read the data set.

OUTPUT
specifies that SAS wrote the data set.

VARIABLE
specifies the name of the current variable.

TYPE
specifies whether the variable is character or numeric.

LENGTH
specifies the length of the variable in bytes.

LABEL
specifies the variable label if it has one.

FORMAT
specifies the variable format if it has one.

INFORMAT
specifies the variable informat if it has one.

`/* JOBSPLIT: SYMBOL SET|GET` *name* `*/`
specifies that a macro symbol was accessed.

SET
specifies that SAS set the symbol. For example, SAS set the symbol **sym1** in the following code: `%let sym1=sym2`

GET
specifies that SAS retrieved the symbol. For example, SAS retrieved the symbol **sym** in the following code: `a="&sym"`

name
specifies the name of the symbol.

`/* JOBSPLIT: ELAPSED` *number* `*/`
specifies a number for you to use to determine the relative run times of tasks.

number
specifies a number for you to use to determine the relative run times of tasks.

`/* JOBSPLIT: USER` *useroption* `*/`
specifies that SAS uses the USER option with the grid job code to enable single-level data set names to reside in the Work library.

useroption
specifies the value that is to be used while the code is running.

`/* JOBSPLIT: _DATA_ */`
specifies that SAS is to use the reserved data set name _DATA_.

`/* JOBSPLIT: _LAST_ */`
specifies that SAS is to use the reserved data set name _LAST_ .

`/* JOBSPLIT: PROCNAME procname|DATASTEP */`
specifies the name of the SAS procedure or DATA step for this step.

`/* JOBSPLIT: LIBNAME <libname options> */`
specifies the LIBNAME options that were provided in a LIBNAME statement or were set internally.

`/* JOBSPLIT: SYSSCP <sysscp> */`
specifies the value of the SYSSCP automatic macro variable when the SAS job was run.

`/* JOBSPLIT: JOBSTARTTIME <datetime> */`
records the date and time that a job started.

`/* JOBSPLIT: JOBENDTIME <datetime> */`
records the date and time that a job ended.

```
/* JOBSPLIT: TASKSTARTTIME <datetime> */
```
records the date and time that a task started.

```
/* JOBSPLIT: INTCON <table name> <INPUT | OUTPUT> NAME:<name>
TYPE:<UNIQUE|CHECK|NOTNULL|PRIMARY|FOREIGN|REFERENTIAL>
VARIABLES:<names> WHERE:<where clause> REFERENCE: ONDELETE: ONUPDATE:
MESSAGE:<msg> MESSAGETYPE:<USER> */
```
table name
specifies the name of the table.

INPUT
specifies that the table was opened for input.

OUTPUT
specifies that the table was opened for output.

NAME
specifies the name of the integrity constraint.

TYPE
specifies the type of integrity constraint:

Table 61.1 *Integrity Constraint for Each Type*

Type	Integrity Constraint
UNIQUE	unique
CHECK	check
NOTNULL	not null
PRIMARY	primary key
FOREIGN	foreign key
REFERENTIAL	a FOREIGN integrity constraint in another table that references this table

VARIABLES
specifies the variables involved with this integrity constraint. Otherwise, it is empty.

WHERE
specifies the WHERE expression for CHECK integrity constraints. Otherwise, it is empty.

REFERENCE
specifies one of the following integrity constraints:

- For FOREIGN integrity constraints, it specifies the table the foreign key references.
- For REFERENTIAL integrity constraints, it specifies the table containing the foreign key.

- Otherwise, it is empty.

ONDELETE
specifies the ON DELETE referential action for FOREIGN and REFERENTIAL integrity constraints. Otherwise, it is empty.

ONUPDATE
specifies the ON UPDATE referential action for FOREIGN and REFERENTIAL integrity constraints. Otherwise, it is empty.

MESSAGE
specifies the text of the error message, if there is any.

MESSAGETYPE
specifies USER if MESSAGETYPE=USER was specified. Otherwise, it is empty.

Examples: SCAPROC Procedure

Example 1: Specifying a Record File

Features: RECORD statement
WRITE statement

This example specifies the record file **'record.txt'** and writes information from the SAS Code Analyzer to the file.

Program

```
proc scaproc;
   record 'record.txt';
run;

data a;
   do i = 1 to 100000;
      j = cos(i);
      output;
   end;
run;

proc print data=a(obs=25);
run;
```

```
proc means data=a;
run;

proc scaproc;
   write;
run;
```

Output

Output 61.1 *Contents of the record.txt File*

```
/* JOBSPLIT: DATASET OUTPUT SEQ WORK.A.DATA */
/* JOBSPLIT: LIBNAME WORK ENGINE V9 PHYS C:\DOCUME~1\userid\LOCALS~1\Temp\SAS
Temporary Files\_TD1252 */
/* JOBSPLIT: ELAPSED 3984  */
/* JOBSPLIT: PROCNAME DATASTEP */
/* JOBSPLIT: STEP SOURCE FOLLOWS */

data a;
    do i = 1 to 1000000;
        j = cos(i);
        output;
    end;
run;


/* JOBSPLIT: ITEMSTOR INPUT SASUSER.TEMPLAT */
/* JOBSPLIT: ITEMSTOR INPUT SASHELP.TMPLMST */
/* JOBSPLIT: DATASET INPUT SEQ WORK.A.DATA */
/* JOBSPLIT: LIBNAME WORK ENGINE V9 PHYS C:\DOCUME~1\userid\LOCALS~1\Temp\SAS
Temporary Files\_TD1252 */
/* JOBSPLIT: ELAPSED 5187  */
/* JOBSPLIT: PROCNAME PRINT */
/* JOBSPLIT: STEP SOURCE FOLLOWS */
proc print data=a(obs=25);
run;


/* JOBSPLIT: DATASET INPUT SEQ WORK.A.DATA */
/* JOBSPLIT: LIBNAME WORK ENGINE V9 PHYS C:\DOCUME~1\userid\LOCALS~1\Temp\SAS
Temporary Files\_TD1252 */
/* JOBSPLIT: FILE OUTPUT C:\winnt\profiles\userid\record.txt */
/* JOBSPLIT: SYMBOL GET SYSSUMTRACE */
/* JOBSPLIT: ELAPSED 2750  */
/* JOBSPLIT: PROCNAME MEANS */
/* JOBSPLIT: STEP SOURCE FOLLOWS */
proc means data=a;
run;


/* JOBSPLIT: END */
```

Example 2: Specifying the Grid Job Generator

Features: RECORD statement

GRID statement

Details

This example writes information from the SAS Code Analyzer to the file that is named `1.txt`. The example code also runs the Grid Job Generator, and writes that information to the file that is named `1.grid`. Notice that this example does not have an ending statement that contains this code:

```
proc scaproc;
   write;
run;
```

When SAS terminates, PROC SCAPROC automatically runs any pending RECORD or GRID statements.

For the GRID statement to work, your site has to license SAS Grid Manager or SAS/CONNECT. SAS Grid Manager enables your generated grid job to run on a grid of distributed machines. SAS/CONNECT enables your generated grid job to run on parallel SAS sessions on one symmetric multiprocessing (SMP) machine.

Program

```
proc scaproc;
   record '1.txt' grid '1.grid';
run;

data a;
   do i = 1 to 100000;
      j = cos(i);
      output;
   end;
run;

proc print data=a(obs=25);
run;

proc means data=a;
run;
```

Output

Output 61.2 *Contents of the 1.txt File*

```
/* JOBSPLIT: DATASET OUTPUT SEQ WORK.A.DATA */
/* JOBSPLIT: LIBNAME WORK ENGINE V9 PHYS C:\DOCUME~1\userid\LOCALS~1\Temp\SAS
Temporary Files\_TD1252 */
/* JOBSPLIT: ELAPSED 375  */
/* JOBSPLIT: PROCNAME DATASTEP */
/* JOBSPLIT: STEP SOURCE FOLLOWS */

data a;
    do i = 1 to 1000000;
        j = cos(i);
        output;
    end;
run;


/* JOBSPLIT: DATASET INPUT SEQ WORK.A.DATA */
/* JOBSPLIT: LIBNAME WORK ENGINE V9 PHYS C:\DOCUME~1\userid\LOCALS~1\Temp\SAS
Temporary Files\_TD1252 */
/* JOBSPLIT: ELAPSED 46  */
/* JOBSPLIT: PROCNAME PRINT */
/* JOBSPLIT: STEP SOURCE FOLLOWS */
proc print data=a(obs=25);
run;


/* JOBSPLIT: DATASET INPUT SEQ WORK.A.DATA */
/* JOBSPLIT: LIBNAME WORK ENGINE V9 PHYS C:\DOCUME~1\userid\LOCALS~1\Temp\SAS
Temporary Files\_TD1252 */
/* JOBSPLIT: FILE OUTPUT C:\WINNT\Profiles\userid\1.txt */
/* JOBSPLIT: SYMBOL GET SYSSUMTRACE */
/* JOBSPLIT: ELAPSED 81453  */
/* JOBSPLIT: PROCNAME MEANS */
/* JOBSPLIT: STEP SOURCE FOLLOWS */
proc means data=a;
run;

/* JOBSPLIT: END */
```

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SCOREACCEL Procedure

Overview: SCOREACCEL Procedure

What Does the SCOREACCEL Procedure Do?

PROC SCOREACCEL is an interactive procedure that provides an interface to the CAS server and external data sources for model publishing and scoring.

- Models are supported in the form of DATA step code, DS2 code, or analytic stores.
- Model code can be published to a session-local or global CAS table and executed in CAS. Session-local means it is accessible only to the current CAS session that is executing PROC SCOREACCEL. Publishing to a global CAS table is supported in SAS Viya 3.5.
- Alternatively, models can be published to Teradata or Hadoop. After a model is published to an external data source, it can be executed there. Running a model invokes the SAS Embedded Process (EP). To operate in these environments, you need to license SAS In-Database Technologies for Hadoop (on SAS Viya) or SAS In-Database Technologies for Teradata (on SAS Viya).
- As of SAS Viya 3.4 and SAS 9.4M6, models can be removed from CAS and from external databases using the PROC SCOREACCEL DELETEMODEL statement.
- PROC SCOREACCEL calls CAS actions to complete the tasks. For more information about the actions, see "Using DS2 Actions to Publish, Run, and Delete Models in CAS" in *SAS DS2 Programmer's Guide*.
- When publishing DATA step model code, PROC SCOREACCEL translates DATA step code into DS2 code on the SAS client.

Concepts: SCOREACCEL Procedure

Publishing Models to a Model Table on the CAS Server

Publishing a model to CAS involves adding or replacing a row in a model table. In order to publish a model to an existing model table, the model table must first be loaded on the CAS server. If the specified model table has been loaded on the CAS server, then the model table is updated. Otherwise, a new model table is created.

Prior to SAS Viya 3.5, a model could be published only to a model table local to the current CAS session. The local session table could then be promoted to global scope using the PUBLISHMODEL PROMOTETABLE= parameter.

Beginning in SAS Viya 3.5, a model can be published directly to a global model table in CAS. A model is published to a global model table in CAS when the PUBLISHMODEL PUBLISHGLOBAL= parameter is set to YES.

Syntax: SCOREACCEL Procedure

PROC SCOREACCEL *session-name* | *session-uuid*;
PUBLISHMODEL *required-arguments* <*publish-model-options*>;
RUNMODEL *required-arguments* <*run-model-options*>;
DELETEMODEL *required-arguments* <*delete-model-options*>;

Statement	Task	Example
PROC SCOREACCEL	Publish, execute, and delete models in CAS or an external database	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7
PUBLISHMODEL	Publish models in CAS or an external database	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 7
RUNMODEL	Run models in CAS or an external database	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7
DELETEMODEL	Delete models from CAS or an external database	Ex. 1, Ex. 2

PROC SCOREACCEL Statement

Publishes, executes, or deletes a model in CAS or an external data source.

Examples:

"Example 1: Publishing, Running, and Deleting a DATA Step Model in CAS" on page 2329
"Example 2: Publishing, Running, and Deleting a DS2 Model in Teradata" on page 2331
"Example 3: Publishing and Running a DATA Step Model in Teradata Using a CASLIB" on page 2334
"Example 4: Publishing and Running a Model in Hadoop" on page 2336
"Example 5: Publishing and Running a Model in Hadoop (Hive)" on page 2337

Syntax

PROC SCOREACCEL SESSREF=*session-name* | SESSUUID="*session-uuid*";

Arguments

SESSREF=*session-name* | SESSUUID="*session-uuid*"
specifies the name of a CAS session or the universally unique identifier (UUID) of an existing CAS session to which you want to connect. If no option is specified, the automatic CAS session, CASAUTO, is used.

SESSREF=*session-name*
specifies the name of a CAS session to which you want to connect.

SESSUUID="*session-uuid*"
specifies the universally unique identifier (UUID) of an existing CAS session. You must obtain the SESSUUID from the existing session before you can specify it in this option. The engine connects to the session that is identified in the UUID.

DELETEMODEL Statement

Deletes a model from CAS or an external database.

Restriction: This statement is available as of SAS Viya 3.4 and SAS 9.4M6.

Examples: "Example 1: Publishing, Running, and Deleting a DATA Step Model in CAS" on page 2329

"Example 2: Publishing, Running, and Deleting a DS2 Model in Teradata" on page 2331

Syntax

DELETEMODEL
MODELNAME="*model-name*"
MODELTABLE="*model-table*" | "*caslib.model-table*" | "*schema.model-table*"
<*delete-model-options*>;

Required Arguments

MODELNAME="*model-name*"
specifies the name of the model to be deleted.

Alias MODEL=

Applies to CAS

Hadoop

Teradata

MODELTABLE="*model-table*" | "*caslib.model-table*" | "*schema.model-table*"
specifies the name of the table that contains the model to be deleted.

Applies to CAS

Teradata

Restriction This parameter is required when deleting a model from CAS or Teradata. It does not apply when deleting a model from Hadoop.

Requirement Deleting a model from CAS involves removing a row from a model table. In order to remove the model, the model table must first be loaded to the CAS server.

Note The model table can be specified as a one-part or a two-part name. When deleting a model from CAS, the first part of a two-part name is interpreted as the name of the caslib that contains the model table. When deleting a model from Teradata, the first part of a two-part name is interpreted as the name of the database schema that contains the model table.

Delete Model Options

AUTHDOMAIN = "*authentication-domain*"
specifies the name of the authentication domain that contains the credentials (user name and password) that are used to access Teradata.

Applies to Teradata

CASLIB="*caslib*"
specifies the name of the caslib associated with the model table when deleting a model from CAS. When deleting models in Teradata or Hadoop, this is the name of the caslib whose associated data source is used to obtain options that are specific to the external database. This includes any user credentials that are specified in the data source definition.

Applies to CAS

Hadoop

Teradata

Requirement The caslib that is specified as the first part of a two-part model table name takes precedence over the caslib that is specified with the CASLIB option.

CLASSPATH="*classpath*"
specifies the class path used in the Hadoop call context. The class path can be a folder or individual JAR files. The Hadoop configuration folder must be included in the class path.

Applies to Hadoop

DATABASE="*database-name*"
specifies the name of the Teradata database.

Default "" (a zero-length string)

Applies to Teradata

Note This option provides the connection option that names the Teradata database to be accessed.

DELETEGLOBAL=YES | NO
specifies whether the model is deleted from a global model table in CAS. If DELETEGLOBAL=YES, then the model is deleted from the global model table. If DELETEGLOBAL=NO, then the model is deleted from the model table in the local CAS session, leaving the global table unaltered.

Default NO

Applies to CAS

Restriction This option is available as of SAS Viya 3.5.

JOBMANAGEMENTURL="*rest-url*"
specifies the URL used to submit execution requests over a REST interface to services such as Apache Livy.

Alias RESTURL=

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.5 (August 2021 release, or earlier if you apply a hot fix).

MODELDIR="*model-directory*"
specifies the root HDFS folder containing the model directory from which the model is to be deleted.

Applies to Hadoop

PASSWORD="*password*"
is the password for the user ID on the Hadoop or Teradata server.

Aliases PASS=

PASSWD=

PWD=

Applies to Hadoop

Teradata

PERSISTTABLE=YES | NO
specifies whether the updated model table, that results from deleting a model, should be saved to the caslib data source associated with the table.

Default NO

Applies to CAS

Requirement If the model table already exists in the caslib data source, you must also specify REPLACETABLE=YES to save the table.

See REPLACETABLE= option

PROMOTETABLE=YES | NO
specifies whether the updated model table, that results from deleting a model, should be promoted to global scope on the CAS server.

Default NO

Applies to CAS

REPLACETABLE=YES | NO
specifies whether to allow an existing model table, that results from deleting a model, to be replaced when the updated model table is saved to the caslib data source.

Default YES

Applies to CAS

Requirement You must also specify PERSISTTABLE=YES to save the model table to the caslib data source.

See PERSISTTABLE= option

SCHEMA="*schema-name*"
specifies the name of the Teradata schema.

Applies to Teradata

Note This option provides the connection option that the Teradata database uses to qualify the Teradata tables.

SERVER="*server*"
specifies the name of the Teradata server.

Applies to Teradata

TARGET=CAS | HADOOP | TERADATA
specifies the target environment to which the model is to be deleted.

CAS
specifies to delete the model from a model table in CAS.

HADOOP
specifies to delete the model from the Hadoop server.

TERADATA
specifies to delete the model from a model table in the Teradata database.

Default CAS

Applies to CAS

Hadoop

Teradata

USERNAME='*id*'
is an authorized user ID on the Hadoop or Teradata server.

Aliases USER=

USERID=

UID=

Applies to Hadoop

Teradata

WEBHDFSURL="*webhdfs-url*"
specifies the URL used to access the Hadoop distributed file system through the REST API.

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.5 (August 2021 release, or earlier if you apply a hot fix).

Note Use this argument when you delete, publish, or run a model in a platform that is configured to access the distributed file system through the REST API.

PUBLISHMODEL Statement

Publishes a model in CAS or an external database.

Examples:
"Example 1: Publishing, Running, and Deleting a DATA Step Model in CAS" on page 2329
"Example 2: Publishing, Running, and Deleting a DS2 Model in Teradata" on page 2331
"Example 3: Publishing and Running a DATA Step Model in Teradata Using a CASLIB" on page 2334
"Example 4: Publishing and Running a Model in Hadoop" on page 2336
"Example 5: Publishing and Running a Model in Hadoop (Hive)" on page 2337

Syntax

PUBLISHMODEL
MODELNAME ="*model-name*"
MODELTABLE="*model-table*" | "*caslib.model-table*" | "*schema.model-table*"
PROGRAMFILE="*file-path*" | *fileref*
< *publish-model-options*> ;

Required Arguments

MODELNAME="*model-name*"
specifies the name of the model to be published.

Alias MODEL=

Applies to CAS

Hadoop

Teradata

MODELTABLE="*model-table*" | "*caslib.model-table*" | "*schema.model-table*"
specifies the name of the table to which the model is published.

Applies to CAS

Teradata

Interaction The caslib that is specified as the first part of a two-part model table name takes precedence over the caslib that is specified with the CASLIB option.

Notes The model table can be specified as a one-part or a two-part name. When you publish a model to CAS, the first part of a two-part name is interpreted as the name of the caslib that contains the model table. When you publish a model to Teradata, the first part of a two-part name is interpreted as the name of the database schema that contains the model table.

Publishing a model to CAS involves adding or replacing a row in a model table. In order to publish a model to an existing model table, the model table must first be loaded onto the CAS server. If the specified model table has been loaded onto the CAS server, then the model table is updated. Otherwise, a new model table is created.

PROGRAMFILE="*file-path*" | *fileref*
specifies the file that contains the model program to be published.

Applies to CAS

Hadoop

Teradata

Interaction This argument is not required if a single analytic store is provided using the STOREFILES or the STORETABLES option.

Publish Model Options

AUTHDOMAIN = "*authentication-domain*"
specifies the name of the authentication domain that contains the credentials (user name and password) that will be used to access the specified Teradata database.

Applies to Teradata

Restriction This option is available as of SAS Viya 3.4 and SAS 9.4M6.

CASLIB="*caslib*"
specifies name of the caslib in which the model table is created or to which the updated model table is written, when publishing a model to CAS.

Applies to CAS

Hadoop

Teradata

Interaction The caslib that is specified as the first part of a two-part model table name takes precedence over the caslib that is specified with the CASLIB option.

Note When you publish a model to Teradata or Hadoop, this argument specifies the name of the caslib whose associated data source is used to obtain options specific to the external database. This includes any user credentials that are specified in the data source definition.

CLASSPATH="*class_path*"
specifies the class path used in the Hadoop call. The class path must include the Hadoop configuration folder and it must also include either a folder containing the JAR files or the individual JAR files.

Applies to Hadoop

DATABASE="*database-name*"
specifies the name of the Teradata database.

Default "" (a zero-length string)

Applies to Teradata

Note This option provides the connection option that names the Teradata database to be accessed.

FORMATFILE=*file-path* | *fileref*
specifies the file that contains the user-defined format XML definition to be published.

Applies to CAS

Hadoop

Teradata

FORMATITEMSTOREFILE=*file-path* | *fileref*
specifies the file containing the format item store to be published.

Applies to CAS

Hadoop

Teradata

Restriction This option is available as of SAS Viya 3.4 and SAS 9.4M6.

JOBMANAGEMENTURL="*rest-url*"
specifies the URL used to submit execution requests over a REST interface to services such as Apache Livy.

Alias RESTURL=

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.5 (August 2021 release, or earlier if you apply a hot fix).

KEEPLIST=YES | NO
specifies whether to include a KEEP statement in the DS2 model program that was automatically generated from an analytic store model.

Default NO

Applies to CAS

Hadoop

Teradata

Restriction This option is available as of SAS Viya 3.4 and SAS 9.4M6.

Interaction KEEPLIST can be specified when the STOREFILES or the STORETABLES option contains a single analytic store model, and an accompanying DS2 model program is not specified.

MODELDIR="*model-directory*"
specifies the root HDFS folder where the model directory is created.

Applies to Hadoop

MODELNOTES="*model-notes*"
specifies the model notes to be written to the model table.

Applies to CAS

Teradata

MODELTYPE=DATASTEP | DS2
specifies the type of the input model program.

DATASTEP
specifies that the input model program is DATA step code.

Alias DS

DS2
specifies that the input model program is DS2 code.

Default DS2

Applies to CAS

Hadoop

Teradata

Note The DATA step code is converted to DS2 code before being bundled into an item store.

MODELUUID="*model-uuid*"
specifies that the Model UUID is written to the model table.

Applies to CAS

Teradata

OUTDIR="*work-directory*"
specifies the local output directory that contains the program file that was converted from DATA step to DS2.

Applies to CAS

Hadoop

Teradata

PASSWORD="*password*"
is the password for the user ID on the Hadoop or Teradata server.

Aliases PASS=

PASSWD=

PWD=

Applies to Hadoop

Teradata

PERSISTTABLE=YES | NO
specifies whether the updated model table should be saved to the caslib data source associated with the table.

Default NO

Applies to CAS

Requirement If the model table already exists in the caslib data source, you must also specify REPLACETABLE=YES to save the table.

See REPLACETABLE= option

PROMOTETABLE=YES | NO
specifies whether the updated model table should be promoted to global scope on the CAS server.

Default NO

Applies to CAS

PUBLISHGLOBAL=YES | NO
specifies whether the model is published to a global model table in CAS. If PUBLISHGLOBAL=YES, then the model is published to a global model table. If PUBLISHGLOBAL=NO, then the model is published to the model table in the local CAS session, leaving the global model table unaltered.

Default NO

Applies to CAS

Restriction This option is available as of SAS Viya 3.5.

REPLACEMODEL=YES | NO
specifies whether to allow an existing model in the model table to be replaced by the model being published.

Default YES

Applies to CAS

Hadoop

Teradata

REPLACETABLE=YES | NO
specifies whether to allow an existing model table to be replaced when the updated model table is saved to the caslib data source.

Default YES

Applies to CAS

Requirement You must also specify PERSISTTABLE=YES to save the model table to the caslib data source.

See PERSISTTABLE= option

SCHEMA="*schema-name*"
specifies the name of the Teradata schema.

Applies to Teradata

Note This option provides the connection option that the Teradata database uses to qualify the Teradata tables.

SERVER="*server-name*"
specifies the name of the Teradata or Hive server.

Applies to Hadoop

Teradata

STOREFILES="*file-path*" <, "*file-path*"> | *fileref* <, *fileref*>
specifies a list of files, one for each analytic store to be published.

Alias STOREFILE=

Applies to CAS

Hadoop

Teradata

Interaction As of SAS Viya 3.4 and SAS 9.4M6, if a single analytic store model is specified without an accompanying DS2 program, the KEEPLIST option can also be specified.

Tip The list of files can be a mixture of file pathnames and file references.

STORETABLES= ("*store-table-1*" | "*caslib.store-table-1*" <, "*store-table-n*" | "*caslib.store-table-n*">
specifies one or more CAS blob table names that contain the analytic stores to be published. Each table must include a VARBINARY column named "_state_" that contains the analytic store blob.

Applies to CAS

Hadoop

Teradata

Restriction This option is available as of SAS Viya 3.4 and SAS 9.4M6.

Interaction If a single analytic store model is specified without an accompanying DS2 program, then the KEEPLIST option can also be specified.

TARGET=CAS | HADOOP | TERADATA
specifies the target environment to which the model is published.

CAS
specifies to publish to a model table in CAS.

HADOOP
specifies to publish to the Hadoop server.

TERADATA
specifies to publish to a model table in the Teradata database.

Default CAS

Applies to CAS

Hadoop

Teradata

USERNAME='*ID*'
is an authorized user ID on the Hadoop or Teradata server.

Aliases USER=

USERID=

UID=

Applies to Hadoop

Teradata

VARXMLFILE=*file-path* | *fileref*
specifies the file that contains the variable metadata XML to be used during translation of an input DATA step model program to DS2.

Alias XMLFILE=

Applies to CAS

Hadoop

Teradata

WEBHDFSURL="*webhdfs-url*"
specifies the URL used to access the Hadoop distributed file system through the REST API.

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.5 (August 2021 release, or earlier if you apply a hot fix).

Note Use this argument when you delete, publish, or run a model in a platform that is configured to access the distributed file system through the REST API.

RUNMODEL Statement

Runs a model in CAS or an external database.

Examples:
"Example 1: Publishing, Running, and Deleting a DATA Step Model in CAS" on page 2329
"Example 2: Publishing, Running, and Deleting a DS2 Model in Teradata" on page 2331
"Example 3: Publishing and Running a DATA Step Model in Teradata Using a CASLIB" on page 2334
"Example 4: Publishing and Running a Model in Hadoop" on page 2336
"Example 5: Publishing and Running a Model in Hadoop (Hive)" on page 2337

Syntax

RUNMODEL
MODELNAME ="*model-name*"
MODELTABLE="*model-table*" | "*caslib.model-table*" | "*schema.model-table*"
<*run-model-options*>;

Required Arguments

MODELNAME="*model-name*"
specifies the name of the model to run.

Alias: MODEL=

Applies to: CAS, Hadoop, Teradata

MODELTABLE="*model-table*" | "*caslib.model-table*" | "*schema.model-table*"
specifies the name of the table that contains the model to run.

Applies to: CAS, Teradata

Requirement: The caslib that is specified as the first part of a two-part model table name takes precedence over the caslib that is specified with the CASLIB option.

Note: The model table can be specified as a one-part or a two-part name. When running a model in CAS, the first part of a two-part name is interpreted as the name of the caslib that contains the

model table. When running a model in Teradata, the first part of a two-part name is interpreted as the name of the database schema that contains the model table.

Run Model Options

AUTHDOMAIN = "*authentication-domain*"
specifies the name of the authentication domain that contains the credentials (user name and password) that will be used to access Teradata.

Applies to Teradata

Restriction This option is available as of SAS Viya 3.4 and SAS 9.4M6.

CASLIB="*caslib*"
specifies the name of the caslib associated with the model table, input table, and output table, when running a model in CAS. When running models in Teradata or Hadoop, the name of the caslib whose associated data source is used to obtain options that are specific to the external database. This includes any user credentials that are specified in the data source definition.

Applies to CAS

Hadoop

Teradata

Requirement The caslib that is specified as the first part of a two-part model table name takes precedence over the caslib that is specified with the CASLIB option.

CLASSPATH="*class_path*"
specifies the class path used in the Hadoop call context. The class path contains a folder or individual JAR files. The Hadoop configuration folder must be included in the class path if you are not specifying the CONFIGPATH option. If you are using Spark, Hadoop JAR files and Spark JAR files must be located in separate folders, and the Spark JAR folder must be specified as the last entry in the class path.

Applies to Hadoop

CONFIGPATH="*configuration-path*"
specifies a single folder where all the Hadoop and Spark configuration files reside.

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.4 and SAS 9.4M6.

Interactions This option is required if PLATFORM= is set to SPARK.

When the CONFIGPATH option is specified, the configuration folder does not need to be added to the CLASSPATH option.

CUSTOMJAR="*file-path*"
specifies the local JAR file that contains the user-provided custom reader. The custom JAR file is automatically copied to the Hadoop cluster during job submission.

Applies to Hadoop

DATABASE="*database-name*"
specifies the name of the Teradata database.

Default "" (a zero-length string)

Applies to Teradata

Note This option provides the connection option that names the Teradata database to be accessed.

DBMAXTEXT=*number-of-bytes*
specifies the maximum number of bytes to allocate for STRING data type columns. This option does not apply to CHAR or VARCHAR columns.

Default 32767

Range 1–32767

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.4 and SAS 9.4M6.

EPOPTIONS="*options-string*"
specifies the options that are passed to the SAS_SCORE_EP stored procedure that invokes the SAS Embedded Process for Teradata.

Applies to Teradata

Note The string specified by this parameter is passed directly to the SAS_SCORE_EP stored procedure via the stored procedure's OPTIONS parameter.

FORCEOVERWRITE=YES | NO
specifies whether to force deletion of the output data directory before running the Hadoop MapReduce job.

Applies to Hadoop

HIVEPORT=*integer*
specifies the Hive server port number.

Applies to Hadoop

INDATASET="*input-dataset*"
specifies the name of the Spark dataset passed as input to the SAS Embedded Process.

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.5 (August 2021 release, or earlier if you apply a hot fix).

Requirement When running a model in Hadoop, either INDATASET, INHDMD, or INTABLE must be specified.

See INHDMD= option

INTABLE= option

INHDMD="*file-path*"
specifies the name of the input Hadoop metadata file on HDFS.

Applies to Hadoop

Requirement When running a model in Hadoop, either INDATASET, INHDMD, or INTABLE must be specified.

See INDATASET= option

INTABLE= option

INQUERY="*sql-query*"
specifies an SQL SELECT statement that defines the inputs to the SAS Embedded Process for Teradata.

Applies to Teradata

Requirement When running a model in Teradata, either INTABLE or INQUERY must be specified.

See INTABLE= option

INTABLE="*input-table*" | "*caslib.input-table*" | "*schema.input-table*"
specifies the name of the input table.

Alias INPUTTABLE=

Applies to CAS

Hadoop

Teradata

Requirement When running a model in Hadoop, either INDATASET, INHDMD, or INTABLE must be specified. When running a model in Teradata, either INTABLE or INQUERY must be specified.

Note The input table can be specified as a one-part or a two-part name. When running a model in CAS, the first part of a two-part name is interpreted as the name of the caslib that contains the input table. When running a model in Teradata, the first part of a two-part name is interpreted as the name of the database schema that contains the input table.

See INDATASET= option

INHDMD= option

INQUERY= option

JOBMANAGEMENTURL="*rest-url*"
specifies the URL used to submit execution requests over a REST interface to services such as Apache Livy.

Alias RESTURL=

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.5 (August 2021 release, or earlier if you apply a hot fix).

KEEPLISTCOLUMNS="*column-1* <*column-2* ... >"
KEEPLISTCOLUMNS=(*column-1* <*column-2* ... >)
KEEPLISTCOLUMNS=("*column-1*" <"*column-2*" ... >)
specifies the name of the column (or columns) to be kept by the DS2 program.

Alias KEEPLISTCOLS=

Applies to Hadoop

Interaction The parameters KEEPLISTFILE and KEEPLISTCOLUMNS are mutually exclusive.

KEEPLISTFILE="*file-path*"
specifies the name of the file that contains a list of columns to be kept by the DS2 program.

Applies to Hadoop

Interaction The parameters KEEPLISTFILE and KEEPLISTCOLUMNS are mutually exclusive.

MODELDIR="*model-directory*"
specifies the root HDFS folder where the model directory is created.

Applies to Hadoop

OUTDATASET="*output-dataset*"
specifies the name of the output Spark dataset to be created by the SAS Embedded Process.

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.5 (August 2021 release, or earlier if you apply a hot fix).

Requirement When running a model in Hadoop, either OUTDATASET, OUTHDMD, or OUTTABLE must be specified.

See OUTHDMD= option

OUTTABLE= option

OUTHDMD="*file-path*"
specifies the name of the output Hadoop metadata file that is created by the SAS Embedded Process.

Applies to Hadoop

Requirement When running a model in Hadoop, either OUTDATASET, OUTHDMD, or OUTTABLE must be specified.

See OUTDATASET= option

OUTTABLE= option

OUTKEY=(*column*, ..., *column*)
specifies the name of one or more columns used for the primary index of the output table that is created by the SAS Embedded Process for Teradata.

Applies to Teradata

OUTPUTFOLDER="*directory-path*"
specifies the name of the directory where the output files are stored.

Applies to Hadoop

OUTPUTFORMATCLASS="*class-name*"
specifies the name of the output format class in dot notation that is used to write the output records.

Applies to Hadoop

OUTRECORDFORMAT=BINARY | DELIMITED
specifies the format of the output record that is produced by the SAS Embedded Process for Hadoop.

BINARY
specifies that the output record is binary.

DELIMITED
specifies that the output record is delimited.

Default DELIMITED

Applies to Hadoop

OUTSCHEMA="*output-schema*"
specifies the Hive output database schema name when running a model in Hadoop.

Applies to Hadoop

OUTTABLE="*output-table*" | "*caslib.output-table*" | "*schema.output-table*"
specifies the name of the output table.

Alias OUTPUTTABLE=

Applies to CAS

Hadoop

Teradata

Requirement When running a model in Hadoop, either OUTDATASET, OUTHDMD, or OUTTABLE must be specified.

Note The output table can be specified as a one-part or a two-part name. When running a model in CAS, the first part of a two-part name is interpreted as the name of the caslib that contains the output table. When running a model in Teradata, the first part of a two-part name is interpreted as the name of the database schema that contains the output table.

See OUTDATASET= option

OUTHDMD= option

OUTTABLEOPTIONS="*options-string*"
provides user-specified options that are appended to the Hive CREATE TABLE statement.

Applies to Hadoop

PASSWORD="*password*"
is the password for the user ID on the Hadoop or Teradata server.

Aliases PASS=

PASSWD=

PWD=

Applies to Hadoop

Teradata

PLATFORM=MAPRED | SPARK
specifies the platform where the Hadoop Embedded Process is to be executed.

MAPRED
specifies to run the model in MapReduce.

SPARK
specifies to run the model in Spark.

Interaction If PLATFORM is set to SPARK, you must specify the CONFIGPATH option.

Default MAPRED

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.4 and SAS 9.4M6.

PROPERTIES="*name1=value*" <PROPERTIES="*name2=value*"> | PROPERTIES=("*name=value*"<, "*name=value*", ...>)

specifies a Hadoop configuration property as a name-value pair. For multiple properties, specify multiple PROPERTIES arguments or specify a single argument containing a comma-separated list of name-value pairs enclosed in parentheses. Any Hadoop configuration property can be assigned using this option.

If multiple properties are required, then the PROPERTIES parameter can also be specified multiple times, once for each property.

Applies to Hadoop

Requirement If your output is to a Hive table and the Hive database folder is under an HDFS encrypted zone, you must set the SAS Embedded Process temporary folder to a location that is under the same encrypted zone. To do this, set the sas.ep.tempdir configuration property. Here is an example:

```
properties="sas.ep.tempdir=yourSASEPTemporaryFolder"
```

SCHEMA="*schema-name*"

specifies the name of the Teradata schema.

Applies to Teradata

Note This option provides the connection option that the Teradata database uses to qualify the Teradata tables.

SENDPROGRAM=YES | NO

specifies whether the model program source code should be sent back to the client and displayed for the user.

Applies to CAS

SERVER="*server*"

specifies the name of the Teradata or Hive server.

Applies to Hadoop

Teradata

TARGET=CAS | HADOOP | TERADATA

specifies the target environment to which the model is published.

CAS

specifies to publish to a model table in CAS.

HADOOP

specifies to publish to the Hadoop server.

TERADATA

specifies to publish to a model table in the Teradata database.

Default CAS

Applies to CAS

Hadoop

Teradata

TRACE
runs the SAS Embedded Process for Hadoop with traces on.

Applies to Hadoop

USERNAME='*id*'
is an authorized user ID on the Hadoop or Teradata server.

Aliases USER=

USERID=

UID=

Applies to Hadoop

Teradata

VERBOSE
specifies that the SAS Embedded Process for Hadoop provide additional logging information.

Applies to Hadoop

WEBHDFSURL="*webhdfs-url*"
specifies the URL used to access the Hadoop distributed file system through the REST API.

Applies to Hadoop

Restriction This option is available as of SAS Viya 3.5 (August 2021 release, or earlier if you apply a hot fix).

Note Use this argument when you delete, publish, or run a model in a platform that is configured to access the distributed file system through the REST API.

Examples: SCOREACCEL Procedure

Example 1: Publishing, Running, and Deleting a DATA Step Model in CAS

Features:
PROC SCOREACCEL statement
PUBLISHMODEL statement
RUNMODEL statement
DELETEMODEL statement
CASLIB LIBNAME statement

Details

In this PROC SCOREACCEL example, a DATA step model is published and run in CAS. The model is then deleted.

PROC SCOREACCEL translates DATA step code into DS2 code on the SAS client.

Program

```
cas mysess1;
libname mycaslib cas casref=mysess1;

proc delete data=mycaslib.model01_score_data; run;
libname eminput "/mydir/scoring/model01";
data mycaslib.model01_score_data;
   set eminput.traindata;
   id=_n_; run;
quit;

proc scoreaccel sessref=mysess1;
   publishmodel
      modelname="model01"
      modeltype=datastep
      modeltable="modeltable1"
      programfile="/mydir/scoring/model01/score.sas"
      xmlfile="/mydir/scoring/model01/score.xml"
```

```
      outdir="/user1/score/work/"
      modelnotes="Simple model01 test model"
      replacemodel=yes
      promotetable=no
      persisttable=no
      ;
quit;

proc delete data=mycaslib.model01out_data run;
proc scoreaccel sessref=mysess1;
   runModel
      modelname="model01"
      modeltable="modeltable1"
      intable="model01_score_data"
      outtable="model01_out_data"
      ;
quit;

proc scoreaccel sessref=mysess1;
   deletemodel
      modelname="model01"
      modeltable="modeltable1"
      ;
quit;
```

Program Description

Assign a CAS LIBNAME. The CAS LIBNAME is passed to the DATA step in PROC DELETE.

```
cas mysess1;
libname mycaslib cas casref=mysess1;
```

Create an input scoring table in CAS. The DELETE procedure removes an existing input scoring table.

```
proc delete data=mycaslib.model01_score_data; run;
libname eminput "/mydir/scoring/model01";
data mycaslib.model01_score_data;
   set eminput.traindata;
   id=_n_; run;
quit;
```

Publish a model in CAS. The DATA step model is converted to DS2 in this step and is published in CAS.

```
proc scoreaccel sessref=mysess1;
   publishmodel
      modelname="model01"
      modeltype=datastep
      modeltable="modeltable1"
      programfile="/mydir/scoring/model01/score.sas"
      xmlfile="/mydir/scoring/model01/score.xml"
      outdir="/user1/score/work/"
      modelnotes="Simple model01 test model"
      replacemodel=yes
      promotetable=no
```

```
      persisttable=no
      ;
quit;
```

Run the model in CAS. The DELETE procedure removes an existing CAS table before running the model.

```
proc delete data=mycaslib.model01out_data run;
proc scoreaccel sessref=mysess1;
   runModel
      modelname="model01"
      modeltable="modeltable1"
      intable="model01_score_data"
      outtable="model01_out_data"
      ;
quit;
```

Delete the model from the model table in CAS. T

```
proc scoreaccel sessref=mysess1;
   deletemodel
      modelname="model01"
      modeltable="modeltable1"
      ;
quit;
```

Example 2: Publishing, Running, and Deleting a DS2 Model in Teradata

Features:

PROC SCOREACCEL statement

PUBLISHMODEL statement

RUNMODEL statement

DELETEMODEL statement

Details

This PROC SCOREACCEL example publishes and runs a DS2 Model in Teradata. PROC SCOREACCEL invokes the Model publishing or DS2 actions in CAS to delete a model, publish a model, or run a model.

Program

```
libname mytdlib teradata server=mytdserver user=model password=XXXXX
   database=model;

proc delete data=mytdlib.model01_score_data; run;
```

```
libname eminput "/mydir/scoring/model01";
data mytdlib.model01_score_data;
   set eminput.traindata;
   id=_n_; run;
quit;

proc scoreaccel sessref=mysess1;
   publishmodel
      target=teradata
      modelname="model01"
      modeltype=DS2
      modeltable="modeltable1"
      programfile="/mydir/scoring/model01/score.ds2"
      modelnotes="Simple model01 test model"
      username="model"
      password="XXXXX"
      server="mytdserver"
      database="model"
      replacemodel=yes
   ;
quit;

proc scoreaccel sessref=mysess1;
   runmodel
      target=teradata
      modelname="model01"
      modeltable="modeltable1"
      intable="model01_score_data"
      outtable="model01_out_data"
      outkey="id"
      username="model"
      password="XXXXX"
      server="mytdserver"
      database="model"
      ;
   quit;

proc scoreaccel sessref=mysess1;
   deletemodel
      target=teradata
      modelname="model01"
      modeltable="modeltable1"
      authdomain="indb"
      server="mytdserver"
      database="model"
      ;
   quit;
```

Program Description

Create the Teradata LIBNAME reference. The Teradata libref is needed for PROC DELETE and the DATA step program.

```
libname mytdlib teradata server=mytdserver user=model password=XXXXX
   database=model;
```

Create an input scoring table in CAS. The DELETE procedure removes an existing input scoring table.

```
proc delete data=mytdlib.model01_score_data; run;
libname eminput "/mydir/scoring/model01";
data mytdlib.model01_score_data;
   set eminput.traindata;
   id=_n_; run;
quit;
```

Publish a DS2 model to Teradata. The PROGRAMFILE statement contains the DS2 model.

```
proc scoreaccel sessref=mysess1;
   publishmodel
      target=teradata
      modelname="model01"
      modeltype=DS2
      modeltable="modeltable1"
      programfile="/mydir/scoring/model01/score.ds2"
      modelnotes="Simple model01 test model"
      username="model"
      password="XXXXX"
      server="mytdserver"
      database="model"
      replacemodel=yes
   ;
quit;
```

Run the DS2 model in Teradata.

```
proc scoreaccel sessref=mysess1;
   runmodel
      target=teradata
      modelname="model01"
      modeltable="modeltable1"
      intable="model01_score_data"
      outtable="model01_out_data"
      outkey="id"
      username="model"
      password="XXXXX"
      server="mytdserver"
      database="model"
      ;
   quit;
```

Delete the model from the model table in Teradata.

```
proc scoreaccel sessref=mysess1;
   deletemodel
      target=teradata
      modelname="model01"
      modeltable="modeltable1"
      authdomain="indb"
      server="mytdserver"
      database="model"
      ;
   quit;
```

Example 3: Publishing and Running a DATA Step Model in Teradata Using a CASLIB

Features: PROC SCOREACCEL statement
PUBLISHMODEL statement
RUNMODEL statement
CASLIB LIBNAME statement
CAS procedure

Details

In this PROC SCOREACCEL example, a DATA step model is published and run in CAS. PROC SCOREACCEL translates DATA step code into DS2 code on the SAS client. Here, the user credentials and other database connection information is pulled from the specified CASLIB.

Program

```
libname mytdlib teradata server=mytdserver user=model password=XXXXX
   database=model;

proc delete data=mytdlib.model01_score_data; run;

libname eminput "/mydir/scoring/model01";
data mytdlib.model01_score_data;
   set eminput.traindata;
   id=_n_; run;
quit;

proc cas;
   session mysess1;
   action addCaslib /
       caslib="tdlib1"
       datasource={
       srcType="teradata",
       dataTransferMode="parallel",
       server="mytdserver",
       username="model",
       password="XXXXX",
       database="model"
   };
run;

proc scoreaccel sessref=mysess1;
```

```
   publishmodel
      target=teradata
      modelname="model01"
      modeltype=datastep
      modeltable="modeltable1"
      programfile="/mydir/scoring/model01/score.sas"
      xmlfile="/mydir/scoring/model01/score.xml"
      outdir="/score/work/"
      modelnotes="Simple model01 test model"
      replacemodel=yes
      ;
   runmodel
      target=teradata
      caslib="tdlib1"
      modelname="model01"
      modeltable="modeltable1"
      intable="model01_score_data"
      outtable="model01_out_data"
      outkey="id"
      ;
   quit;
```

Program Description

Create the Teradata connection options and LIBNAME reference.

```
libname mytdlib teradata server=mytdserver user=model password=XXXXX
   database=model;
```

Create an input scoring table in Teradata. PROC DELETE removes an existing input scoring table.

```
proc delete data=mytdlib.model01_score_data; run;

libname eminput "/mydir/scoring/model01";
data mytdlib.model01_score_data;
   set eminput.traindata;
   id=_n_; run;
quit;
```

Define a Teradata caslib. The addCaslib action adds a CAS library to the current mysess1 session.

```
proc cas;
   session mysess1;
   action addCaslib /
       caslib="tdlib1"
       datasource={
       srcType="teradata",
       dataTransferMode="parallel",
       server="mytdserver",
       username="model",
       password="XXXXX",
       database="model"
   };
run;
```

Publish and run the DATA step model in Teradata.

```
proc scoreaccel sessref=mysess1;
   publishmodel
      target=teradata
      modelname="model01"
      modeltype=datastep
      modeltable="modeltable1"
      programfile="/mydir/scoring/model01/score.sas"
      xmlfile="/mydir/scoring/model01/score.xml"
      outdir="/score/work/"
      modelnotes="Simple model01 test model"
      replacemodel=yes
      ;
   runmodel
      target=teradata
      caslib="tdlib1"
      modelname="model01"
      modeltable="modeltable1"
      intable="model01_score_data"
      outtable="model01_out_data"
      outkey="id"
      ;
   quit;
```

Example 4: Publishing and Running a Model in Hadoop

Features: PROC SCOREACCEL statement
PUBLISHMODEL statement
RUNMODEL statement

Details

In this PROC SCOREACCEL example, a simple DS2 model is published and run in Hadoop.

Program

The CLASSPATH option specifies a link to the Hadoop cluster.

```
proc scoreaccel sessref=mysess1;
   publishmodel
      target=hadoop
      modelname="simple01"
```

```
      modeltype=DS2
      programfile="/score/simple/simple.ds2"
      username="test"
      password="XXXXX"
      modeldir="/data/model/dlm/ds2"
      classpath="/server/sdm/hadoopjars/cdh58/prod:
                 /server/sdm/hadoopcfg/cdh58/prod";
   ;
quit;
proc scoreaccel sessref=mysess1;
   runmodel
      target=hadoop
      modelname="simple01"
      username="test"
      password="XXXXX"
      modeldir="/data/model/dlm/ds2"
      server="server1.com"
      inhdmd="/data/model/dlm/meta/simple01sashdmd"
      outhdmd="/data/model/dlm/meta/simple01_out.sashdmd"
      outputfolder="/data/model/dlm/temp/simple01"
      forceoverwrite=yes
      classpath="/server/sdm/hadoopjars/cdh58/prod:
                 /user1/server/sdm/hadoopcfg/cdh58/prod";
      ;
quit;
```

Example 5: Publishing and Running a Model in Hadoop (Hive)

Features: PROC SCOREACCEL statement
PUBLISHMODEL statement
RUNMODEL statement

Details

In this PROC SCOREACCEL example, a simple DS2 model is published to Hadoop and executed there with Hive.

Program

The classpath statement specifies a link to the Hadoop cluster. The input and output tables, *carsorc* and *carsout*, already exist on the Hadoop cluster.

```
proc scoreaccel sessref=mysess1;
```

```
   publishmodel
      target=hadoop
      modelname="simple01"
      modeltype=DS2
      filelocation=local
      programfile="/user1/score/simple/simple.ds2"
      username="test"
      modeldir="/user/user1/cas/models"
      classpath="/server/sdm/hadoopjars/cdh58/prod:
                 /user1/server/sdm/hadoopcfg/cdh58/prod";
      ;
   runmodel
      target=hadoop
      modelname="simple01"
      username="test"
      modeldir="/user/user1/cas/models"
      server="server2.com"
      intable="carsorc"
      outtable="carsout"
      outtableoptions="stored as ORC"
      forceoverwrite=yes
      classpath="/server/sdm/hadoopjars/cdh58/prod:
                 /user1/server/sdm/hadoopcfg/cdh58/prod";
      ;
quit;
```

Example 6: Running a Model in Spark

Features: PROC SCOREACCEL statement
RUNMODEL statement

Details

In this PROC SCOREACCEL example, a DS2 model is run in Spark with the SAS Embedded Process.

Program

To run in Spark, the cluster must have Spark installed and configured. When the Hadoop tracer script is run to collect JAR files, the **spark** folder is created along with the required Spark JAR files. During this process, the Spark configuration file is placed into the user's configuration folder. To run the model in Spark, specify the PLATFORM=SPARK option in the RUNMODEL statement. To run the model, the folder containing the client-side Spark JAR files must be specified last in the

CLASSPATH option. In this example, the input and output tables, *carsorc* and *carsout*, already exist on the Hadoop cluster.

```
proc scoreaccel sessref=mysess1;
runmodel
    target=hadoop
    modelname="cars"
    username="test"
    modeldir="/user1/cas/models"
    server="server2.com"
    intable="carsorc"
    outtable="carsout"
    forceoverwrite=yes
    classpath="/nfs/hadoop/jars"
    configpath="/nfs/hadoop/cfg"
    platform=SPARK
    ;
  quit;
```

Example 7: Running a Model in Spark by Using the Apache Livy REST Interface

Features:

CASLIB statement
CAS procedure
PROC SCOREACCEL statement
PUBLISHMODEL statement
RUNMODEL statement

Details

In this example, PROC SCOREACCEL publishes and runs a model in Spark. The request to run the model is submitted by using the Apache Livy REST service.

Create a CAS session, and assign a caslib to Spark. A best practice is to specify all the connection properties in the caslib, so that you do not have to remember which connection properties are required by the different actions and statements.

```
cas mysess;

caslib myspark datasource=(srctype='spark',
       schema="model",
       username="myuser",
       password="mypwd",
       jobmanagementurl="https://nnnnn.cloud.company.com/cdp-proxy-api/
livy/",
       server="cloud.company.com",
```

```
      hadoopJarPath="path-to-hadoop-jar-files",
      hadoopConfigDir="path-to-hadoop-configuration",
      dbmaxtext=512);
```

Start the SAS Embedded Process for Spark continuous session. Most customers choose to use a continuous session for better performance.

```
proc cas;
   sparkEmbeddedProcess.startSparkEP
   caslib="myspark";
run;
quit;
```

Publish a model to Spark.

```
proc scoreaccel sessref=mysess;
   publishmodel
      target=hadoop
      caslib="myspark"
      modelname="mymodel"
      programfile="/mydir/myscorefile.ds2"
      modeldir="/user/dir"
      replacemodel=yes;
run;
quit;
```

Run the model in Spark. The INTABLE= option specifies the input Spark table that contains the data to run the model against.

```
proc scoreaccel sessref=mysess;
   runmodel
      target=hadoop
      caslib="myspark"
      modelname="mymodel"
      modeldir="/user/dir"
      intable="mytable"
      outtable="mytable_out"
      forceoverwrite=yes;
run;
quit;
```

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SOAP Procedure

Overview: SOAP Procedure

What Does the SOAP Procedure Do?

The Simple Object Access Protocol (SOAP) procedure reads XML input from a file that has a fileref and writes XML output to another file that has a fileref. The message component, an XML document that corresponds to a service request, is part of the content of the fileref. It is defined in the IN option of PROC SOAP. The input XML is either a SOAPEnvelope element, or an element inside the SOAPEnvelope that is required to invoke the web service.

For information about using PROC SOAP to invoke web services, see *SAS BI Web Services: Developer's Guide*.

Concepts: SOAP Procedure

Concepts: SOAP Procedure

With PROC SOAP, you can include an optional SOAPEnvelope element in your XML file. Do this if you want to include custom information in the SOAPHeader element. A SOAP envelope wraps the message, which has an application-specific message vocabulary. The SOAPHeader content is added to the actual SAS registered web service request. This addition occurs because there could be additional SOAPHeader elements that were not included in the XML file that was passed to PROC SOAP. The XML code that is transmitted might not exactly match the XML code provided in this case.

Examples of additional elements that might be included are those for WS-Security or WS-Addressing. Web Services Security (WS-Security) is a specification that defines how security measures are implemented in web services to protect them from external attacks. It is a set of protocols that ensure security for SOAP-based messages by implementing the principles of confidentiality, integrity, and authentication. WS-Addressing is a standard for adding addressing information to SOAP messages. For more information, see Overview of Security for Web Services.

A request does not need to be contained in a SOAP envelope. An envelope is added if you do not specify an envelope. If an envelope is specified, it is incorporated into the envelope that is sent. A response is returned within an envelope only if the envelope property is set. The default behavior is to return only the contents of the envelope.

You can set the amount of time to wait for a response from the web service by using the CONFIGFILE option. The default time to wait is 60 seconds.

Requests must not include an encoding declaration even if the envelope is included. If the request is being read from a file, the file must be encoded in the same encoding as the session encoding. Requests are encoded as UTF-8 before being sent to the web service.

z/OS Specifics: Calling SAS registered services is not available in the z/OS operating environment. SAS registered web services require WS-Security with Password Digest, and Password Digest is not supported on z/OS.

Syntax: SOAP Procedure

Restrictions: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

When SAS is in a locked-down state, the SOAP procedure is not available. Your server administrator can re-enable this procedure so that it is accessible in the lockdown state. When the FILENAME URL access method is re-enabled by using the LOCKDOWN ENABLE_AMS = statement, the SOAP procedure is automatically re-enabled. For more information, see "SAS Processing Restrictions for Servers in a Locked-Down State" in *SAS Programmer's Guide: Essentials*.

See: "LOCKDOWN Statement" in *SAS Intelligence Platform: Application Server Administration Guide*

Locked-Down Servers

PROC SOAP *options* <*properties*>;

Statement	Task	Example
PROC SOAP	Invoke a Web Service By Using a Proxy and Using PROC SOAP with a SOAPEnvelope Element	Ex. 1
	Invoke a Web Service By Using a Proxy and Using PROC SOAP without a SOAPEnvelope Element	Ex. 2
	Add numbers using Online Calculator	Ex. 3

PROC SOAP Statement

Invokes a web service through Java Native Interface (JNI).

Syntax

PROC SOAP *options* <*properties*>;

Summary of Optional Arguments

CONFIGFILE
: sets the time-out limit for web service calls.

DEBUG
: specifies an output log file.

ENVFILE
: specifies the location of the SAS environments file.

ENVIRONMENT
: specifies that you use the environment that is defined in the SAS environments file.

MUSTUNDERSTAND
: specifies the setting for the mustUnderstand attribute.

OUT=*fileref 'your-output-file'*
: specifies a fileref for response output.

PROXYDOMAIN
: specifies an HTTP proxy server domain.

PROXYHOST
: specifies an HTTP proxy server host name.

PROXYPASSWORD
: specifies an HTTP proxy server password.

PROXYPORT
: specifies an HTTP proxy server port.

PROXYUSERNAME
: specifies an HTTP proxy server user name.

SOAPACTION
: specifies a SOAPAction element.

SRSURL
: specifies the URL of the System Registry Service.

WEBAUTHDOMAIN
: specifies user name and password retrieval from metadata.

WEBDOMAIN
: specifies the domain or realm for a user name and password.

WEBPASSWORD
: specifies a password for web service authentication.

WEBUSERNAME
: specifies a user name for web service authentication.

WSSAUTHDOMAIN
: specifies that the active connection to the SAS Metadata Server is used to retrieve credentials.

WSSPASSWORD
: specifies a WS-Security password.

WSSUSERNAME
: specifies a WS-Security user name.

Required Arguments

IN=*fileref* '*your-input-file*'
specifies the fileref that is used to input XML data that contains a PROC SOAP request.

The fileref might have SOAPEnvelope and SOAPHeader elements as part of its content, but they are not required unless you have specific header information to provide.

SERVICE
specifies the SAS registered web service that you want to call.

Tip If you use the SERVICE option, then do not use the URL option.

URL
specifies the URL of the web service endpoint.

Tip If you use the URL option, then do not use the SERVICE option.

Optional Arguments

CONFIGFILE
enables you to set the time-out limit for web service calls. The default time-out is 60 seconds.

DEBUG
enables you to specify an output log file. The debug option turns on wire logging for httpclient and writes the output to the specified file. The value of this option is the path or filename to the desired output.

ENVFILE
specifies the location of the SAS environments file.

ENVIRONMENT
specifies to use the environment that is defined in the SAS environments file.

MUSTUNDERSTAND
specifies the setting for the mustUnderstand attribute in the PROC SOAP header.

OUT=*fileref* '*your-output-file*'
specifies the fileref where the PROC SOAP XML response output is written.

PROXYDOMAIN
specifies an HTTP proxy server domain.

Tip This option is required only if your proxy server requires domain- or realm-qualified credentials.

PROXYHOST
specifies an HTTP proxy server host name.

PROXYPASSWORD
specifies an HTTP proxy server password. Encodings that are produced by PROC PWENCODE are supported.

Tip This option is required only if your proxy server requires credentials.

PROXYPORT
specifies an HTTP proxy server port.

PROXYUSERNAME
specifies an HTTP proxy server user name.

Tip This option is required only if your proxy server requires credentials.

SOAPACTION
specifies a SOAPAction element to invoke on the web service.

SRSURL
specifies the URL of the System Registry Service.

WEBAUTHDOMAIN
specifies that a user name and password be retrieved from metadata for the specified authentication domain.

WEBDOMAIN
specifies the domain or realm for the user name and password.

WEBPASSWORD
specifies a password for basic web service authentication. Encodings that are produced by PROC PWENCODE are supported.

WEBUSERNAME
specifies a user name for basic web service authentication.

WSSAUTHDOMAIN
specifies that the active connection to the SAS Metadata Server is used to retrieve credentials in the specified authentication domain.

If credentials are found, they are used as the credentials for a WS-Security UsernameToken.

WSSUSERNAME
specifies a WS-Security user name. If a value is set, then WS-Security is used and a UsernameToken is sent with the web service request for user authentication, security, and encryption.

WSSPASSWORD
specifies a WS-Security password that is the password for WSSUSERNAME. Encodings that are produced by PROC PWENCODE are supported.

Properties

ENVELOPE
specifies that a SOAP envelope is to be included in the response.

Usage: SOAP Procedure

Using PROC SOAP with Transport Layer Security (TLS)

TLS and Data Encryption

Transport Layer Security (TLS) enables web browsers and web servers to communicate over a secured connection by encrypting data. Both browsers and servers encrypt data before the data is transmitted. The receiving browser or server then decrypts the data before it is processed. Because PROC SOAP invokes a web service using the Java Native Interface, JREOPTIONS need to be specified either on the command line or in a configuration file to configure a TLS connection.

Note: All discussion of TLS is also applicable to the predecessor protocol, Secure Sockets Layer (SSL).

When you require client authentication, TLS has a renegotiation feature that prevents unauthorized text from being added to the beginning or end of an encrypted data stream. This feature is specifically used by certificate-based client authentication. This feature disables TLS renegotiation in the Java Secure Sockets Extension (JSSE) by default. As a result, when you attempt to access a web resource that requires certificate-based client authentication through the interception proxy, the following Java TLS error message is generated:

```
(javax.net.ssl.SSLException): HelloRequest followed by
an unexpected handshake message
```

However, it is still possible to enable the TLS renegotiation in Java by setting the following system property to true before the JSSE library is initialized.

```
sun.security.ssl.allowUnsafeRenegotiation
```

Making PROC SOAP Calls By Using the HTTPS Protocol

In order to make PROC SOAP calls using the HTTPS protocol, you must have a truststore that contains the certificates for the services that you trust. This truststore must be provided to the SAS session by setting Java system option Djavax.net.ssl.trustStore.

Clients must ensure that the CA that signed the certificate has been added to their truststore. You can provide the path to the truststore on the SAS command line or in a SAS configuration file using JREOPTIONS.

```
-jreoptions (-Djavax.net.ssl.trustStore=full-path-to-the-trust-store)
```

Note: As a best practice, anytime that you are using passwords in configuration files, use file system permissions that allow write only access by the owner of the SAS or SAS Viya deployment. By default, the owner is "sas".

Here is an example using the SAS command line. The example uses the Windows operating environment.

Note: Add the following entry on one line.

```
"C:\Program Files\SAS\SASFoundation\9.4\sas.exe" -CONFIG "C:\Program
Files\SAS\SASFoundation\9.4\nls\en\SASV9.CFG" -jreoptions
(-Djavax.net.ssl.trustStore=C:\Documents and Settings\mydir\.keystore)
```

Here is an example of how to specify the JREOPTIONS in the sasv9.cfg file.

Note: Add the system option and value on one line.

```
-JREOPTIONS (-Djavax.net.ssl.trustStore=
!SASHOME/../config/etc/SASSecurityCertificateFramework/
cacerts/trustedcerts.jks)
```

Methods of Calling SAS Registered Web Services

You can use two methods to call SAS registered web services. The first method requires that you know the URL of the Service Registry Service and the URL of the endpoint of the service that you are calling. You must set the URL of the Service Registry Service on the SRSURL option. The URL option indicates the endpoint of the service that you are calling.

The second method that is used to call SAS registered web services uses the SAS environments file to specify the endpoint of the service that you are calling. Using

this method, you can indicate the location of the SAS environments file in one of two ways:

- use the ENVFILE option in PROC SOAP
- define the Java property **env.definition.location** in JREOPTIONS on the SAS command line or in the SAS configuration file

Use the following –JREOPTIONS syntax:

```
-jreoptions (-Denv.definition.location=http://your-SAS-environment.xml)
```

You must also specify the desired environment within that file using the ENVIRONMENT option, and specify the name of the service that you are calling using the SERVICE option.

In both cases, the WSUSERNAME and WSPASSWORD options are set to the user name and password that are required to contact the Security Token Service.

Calling a SAS Secured Service without Providing Credentials

You can use the SRSURL, ENVFILE, or ENVIRONMENT options to call a SAS secured service without having to supply a set of credentials. In this case, you do not need to use the WSSUSERNAME, WSSPASSWORD, or WSSAUTHDOMAIN options. This functionality eliminates the need to store user credentials in metadata and reduces the flow of credentials across the network. A connection to the metadata server is required. Credentials that are valid for a single use are generated for the user that is connected to the metadata server.

Specifying an Output Log File

The log file contains HTTP headers and data that are transmitted to and from servers when transmitting the HTTP request in PROC SOAP. You use the log file that is created with the DEBUG option to log debug output.

PROC SOAP uses log4j for logging requests and responses so that you can trace them. To create a log file that contains the request issued and the response received, create a file that has the following contents:

```
log4j.appender.FILE=org.apache.log4j.FileAppender
log4j.appender.FILE.File=wire.log
log4j.appender.FILE.layout=org.apache.log4j.PatternLayout
log4j.appender.FILE.layout.ConversionPattern =%d %5p [%c] %m%n

log4j.logger.httpclient.wire=DEBUG, FILE
```

To turn on logging to see the SOAP request and response for an entire SAS session, you must restart SAS with the –jreoptions command line option. Enable logging by setting a Java system option using –jreoptions on the SAS command line or in a SAS configuration file. The following syntax shows how to set the system option:

```
-jreoptions (-Dlog4j.configuration=path-to-log4j-config-file)
```

The following example shows how to use the entry on the SAS command line. The example uses the Windows operating environment.

Note: Add entry on one line.

```
"C:\Program Files\SAS\SASFoundation\9.2\sas.exe" -CONFIG
"C:\ProgramFiles\SAS\SASFoundation\9.2\nls\en\SASV9.CFG"
-jreoptions(- Dlog4j.configuration=file:/c:/public/log4j.properties)
```

Using the configuration file and JREOPTIONS method described above turns on logging for the entire SAS session. To turn on httpclient.wire for an individual PROC SOAP call, use the DEBUG option.

You can use the DEBUG option to turn on wire logging for the duration of a PROC SOAP call. The value of the DEBUG option is the path or filename to the output file.

Examples: SOAP Procedure

Example 1: Using a Proxy and PROC SOAP with a SOAPEnvelope Element

Details

This example uses a proxy and a SOAPEnvelope element.

Program

```
filename REQUEST temp;
filename RESPONSE temp;
data _null_;
   file request;
   input;
   put _infile_;
   datalines4;
```

```
<soapenv:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xmlns:xsd="http://www.w3.org/2001/XMLSchema"
         xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/"
         xmlns:soap="http://www.SoapClient.com/xml/SoapResponder.xsd">
<soapenv:Header/>
<soapenv:Body>
   <soap:Method1
         soapenv:encodingStyle="http://schemas.xmlsoap.org/soap/
encoding/">
         <bstrParam1 xsi:type="xsd:string">apple</bstrParam1>
         <bstrParam2 xsi:type="xsd:string">zebra3</bstrParam2>
   </soap:Method1>
</soapenv:Body>
</soapenv:Envelope>
;;;;

run;

proc soap in= request
          out= response
          url="http://soapclient.com/xml/soapresponder.wsdl"
          soapaction="http://www.SoapClient.com/SoapObject"
          proxyhost="proxygw.unx.sas.com"
          proxyusername="soaptest"
          proxypassword="testpw"
          proxyport=80;
run;
```

Example 2: Using a Proxy and PROC SOAP without a SOAPEnvelope Element

Details

This example uses a proxy and does not use a SOAPEnvelope element.

Program

```
filename REQUEST temp;
filename RESPONSE temp;
data _null_;
   file request;
   input;
   put _infile_;
   datalines4;
```

```
<soap:Method1 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xmlns:xsd="http://www.w3.org/2001/XMLSchema"
      xmlns:soap="http://www.SoapClient.com/xml/SoapResponder.xsd"
      encodingStyle="http://schemas.xmlsoap.org/soap/encoding/">
      <bstrParam1 xsi:type="xsd:string">apple</bstrParam1>
      <bstrParam2 xsi:type="xsd:string">zebra3</bstrParam2>
</soap:Method1>
;;;;

run;

proc soap in=request
          out=response
          url="http://soapclient.com/xml/soapresponder.wsdl"
          soapaction="http://www.SoapClient.com/SoapObject"
          proxyhost="proxygw.unx.sas.com"
          proxyusername="soaptest"
          proxypassword="testpw"
          proxyport=80;
run;
```

Example 3: Add Numbers Using Online Calculator

Details

This example uses the DNEONLINE Calculator to add 7 and 4.

Program

```
/*Set up filename statements to create temporary REQUEST and RESPONSE
*/
/* files. */
filename request temp;
filename response temp;

/*Create a soap request to submit to the URL (writing to filename*/
/* request above).*/
/* This request is specific to each application (ie url)in this case,
*/
/* the calculator application in DNEONLINE requires two integers that
*/
/* are added together. */
data _null_;
   file request;
```

```
   input;
   put _infile_;
   datalines4;
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/
envelope/"
                  xmlns:tem="http://tempuri.org/">
   <soapenv:Header/>
   <soapenv:Body>
      <tem:Add>
         <tem:intA>7</tem:intA>
         <tem:intB>4</tem:intB>
      </tem:Add>
   </soapenv:Body>
</soapenv:Envelope>
;;;;

/*submit the request to the url:*/
/*a response is returned via OUT=*/
proc soap
   in=request
   out=response
   url="http://www.dneonline.com/calculator.asmx"
   soapaction="http://tempuri.org/Add";
   run;
```

After running the program in SAS 9.4M6, the RESPONSE in the SAS log file shows the following result:

```
<AddResponse xmls="http://tempuri.org"><AddResult>11</AddResult></AddResponse>
```

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SORT Procedure

Overview: SORT Procedure

What Does the SORT Procedure Do?

The SORT procedure orders SAS data set observations by the values of one or more character or numeric variables. The SORT procedure either replaces the original data set or creates a new data set. PROC SORT produces only an output data set. For more information, see "Procedure Output" on page 2390.

Note: If extended attributes are defined on the input data set, PROC SORT propagates the extended attributes to the output data set. For information about extended attributes, see "Extended Attributes" on page 567.

Operating Environment Information: The sorting capabilities that are described in this chapter are available for all operating environments. In addition, if you use the HOST value of the SAS system option SORTPGM=, you might be able to use other sorting options that are available for your operating environment. For more information about other sorting capabilities, see the SAS documentation for your operating environment.

Sorting SAS Data Sets

In the following example, the original data set was in alphabetical order by last name. PROC SORT replaces the original data set with a data set that is sorted by employee identification number. The following log shows the results from running this PROC SORT step. Output 64.331 on page 2357 shows the results of the PROC PRINT step. The statements that produce the output follow:

```
proc sort data=employee;
   by idnumber;
run;

proc print data=employee;
run;
```

Example Code 64.1 SAS Log Generated by PROC SORT

```
NOTE: There were six observations read from the data set WORK.EMPLOYEE.
NOTE: The data set WORK.EMPLOYEE has six observations and three variables.
NOTE: PROCEDURE SORT used:
      real time           0.01 seconds
      cpu time            0.01 seconds
```

Output 64.1 Observations Sorted by the Values of One Variable

```
                          The SAS System                          1

                 Obs     Name          IDnumber

                  1      Belloit         1988
                  2      Wesley          2092
                  3      Lemeux          4210
                  4      Arnsbarger      5466
                  5      Pierce          5779
                  6      Capshaw         7338
```

The following output shows the results of a more complicated sort by three variables. The businesses in this example are sorted by town, then by debt from highest amount to lowest amount, then by account number. For an explanation of the program that produces this output, see "Example 2: Sorting in Descending Order" on page 2394.

Output 64.2 Observations Sorted by the Values of Three Variables

```
                    Customers with Past-Due Accounts                     1
                 Listed by Town, Amount, Account Number

                                                                Account
     Obs    Company                   Town               Debt     Number

       1    Paul's Pizza              Apex              83.00      1019
       2    Peter's Auto Parts        Apex              65.79      7288
       3    Watson Tabor Travel       Apex              37.95      3131
       4    Tina's Pet Shop           Apex              37.95      5108
       5    Apex Catering             Apex              37.95      9923
       6    Deluxe Hardware           Garner           467.12      8941
       7    Boyd & Sons Accounting    Garner           312.49      4762
       8    World Wide Electronics    Garner           119.95      1122
       9    Elway Piano and Organ     Garner            65.79      5217
      10    Ice Cream Delight         Holly Springs    299.98      2310
      11    Tim's Burger Stand        Holly Springs    119.95      6335
      12    Strickland Industries     Morrisville      657.22      1675
      13    Pauline's Antiques        Morrisville      302.05      9112
      14    Bob's Beds                Morrisville      119.95      4998
```

Concepts: SORT Procedure

Threaded Sorting

The THREADS system option enables threaded sorting. Threaded sorting achieves a degree of parallelism in the sorting operations. This parallelism is intended to reduce the real time to completion for a given operation and therefore limit the cost of additional CPU resources. For more information, see "Support for Parallel Processing" in *SAS Language Reference: Concepts*.

The multi-threaded SAS sort can also be invoked when you specify the THREADS option in the PROC SORT statement. The multi-threaded sort stores all temporary data in a single utility file within one of the locations that are specified by the UTILLOC= system option. The size of this utility file is proportional to the amount of data that is read from the input data set. A second utility file of the same size can be created in another of these locations when the amount of data that is read from the input data set is large or the amount of memory that is available to the SORT procedure is small. For more information, refer to "UTILLOC= System Option" in *SAS System Options: Reference*.

Note: The TAGSORT option on page 2383 does not support threaded sorting.

The multi-threaded SAS sort can be invoked when the THREAD system option is specified and the value of the CPUCOUNT= system option is greater than 1. The value of the SAS system option CPUCOUNT= affects the performance of the threaded sort. CPUCOUNT= suggests how many system CPUs are available for use by the threaded procedures.

Calculated statistics can vary slightly, depending on the order in which observations are processed. Such variations are due to numerical errors that are introduced by floating–point arithmetic, the results of which should be considered approximate and not exact. The order of observation processing can be affected by nondeterministic effects of multithreaded or parallel processing. The order of processing can also be affected by inconsistent or nondeterministic ordering of observations that are produced by a data source, such as a DBMS that delivers query results through an ACCESS engine. For more information, see "Numerical Accuracy in SAS Software" in *SAS Language Reference: Concepts* and "Threading in Base SAS" in *SAS Language Reference: Concepts*.

For more information, see the "THREADS System Option" in *SAS System Options: Reference* and the "CPUCOUNT= System Option" in *SAS System Options: Reference*.

Sorting Orders for Numeric Variables

For numeric variables, the following is the smallest-to-largest comparison sequence:

1. SAS missing values (shown as a period or special missing value)
2. negative numeric values
3. zero
4. positive numeric values

Sorting Orders for Character Variables

Default Collating Sequence

The order in which alphanumeric characters are sorted is known as the collating sequence. This sort order is determined by the session encoding.

By default, PROC SORT uses either the EBCDIC or the ASCII collating sequence when it compares character values, depending on the environment under which the procedure is running.

For more information about the various collating sequences and when they are used, see "Collating Sequence" in *SAS National Language Support (NLS): Reference Guide*.

Note: ASCII and EBCDIC represent the family names of the session encodings. The sort order can be determined by referring to the encoding.

EBCDIC Order

The z/OS operating environment uses the EBCDIC collating sequence.

The sorting order of the English-language EBCDIC sequence is consistent with the following sort order example.

Table 64.1 EBCDIC Sort Order Example

blank . < (+ | & ! $ *) ; ¬ - / , % _ > ? : # @ ' = "
a b c d e f g h i j k l m n o p q r ~ s t u v w x y z
{ A B C D E F G H I } J K L M N O P Q R \ S T
U V W X Y Z
0 1 2 3 4 5 6 7 8 9

The main features of the EBCDIC sequence are that lowercase letters are sorted before uppercase letters, and uppercase letters are sorted before digits. Note also that some special characters interrupt the alphabetic sequences. The blank is the smallest character that you can display.

ASCII Order

The operating environments that use the ASCII collating sequence include the following:

- UNIX and its derivatives
- Windows
- OpenVMS

From the smallest to the largest character that you can display, the English-language ASCII sequence is consistent with the order shown in the following table.

Table 64.2 ASCII Sort Order Example

blank ! " # $ % & ' ( ) * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ? @
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [\ ] ◦ _
a b c d e f g h i j k l m n o p q r s t u v w x y z { } ~

The main features of the ASCII sequence are that digits are sorted before uppercase letters, and uppercase letters are sorted before lowercase letters. The blank is the smallest character that you can display.

Specifying Sorting Orders for Character Variables

The options ASCII, EBCDIC, DANISH, NATIONAL, SWEDISH, and REVERSE specify collating sequences that are stored in the HOST catalog.

If you want to provide your own collating sequences or change a collating sequence provided for you, then use the TRANTAB procedure to create or modify translation tables. When you create your own translation tables, they are stored in your PROFILE catalog, and they override any translation tables that have the same name in the HOST catalog. For complete details, see "TRANTAB Procedure" in *SAS National Language Support (NLS): Reference Guide*.

Note: System managers can modify the HOST catalog by copying newly created tables from the PROFILE catalog to the HOST catalog. Then all users can access the new or modified translation table.

Linguistic Collation sorts data according to rules of language. For detailed information about Linguistic Collation, see "Collating Sequence" in *SAS National Language Support (NLS): Reference Guide*.

Stored Sort Information

PROC SORT records the BY variables, collating sequence, and character set that it uses to sort the data set. This information is stored with the data set to help avoid unnecessary sorts.

Before PROC SORT sorts a data set, it checks the stored sort information. If you try to sort a data set how it is currently sorted, then PROC SORT does not perform the sort and writes a message to the log to that effect. To override this behavior, use the FORCE option. If you try to sort a data set the same way it is currently sorted and you specify an OUT= data set, then PROC SORT simply makes a copy of the DATA= data set.

To override the sort information that PROC SORT stores, use the _NULL_ value with the SORTEDBY= data set option. Refer to the "SORTEDBY= Data Set Option" in *SAS Data Set Options: Reference*.

If you want to change the sort information for an existing data set, then use the SORTEDBY= data set option in the MODIFY statement in the DATASETS procedure. For more information, see "MODIFY Statement" on page 644.

To access the sort information that is stored with a data set, use the CONTENTS statement in PROC DATASETS. For more information, see "CONTENTS Statement" on page 603.

The number of variables by which you can sort a data set with PROC SORT is limited only by available memory. The number of columns by which you can order the rows of a result set using PROC SQL, is also limited only by available memory. The sort indicator, whether stored in the metadata of a Base data set or represented in memory, is limited to 127 variables. For this reason, up to 127 variables can be stored in the sort indicator or listed on the SORTEDBY= data set option. If you are sorting by more than 127 variables, then only the first 127 are recorded in the sort indicator. If you sort the data set again by the entire list of BY variables, the data set is not recognized as being sorted, because the additional variables (beyond 127) are not found within the sort indicator. For a detailed

explanation, refer to "What Is a Sort Indicator?" in *SAS Language Reference: Concepts*.

Presorted Input Data Sets

Specifying the "PRESORTED" on page 2381 option prevents SAS from sorting an already sorted data set. Before sorting, SAS checks the sequence of observations within the input data set to determine whether the observations are in order. Use the PRESORTED option when you know or strongly suspect that a data set is already in order according to the key variables specified in the BY statement. The sequence of observations within the data set is checked by reading the data set and comparing the BY variables of each observation read to the BY variables of the preceding observation. This process continues until either the entire data set has been read or an out-of-sequence observation is detected.

If the entire data set has been read and no out-of-sequence observations have been found, then one of two actions is taken. If no output data set has been specified, the sort order metadata of the input data set is updated to indicate that the sequence has been verified. This verification notes that the data set is validly sorted according to the specified BY variables. Otherwise, the data set is considered sorted and either the input data set metadata is updated or, if OUT= has been specified, the data is copied to an output data set.

If observations within the data set are not in sequence, then the data set is sorted.

If the "NODUPKEY" on page 2378 option has been specified, then the sequence checking determines whether observations with duplicate keys are present in the data set. If observations with duplicate keys are found, then the data set is considered unsorted and a sort is performed. Otherwise, the data set is considered sorted and actions are taken where either the metadata of the input data set is updated or, if OUT= has been specified, data is copied to the output data set. The actions taken are described in more detail in the previous paragraphs.

If the metadata of the input data set indicates that the data is already sorted according to the key variables listed in the BY statement and the input data set has been validated, then neither sequence checking nor sorting is performed.

See "Sorted Data Sets" in *SAS Language Reference: Concepts* and interactions with the "SORTVALIDATE System Option" in *SAS System Options: Reference*.

Linguistic Sorting of Data Sets and ICU

Linguistic collation sorts characters in a culturally sensitive manner according to rules that are associated with a language and locale. The rules and default collating sequence are based on the language specified in the current locale setting. The implementation is provided by the International Components for Unicode (ICU) library. It produces results that are largely compatible with the Unicode Collation Algorithms (UCA).

SAS provides ICU collation when the linguistic option (SORTSEQ=LINGUISTIC) is specified on the Base SAS procedure, PROC SORT. Starting in the third maintenance release of SAS 9.4, you can specify linguistic collation using the SORTSEQ= option in the SQL procedure and by specifying the SORTSEQ=LINGUISTIC system option.

Note: Only PROC SORT and PROC SQL are affected when the SORTSEQ=LINGUISTIC system option is specified.

When the SORTSEQ=LINGUISTIC option is specified, SAS relies on the ICU libraries as the reference implementation of the Unicode Collation Algorithm (UCA) and as a de facto standard.

In SAS 9.4, the ICU library incorporated by SAS and used by PROC SORT is ICU version 4.8.1. This ICU version uses locale data from version 2.0 of the Unicode Common Locale Data Repository (CLDR). For in-depth information about the UCA algorithm or the International Components for Unicode (ICU) library implementation, see Download the ICU 4.8 Release and find the CLDR 2.0 Release Note at CLDR Releases/Downloads.

In SAS Viya, the ICU library version incorporated by SAS and used by PROC SORT is ICU 56. This ICU version uses locale data from version 28 of the Unicode Common Locale Data Repository (CLDR). For in-depth information, see Download ICU 56 and CLDR 28 Release Note.

A change in the version of the ICU that is used by PROC SORT for linguistic collation, can affect the interpretation of data sets sorted by another version of SAS. If a data set is linguistically sorted by one or more character variables in one version of SAS, the data set is recognized as being sorted when accessed in another version of SAS if the two SAS versions use different versions of the ICU. Because collation rules can change between ICU versions, variations in the rules can cause the order of observations produced by PROC SORT to be different. If the ordering differences are ignored, unexpected results can be seen during processing.

When sorting linguistically, the ICU version used by SAS is recorded in the sort indicator that is stored in the data set header. The ICU version is examined when determining if a data set is considered sorted. A difference between the ICU version in use and the ICU version recorded in the sort indicator of a data set causes the SAS system to ignore the indicated sort order and assume that the data set is unsorted.

Note: The PROC CONTENTS output shows the ICU version in use. See "Example 5: Linguistic Sorting Using ALTERNATE_HANDLING=" on page 2401.

If a sort indicator on a permanent data set is ignored, to facilitate processing, it can be desirable to reassert the order and reestablish the sort indicator on the data set. This can be done using PROC SORT with the PRESORTED option. Most often, because the order of observations within the data set has not been disturbed and is likely correct, the SORT procedure probably only needs to sequentially read the data set to reestablish the indicator instead of performing a complete sort. If the order of observations is not correct, then the SORT procedure reorders the observations as necessary.

For both the COPY and MIGRATE procedures, if the ICU version recorded on an input data set is different from the version in use by the SAS system, then the sort indicator on the input data set is ignored, the output data set is not marked as sorted, and a message is written to the SAS log. However, both procedures write observations to an output data set in the same order as they are read from the input. This order is preserved if a physical order is supported by the engine used for the OUT= destination library. For these reasons, when migrating to a new release of SAS, consider re-establishing the sort order of permanent data sets using PROC SORT with the PRESORTED option.

Additional information about how linguistic collation is used by SAS can be found in the following documents, as well as in the PROC SORT SORTSEQ=LINGUISTIC system option.

- See "SORTSEQ=sort-table | LINGUISTIC" in *SAS SQL Procedure User's Guide*.
- See PROC SORT option" LINGUISTIC<*(collating-options)*>" on page 2370.
- See "Specifying Linguistic Collation" in *SAS National Language Support (NLS): Reference Guide*.
- See Chapter 14, "CONTENTS Procedure," on page 489.
- See Chapter 15, "COPY Procedure," on page 521.
- See Chapter 41, "MIGRATE Procedure," on page 1559
- See the Appendix 4, "ICU License," on page 2825.

The following are SAS papers that provide detailed information about Linguistic Collation.

- Creating Order out of Character Chaos: Collation Capabilities of the SAS System
- Linguistic Collation: Everyone Can Get What They Expect
- Processing Multilingual Data with the SAS 9.2 Unicode Server
- New Language Features in SAS 9.2 for the Global Enterprise

Here is a list of third-party documentation that should be read for in-depth information about Linguistic Collation.

- See the Unicode Collation Algorithm (UCA) Specification.
- See the Collation section of the ICU User Guide

Force SAS to Sort Data Sets Using System Option SORTPGM

You can force data sets to be sorted by SAS by setting system option SORTPGM=SAS. This system option must be set prior to using PROC SORT. Setting system option SORTPGM=SAS ensures that your data set is sorted in the order in which SAS expects.

By default, SORTPGM defaults to BEST, what SAS determines is probably the best performance choice. When SORTPGM is set to BEST, sorting might be performed by the following:

- a system or third-party host sorting utility program, if one is installed and available.
- a DBMS if the input data resides in a database and a SAS/ACCESS engine is used to read it.

To work properly, the host sort or DBMS and the SAS system must be configured for compatible operation. The host sort or the DBMS can be configured to order data differently from SAS. When the observations returned to SAS are not ordered as SAS expects, the SORTPGM= system option can be set to SAS to instruct SAS to sort the data in the order needed by SAS.

See "SORTPGM: Windows" in *SAS Companion for Windows*, "SORTPGM System Option: UNIX" in *SAS Companion for UNIX Environments*, , "SORTPGM= System Option: z/OS" in *SAS Companion for z/OS*and "In-Database Processing: PROC SORT" on page 2387.

Syntax: SORT Procedure

Requirement: BY statement

Notes: Some SAS statements and options are not supported when running in CAS and might result in an error when PROC SORT is deciding whether to run in CAS.

Some SAS statements and options are not supported when running in CAS but will not prevent operation in CAS. A note will be printed for such options when PROC SORT decides to run in CAS.

Most PROC SORT specific options do not have any effect and do not prevent running in CAS.

Tips: You can use the ATTRIB, FORMAT, LABEL, and WHERE statements with the PROC SORT procedure. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

For in-database processing to occur, your data must reside within a supported version of a DBMS that has been properly configured for SAS in-database processing. For more information, see "In-Database Processing: PROC SORT" on page 2387.

See: "SORT Procedure: Windows" in *SAS Companion for Windows*, "SORT Procedure Statement: z/OS" in *SAS Companion for z/OS*, "SORT Procedure: UNIX" in *SAS Companion for UNIX Environments*.

PROC SORT <*collating-sequence-option*> <*other options*>;

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...>;

KEY *variable(s)* </ *option*>;

Statement	Task	Example
PROC SORT	Order SAS data set observations by the values of one or more character or numeric variables	Ex. 1, Ex. 3, Ex. 4
BY	Specify the sorting variables	Ex. 1, Ex. 2, Ex. 4
KEY	Specify sorting keys and variables	

PROC SORT Statement

Orders SAS data set observations by the values of one or more character or numeric variables.

Examples:
"Example 1: Sorting by the Values of Multiple Variables" on page 2391
"Example 3: Maintaining the Relative Order of Observations in Each BY Group" on page 2396
"Example 4: Retaining the First Observation of Each BY Group" on page 2399
"Example 7: Eliminate All Duplicate Observations Using NODUPKEY" on page 2408

Syntax

PROC SORT <*collating-sequence-option*> <*other options*>;

Summary of Optional Arguments

DATA= *SAS-data-set*
: specifies the input data set.

DATECOPY
: sorts a SAS data set without changing the created and modified dates.

FORCE
: forces redundant sorting.

OVERWRITE
: deletes the input data set before the replacement output data set is populated.

PRESORTED
: specifies whether the data set is likely already sorted.

SORTSIZE=*memory-specification*
: specifies the available memory.

TAGSORT
: reduces temporary disk usage.

Create output data sets

DUPOUT= *SAS-data-set*
specifies the output data set to which duplicate observations are written.

OUT= *SAS-data-set*
specifies the output data set.

UNIQUEOUT= *SAS-data-set*
specifies the output data set for eliminated observations.

Eliminate duplicate observations

NODUPKEY
deletes observations with duplicate BY values.

Eliminate unique observations

NOUNIQUEKEY
eliminates observations from the output data set that have a unique sort key.

Override SAS system option THREADS

NOTHREADS
prevents threaded sorting.

THREADS

NOTHREADS
enables or prevents the activation of threaded sorting.

Specify the collating sequence

ASCII
specifies ASCII.

DANISH
specifies Danish.

EBCDIC
specifies EBCDIC.

FINNISH
specifies Finnish.

NATIONAL
specifies a customized sequence.

NORWEGIAN
specifies Norwegian.

REVERSE
reverses the collation order for character variables.

SORTSEQ= *collating-sequence*
specifies the collating sequence.

SWEDISH
specifies Swedish.

Specify the output order

EQUALS

NOEQUALS
specifies the relative order within BY groups.

NOEQUALS

does not maintain relative order within BY groups.

Collating-Sequence-Options

Operating Environment Information: For information about behavior specific to your operating environment for the DANISH, FINNISH, NORWEGIAN, or SWEDISH *collating-sequence-option*, see the SAS documentation for your operating environment.

You can specify only one *collating-sequence-option* and multiple *other options* in a PROC SORT step. The order of the two types of options does not matter and both types are not necessary in the same PROC SORT step.

ASCII
sorts character variables using the ASCII collating sequence. You need this option only when you want to achieve an ASCII ordering on a system where EBCDIC is the native collating sequence.

See "ASCII Order" on page 2360

DANISH
sorts characters according to the Danish and Norwegian convention.

The Danish and Norwegian collating sequence is shown in Figure 64.87 on page 2369.

EBCDIC
sorts character variables using the EBCDIC collating sequence. You need this option only when you want to achieve an EBCDIC ordering on a system where ASCII is the native collating sequence.

See "EBCDIC Order" on page 2359

FINNISH
sorts characters according to the Finnish and Swedish convention.

The Finnish and Swedish collating sequence is shown in Figure 64.87 on page 2369.

NATIONAL
sorts character variables using an alternate collating sequence, as defined by your installation, to reflect a country's National Use Differences. To use this option, your site must define a customized national sort sequence. Check with the SAS Installation Representative at your site to determine whether a customized national sort sequence is available.

NORWEGIAN
sorts characters according to the Danish and Norwegian convention.

The Norwegian collating sequence is shown in Figure 64.87 on page 2369.

REVERSE
sorts character variables using a collating sequence that is reversed from the normal collating sequence.

Operating Environment Information: For information about the normal collating sequence for your operating environment, see "EBCDIC Order" on page

2359, "ASCII Order" on page 2360, and the SAS documentation for your operating environment.

Restriction Only one collating-sequence-option can be specified.

Interaction Using REVERSE with the DESCENDING option in the BY statement restores the sequence to the normal order.

See The "DESCENDING" on page 2385 option in the BY statement. The difference is that the DESCENDING option can be used with both character and numeric variables.

SWEDISH
sorts characters according to the Finnish and Swedish convention.

The Finnish and Swedish collating sequence is shown in Figure 64.87 on page 2369.

SORTSEQ= *collating-sequence*
The *collating-sequence* can be one of the following:

- collating-sequence-option on page 2369
- translation_table on page 2369
- encoding-value on page 2370
- LINGUISTIC on page 2370

For detailed information, refer to "Collating Sequence" in *SAS National Language Support (NLS): Reference Guide*.

Figure 64.1 *National Collating Sequences of Alphanumeric Characters*

```
Danish:     0123456789ABCDEFGHIJKLMNOPQRSTUVWXYZÆØÅabcdefghijklmnopqrstuvwxyzæøå
Finnish:    0123456789ABCDEFGHIJKLMNOPQRSTUVWXYZÅÄÖabcdefghijklmnopqrstuvwxyzåäö
Italian:    0123456789AÀBCÇDEÉÈFGHIÌJKLMNOÒPQRSTUÙVWXYZaàbcçdeéèfghiìjklmnoòpqrstuùvwxyz
Norwegian:  0123456789ABCDEFGHIJKLMNOPQRSTUVWXYZÆØÅabcdefghijklmnopqrstuvwxyzæøå
Spanish:    0123456789AÁaáBbCcDdEÉeéFfGgHhIÍiíJjKkLlMmNnÑñOÓoóPpQqRrSsTtUÚuúÜüVvWwXxYyZz
Swedish:    0123456789ABCDEFGHIJKLMNOPQRSTUVWXYZÅÄÖabcdefghijklmnopqrstuvwxyzåäö
```

Here are descriptions of the types of collating sequences:

collating-sequence-option
translation_table
specifies one of the PROC SORT statement *collating-sequence-options* (ASCII, DANISH, EBCDIC, FINNISH, NORWEGIAN, REVERSE, SWEDISH) or a translation table, which can be one that SAS provides or any user-defined translation table. Translation tables provided by SAS are: ASCII, DANISH, EBCDIC, FINNISH, ITALIAN, NORWEGIAN, POLISH, REVERSE, SPANISH, and SWEDISH.

Restriction You can specify only one *collating-sequence-option* or one translation table for the SORTSEQ= option.

Interaction In-database processing will not occur when the SORTSEQ= option is specified.

Tip The SORTSEQ= collating-sequence options are specified without parenthesis and there are no arguments associated with them.

See For a more detailed description of each *collating-sequence-option*, see "Collating-Sequence-Options" on page 2368.

To see the Sorting Order of Character variables, see "EBCDIC Order" on page 2359, "ASCII Order" on page 2360, and Figure 64.87 on page 2369 for all others.

Example
```
proc sort data=mydata SORTSEQ=ASCII;
```

Example For an example of using PROC TRANTAB and PROC SORT with SORTSEQ=, see "Using Different Translation Tables for Sorting" in *SAS National Language Support (NLS): Reference Guide*.

encoding-value

specifies an encoding value. The result is the same as a binary collation of the character data represented in the specified encoding. See the supported encoding value in the *SAS National Language Support (NLS): Reference Guide*.

Restriction PROC SORT is the only procedure or part of the SAS system that recognizes an encoding specified for the SORTSEQ= option.

Tip When the encoding value contains a character other than an alphanumeric character or underscore, the value needs to be enclosed in quotation marks.

See The list of the encodings that can be specified in the *SAS National Language Support (NLS): Reference Guide*.

LINGUISTIC<*(collating-options)*>

specifies linguistic collation, which sorts characters in a culturally sensitive manner according to rules that are associated with a language and locale. The rules and default *collating-sequence* options are based on the language that is specified in the current locale setting. The implementation is provided by the International Components for Unicode (ICU) library. It produces results that are largely compatible with the Unicode Collation Algorithms (UCA). For more information, see " Linguistic Sorting of Data Sets and ICU" on page 2362.

Note: Only PROC SORT and PROC SQL are affected when the linguistic collation system option is specified.

The following are options that can be used when specifying SORTSEQ=LINGUISTIC. These options modify the linguistic collating sequence:

ALTERNATE_HANDLING=SHIFTED
controls the handling of variable characters like spaces, punctuation, and symbols. When this option is not specified (using the default value Non-Ignorable), differences among these variable characters are of the same importance as differences among letters. If the ALTERNATE_HANDLING option is specified, these variable characters are of minor importance.

Default NON_IGNORABLE

Tip The SHIFTED value is often used in combination with STRENGTH= set to Quaternary. In such a case, spaces, punctuation, and symbols are considered when comparing strings, but only if all other aspects of the strings (base letters, accents, and case) are identical.

See "Example 5: Linguistic Sorting Using ALTERNATE_HANDLING=" on page 2401 and "Example 6: Linguistic Sorting Using ALTERNATE_HANDLING= and STRENGTH=" on page 2405.

CASE_FIRST=
specifies the order of uppercase and lowercase letters. This argument is valid for only TERTIARY, QUATERNARY, or IDENTICAL levels. The following table provides the values and information for the CASE_FIRST argument:

Table 64.3 *Arguments for CASE_FIRST=*

Value	Description
UPPER	Sorts uppercase letters first, then the lowercase letters.
LOWER	Sorts lowercase letters first, then the uppercase letters.

COLLATION=
specifies character ordering. The following table lists the available COLLATION= values.

Note: If you do not select a collation value, then the user's locale-default collation is selected.

Table 64.4 *Values for COLLATION=*

Value	Description
BIG5HAN	Specifies Pinyin ordering for Latin and specifies bug5 charset ordering for Chinese, Japanese, and Korean characters.
DIRECT	Specifies a Hindi variant.

Value	Description
GB21312HAN	Specifies Pinyin ordering for Latin and specifies gb2312han charset ordering for Chinese, Japanese, and Korean characters.
PHONEBOOK	Specifies a telephone-book style for ordering of characters. Select PHONEBOOK only with the German language.
PINYIN	Specifies an ordering for Chinese, Japanese, and Korean characters based on character-by-character transliteration into Pinyin. This ordering is typically used with simplified Chinese.
POSIX	Portable Operating System Interface. This option specifies a "C" locale ordering of characters.
STROKE	Specifies a nonalphabetic writing style ordering of characters. Select STROKE with Chinese, Japanese, Korean, or Vietnamese languages. This ordering is typically used with Traditional Chinese.
TRADITIONAL	Specifies a traditional style for ordering of characters. For example, select TRADITIONAL with the Spanish Language.

LOCALE= ***locale_name***
specifies the locale name in the form of a POSIX name (for example, ja_JP). For a list of locale and POSIX values supported by PROC SORT, see "LOCALE= Values for PAPERSIZE and DFLANG, Options" in *SAS National Language Support (NLS): Reference Guide*.

Restriction The following Locales are not supported by PROC SORT:

- Afrikaans_SouthAfrica, af_ZA
- Cornish_UnitedKingdom, kw_GB
- ManxGaelic_UnitedKingdom, gv_GB

NUMERIC_COLLATION=
orders integer values within the text by the numeric value instead of characters used to represent the numbers.

Table 64.5 *Values for NUMERIC_COLLATION*

Value	Description
ON	Order numbers by the numeric value. For example, "8 Main St." would sort before "45 Main St.".

Value	Description
OFF	Order numbers by the character value. For example, "45 Main St." would sort before "8 Main St.".

Default OFF

STRENGTH=
The value of strength is related to the collation level. There are five collation-level values. The following table provides information about the five levels. The default value for strength is related to the locale.

Table 64.6 *Values for STRENGTH=*

Value	Type of Collation	Description
PRIMARY or 1	PRIMARY specifies differences between base characters (for example, "a" < "b").	It is the strongest difference. For example, dictionaries are divided into different sections by base character.
SECONDARY or 2	Accents in the characters are considered secondary differences (for example, "as" < "às" < "at").	A secondary difference is ignored when there is a primary difference anywhere in the strings. Other differences between letters can also be considered secondary differences, depending on the language.
TERTIARY or 3	Upper and lowercase differences in characters are distinguished at the tertiary level (for example, "ao" < "Ao" < "aò"). For an example, see "Example 5: Linguistic Sorting Using ALTERNATE_HANDLING=" on page 2401.	A tertiary difference is ignored when there is a primary or secondary difference

Value	Type of Collation	Description
		anywhere in the strings. Another example is the difference between large and small Kana.
QUATERNARY or 4	When punctuation is ignored at level 1-3, an additional level can be used to distinguish words with and without punctuation (for example, "a-b" < "ab" < "aB"). For an example, see "Example 6: Linguistic Sorting Using ALTERNATE_HANDLING= and STRENGTH=" on page 2405.	The quaternary level should be used if ignoring punctuation is required or when processing Japanese text. This difference is ignored when there is a primary, secondary, or tertiary difference.
IDENTICAL or 5	When all other levels are equal, the identical level is used as a tiebreaker. The Unicode code point values of the Normalization Form D (NFD) form of each string are compared at this level, just in case there is no difference at levels 1-4.	This level should be used sparingly, because code-point value differences between two strings rarely occur. For example, only Hebrew cantillation marks are distinguished at this level.

Alias LEVEL=

Alias UCA

Restrictions The SORTSEQ=LINGUISTIC option is available only on the PROC SORT SORTSEQ= option and is not available for the system option SORTSEQ.

Linguistic collation is not supported on platforms VMS on Itanium (VMI) or 64-bit Windows on Itanium (W64).

Interaction The ICU version can change in a new SAS release. The order of observations produced when sorting a data set linguistically, using one release of SAS, can be different from the order produced by another release if the two releases use different versions of the ICU. When migrating to a new release of SAS, consider re-establishing the sort order of permanent data sets using PROC SORT with the PRESORTED option. For more details, see " Linguistic Sorting of Data Sets and ICU" on page 2362.

Tips The CONTENTS procedure or CONTENTS statement output shows the ICU version number of a data set that is linguistically sorted.

The *collating-options* must be enclosed in parentheses. More than one collating option can be specified.

When BY processing is performed on data sets that are sorted with linguistic collation, the NOBYSORTED system option might need to be specified in order for the data set to be treated properly. BY processing is performed differently than collating sequence processing.

See For ICU License Agreement, see Appendix 4, "ICU License," on page 2825.

For more information, see "Specifying Linguistic Collation" in *SAS National Language Support (NLS): Reference Guide*. For more information, see " Linguistic Sorting of Data Sets and ICU" on page 2362.

CAUTION

If you use a host sort utility to sort your data, then specifying a translation-table-based collating sequence with the SORTSEQ= option might corrupt the character BY variables. For more information, see the PROC SORT documentation for your operating environment.

Interaction In-database processing does not occur when the SORTSEQ= option is specified.

Tip The SORTSEQ= *collating-sequence* options are specified without parenthesis and no arguments are associated with them. Here is an example of how to specify a collating sequence: `proc sort data=mydata SORTSEQ=ASCII;`

Other Options

Options can include one *collating-sequence-option* and multiple other options. The order of the two types of options does not matter and both types are not necessary in the same PROC SORT step.

DATA= *SAS-data-set*
identifies the input SAS data set.

Restrictions For in-database processing to occur, the data set must refer to a table residing on the DBMS.

SAS data set options DROP=, KEEP=, RENAME= are not supported in CAS. When these options are specfied on the data set, CAS operations will not occur.

Notes PROC SORT supports extended attributes by copying the attributes from the input data set to the output data set.

When options NODUPKEY or NOUNIKEY are specified and the DATA= option refers to a CAS table, and the OUT=, DUPOUT=, or UNIOUT= options refer to a CAS table, PROC SORT invokes the CAS deduplicate action on a CAS server. For more information, see the deduplicate Action .

See "Input Data Sets" on page 26

SAS Data Set Options: Reference

DATECOPY
copies the SAS internal date and time at which the SAS data set was created and the date and time at which it was last modified before the sort to the resulting sorted data set. Note that the operating environment date and time are not preserved.

Restriction DATECOPY can be used only when the resulting data set uses the V8 or V9 engine.

Tip You can alter the file creation date and time with the DTC= option in the MODIFY statement in PROC DATASETS. For more information, see "MODIFY Statement" on page 644.

DUPOUT= *SAS-data-set*
specifies the output data set to which duplicate observations are written.

Interactions In-database processing does not occur when the DUPOUT= option is specified.

The DUPOUT= and UNIQUEOUT= options are not compatible and cannot be specified simultaneously.

Note When options NODUPKEY or NOUNIKEY are specified and the DATA= option refers to a CAS table, and the OUT=, DUPOUT=, or UNIOUT= options refer to a CAS table, PROC SORT invokes the

CAS deduplicate action on a CAS server. For more information, see the deduplicate Action .

Tips The DUPOUT= option can be used only with the NODUPKEY option. It cannot be combined with the NOUNIQUEKEY option.

If the DUPOUT= data set name that is specified is the same as the INPUT data set name, SAS does not sort or overwrite the INPUT data set. Instead, SAS generates an error message. The FORCE option must be specified in order to overwrite the INPUT data set with the DUPOUT= data set of the same name.

See *SAS Data Set Options: Reference*

EQUALS | NOEQUALS

specifies the order of the observations in the output data set. For observations with identical BY-variable values, EQUALS maintains the relative order of the observations within the input data set in the output data set. NOEQUALS does not necessarily preserve this order in the output data set.

Default EQUALS

Interactions When you use NODUPKEY to remove observations in the output data set, the choice of EQUALS or NOEQUALS can affect which observations are removed.

The EQUALS | NOEQUALS procedure option overrides the default sort stability behavior that is established with the SORTEQUALS | NOSORTEQUALS system option.

The EQUALS option is supported by the threaded sort. However, I/O performance might be reduced when using the EQUALS option with the threaded sort because partitioned data sets are processed as if they consist of a single partition.

The NOEQUALS option is supported by the threaded sort. The order of observations within BY groups that are returned by the threaded sort might not be consistent between runs.

Tip Using NOEQUALS can save CPU time and memory.

FORCE

sorts and replaces an indexed data set when the OUT= option is not specified. Without the FORCE option, PROC SORT does not sort and replace an indexed data set because sorting destroys user-created indexes for the data set. When you specify FORCE, PROC SORT sorts and replaces the data set and destroys all user-created indexes for the data set. Indexes that were created or required by integrity constraints are preserved.

Restriction If you use PROC SORT with the FORCE option on data sets that were created with the Version 5 compatibility engine or with a sequential engine such as a tape format engine, you must also specify the OUT= option.

Tip PROC SORT checks for the sort indicator before it sorts a data set so that data is not sorted again unnecessarily. By default, PROC SORT does not sort a data set if the sort information matches the requested sort. You can use FORCE to override this behavior. You might need to use FORCE if SAS cannot verify the sort specification in the data set option SORTEDBY=. For more information about SORTEDBY= , see the chapter on SAS data set options in *SAS Data Set Options: Reference*.

NODUPKEY

checks for and eliminates observations with duplicate BY values. If you specify this option, PROC SORT compares all BY values for each observation to the ones for the previous observation that is written to the output data set. If an exact match is found, the observation is not written to the output data set.

Sorting causes observations that have equal BY variable values to be grouped together for output. Normally, PROC SORT writes all observations for each BY group that it assembles to the output data set. The NODUPKEY option instructs the SORT procedure to write only the first observation of each BY group to the output data set and to discard any additional observations that are contained within that BY group.

Several factors dictate whether an observation occurs first within a BY group that PROC SORT has assembled for output. These factors include the order in which observations are read from the input data set, the sort program being used, and whether stability is provided by the sorting algorithm.

When the SORT procedure's input is a Base SAS engine data set and the sorting is done by SAS, then the order of observations within an output BY group is predictable. The order of the observations within the group is the same as the order in which they were written to the data set when it was created. Because the Base SAS engine maintains observations in the order that they were written to the data set, they are read by PROC SORT in the same order. While processing, PROC SORT maintains the order of the observations because it uses a stable sorting algorithm. The stable sorting algorithm is used because the EQUALS option is set by default. Therefore, the observation that is selected by PROC SORT to be written to the output data set for a given BY group is the first observation in the data set having the BY variable values that define the group.

If the SORT procedure reads its input from an engine that does not provide a predictable observation order or an alternative sorting program (when a host sort performs the sort), the observations that are eliminated and the one that is written to the output data set might not be well defined. For example, determining which observations are kept and which observations are discarded might be unpredictable if data is being read into SAS from a DBMS that presents query results in a nondeterministic order due to parallel processing.

Operating Environment Information: If you use the VMS operating environment and are using the VMS host sort, the observation that is written to the output data set is not always the first observation of the BY group.

To ensure that each observation in the output data set is unique, you can use the NODUPKEY option with PROC SORT and sort by _ALL_ variables in the input data set. An observation in a data set is unique when no other observation in the data set has the same combination of variable values. See example

program "Example 7: Eliminate All Duplicate Observations Using NODUPKEY" on page 2408.

Note: If you drop one or more BY variables from the output data set when using NODUPKEY, you void (eliminate) the guarantee that each observation has a unique set of BY variable values. Similarly, when you use NODUPKEY and sort by _ALL_ variables to produce unique observations, if you drop one or more variables from the output data set, observations in the output data set are no longer guaranteed to be unique.

Another way to ensure that observations in an output data set are unique is to use PROC SQL with the DISTINCT keyword. Here is a simple example using PROC SQL:

```
PROC SQL;
 CREATE TABLE DL (keep division league) AS SELECT DISTINCT *
 FROM SASHELP.BASEBALL;
QUIT;
```

Interactions

The Base SAS engine provides a consistent ordering where the first observation (the first observation that was written and stored) is generally the first one that is read by PROC SORT. The sorted data set contains only the first observation of each BY group that PROC SORT reads.

When you are removing observations with duplicate BY values with NODUPKEY, the choice of EQUALS or NOEQUALS can have an effect on which observations are removed. Use the EQUALS option (the default value) with the NODUPKEY option for consistent results in your output data sets.

In-database sorting occurs when the NODUPKEY option is specified and the system option SQLGENERATION= is assigned a DBMS and the system option SORTPGM=BEST.

The options NODUPKEY and NOUNIQUEKEY are not compatible. If these options are specified together, an error is printed to the SAS log.

Note

When options NODUPKEY or NOUNIKEY are specified and the DATA= option refers to a CAS table, and the OUT=, DUPOUT=, or UNIOUT= options refer to a CAS table, PROC SORT invokes the CAS deduplicate action on a CAS server. For more information, see the deduplicate Action .

Tip

The DUPOUT= option can be used with the NODUPKEY option. However, it cannot be used with the NOUNIQUEKEY option.

Examples

"Example 4: Retaining the First Observation of Each BY Group" on page 2399

"Example 7: Eliminate All Duplicate Observations Using NODUPKEY" on page 2408

NOEQUALS
See "EQUALS|NOEQUALS" on page 2377.

NOTHREADS
See "THREADS|NOTHREADS" on page 2383.

NOUNIQUEKEY
checks for and eliminates observations from the output data set that have a unique sort key. A sort key is unique when the observation containing the key is the only observation within a BY group.

Note: Unlike NODUPKEY, which writes one observation of a BY group to the output data set and discards all other observations from the BY group, the NOUNIQUEKEY maintains BY group integrity. Either all observations of a BY group are written to the output data set when the BY group consists of two or more observations, or all observations of the BY group are discarded when the BY group consists of a single observation.

Alias	NOUNIKEY | NOUNIKEYS | NOUNIQUEKEYS
Interaction	Options NODUPKEY and NOUNIQUEKEY are not compatible. If NODUPKEY and NOUNIQUEKEY are specified together, an error is printed to the SAS log.
Note	When options NODUPKEY or NOUNIKEY are specified and the DATA= option refers to a CAS table, and the OUT=, DUPOUT=, or UNIOUT= options refer to a CAS table, PROC SORT invokes the CAS deduplicate action on a CAS server. For more information, see the deduplicate Action .
Tip	The UNIQUEOUT= option can be used with the NOUNIQUEKEY option. It cannot be combined with the NODUPKEY option.
See	UNIQUEOUT= to direct the observations that have been eliminated to an output data set.

OUT= *SAS-data-set*
names the output data set. If *SAS-data-set* does not exist, then PROC SORT creates it.

CAUTION
Use care when you use PROC SORT without OUT=. Without the OUT= option, PROC SORT replaces the original data set with the sorted observations when the procedure executes without errors.

Default	Without OUT=, PROC SORT overwrites the original data set.
Note	When options NODUPKEY or NOUNIKEY are specified and the DATA= option refers to a CAS table, and the OUT=, DUPOUT=, or UNIOUT= options refer to a CAS table, PROC SORT invokes the CAS deduplicate action on a CAS server. For more information, see the deduplicate Action .

Tips With in-database sorts, the output data set cannot refer to the input table on the DBMS.

You can use data set options with OUT=.

See *SAS Data Set Options: Reference*

Example "Example 1: Sorting by the Values of Multiple Variables" on page 2391

OVERWRITE
enables the input data set to be deleted before the replacement output data set of the same name is populated with observations.

CAUTION
Use the OVERWRITE option only with a data set that is backed up or with a data set that you can reconstruct. Because the input data set is deleted, data is lost if a failure occurs while the output data set is being written.

Restrictions If the OVERWRITE and OUT= options are specified and the OUT= data set name is not the same as the INPUT data set name, SAS does not overwrite the INPUT data set.

The OVERWRITE option has no effect if you also specify the TAGSORT option. You cannot overwrite the input data set because TAGSORT must reread the input data set while populating the output data set.

The OVERWRITE option is supported by the SAS sort and SAS threaded sort only. The option has no effect if you are using a host sort.

Tip Using the OVERWRITE option can reduce disk space requirements.

PRESORTED
before sorting, checks within the input data set to determine whether the sequence of observations is in order. Use the PRESORTED option when you know or strongly suspect that a data set is already in order according to the key variables that are specified in the BY statement. By specifying this option, you avoid the cost of sorting the data set.

Interaction Sequence checking is not performed when the "FORCE" on page 2377 option is specified.

Tips You can use the DATA step to import data, from external text files, in a sequence compatible with SAS processing and according to the sort order specified by the combination of SORT options and key variables listed in the BY statement. You can then specify the PRESORTED option if you know or highly suspect that the data is sorted accordingly.

Using the PRESORTED option with ACCESS engines and DBMS data is not recommended. These external databases are not guaranteed to return observations in sorted order unless an ORDER BY clause is

specified in a query. Generally, physical ordering is not a concept that external databases use. Therefore, these databases are not guaranteed to return observations in the same order when executing a query multiple times. Physical order can be important for producing consistent, repeatable results when processing data. Without a repeatable data retrieval order, PROC SORT does not guarantee the return of observations in the same order from one PROC SORT execution to another, even when the "EQUALS| NOEQUALS" on page 2377 option is used to request sort stability. Without a repeatable retrieval order, the detection and elimination of adjacent duplicate records by PROC SORT can also vary from one PROC SORT execution to another.

See System option "SORTVALIDATE System Option" in *SAS System Options: Reference*.

SORTSIZE=*memory-specification*
specifies the maximum amount of memory that is available to PROC SORT. Valid values for *memory-specification* are as follows:

MAX
specifies that all available memory can be used.

n
specifies the amount of memory in bytes, where *n* is a real number.

***n*K**
specifies the amount of memory in kilobytes, where *n* is a real number.

***n*M**
specifies the amount of memory in megabytes, where *n* is a real number.

***n*G**
specifies the amount of memory in gigabytes, where *n* is a real number.

Specifying the SORTSIZE= option in the PROC SORT statement temporarily overrides the SAS system option. For more information, see "SORTSIZE= System Option" in *SAS System Options: Reference*.

Operating Environment Information: Some system sort utilities might treat this option differently. Refer to the SAS documentation for your operating environment.

Alias SIZE=

Default the value of the SAS system option SORTSIZE=

Tips Setting the SORTSIZE= option in the PROC SORT statement to MAX or 0, or not setting the SORTSIZE= option, limits the PROC SORT to the available physical memory based on the settings of the SAS system options REALMEMSIZE and MEMSIZE.

For information about the SAS system options REALMEMSIZE and MEMSIZE, see the SAS documentation for your operating environment.

TAGSORT

stores only the BY variables and the observation numbers in temporary files. The BY variables and the observation numbers are called *tags*. At the completion of the sorting process, PROC SORT uses the tags to retrieve records from the input data set in sorted order.

Note: The utility file created is much smaller than it would be if the TAGSORT option were not specified.

Restriction The TAGSORT option is not compatible with the OVERWRITE option.

Interaction The TAGSORT option is not supported by the threaded sort.

Tip When the total length of BY variables is small compared with the record length, TAGSORT reduces temporary disk usage considerably. However, processing time might be much higher.

THREADS | NOTHREADS

enables or prevents the activation of threaded sorting.

Default The value of the THREADS | NOTHREADS SAS system option. Note that the default can be overridden using the SORT procedure THREADS | NOTHREADS option.

Restrictions Your site administrator can create a restricted options table. A restricted options table specifies SAS system option values that are established at start-up and cannot be overridden. If the THREADS | NOTHREADS system option is listed in the restricted options table, any attempt to set these system options is ignored and a warning message is written to the SAS log.

If a failure occurs when adding the THREADS | NOTHREADS procedure option using the SPD engine, PROC SORT stops processing and writes a message to the SAS log.

Interactions The PROC SORT THREADS | NOTHREADS options override the SAS system THREADS | NOTHREADS options unless the system option is restricted. (See Restriction.) For more information, see "THREADS System Option" in *SAS System Options: Reference*.

The THREADS system option is honored if PROC SORT determines that threaded processing is deemed to be beneficial. If the value of the SAS system option CPUCOUNT=1, then threaded processing is not beneficial. However, you can specify the PROC SORT THREADS option to force threaded processing when the system option is set to NOTHREADS or when the system option is THREADS and the procedure option is NOTHREADS. This option combination prevents threaded processing and overrides the actions taken that are based on the system options. Note that when threaded sorting is in effect and NOEQUALS is specified,

observations within BY groups might be returned in an unpredictable order.

If threaded SAS sort is being used, the UTILLOC= system option affects the placement of utility files. Thread-enabled SAS applications are able to create temporary files that can be accessed in parallel by separate threads. For more information, see "UTILLOC= System Option" in *SAS System Options: Reference*.

The page size of the utility file used by PROC SORT is influenced by the new STRIPESIZE= system option. For more information, see "STRIPESIZE= System Option" in *SAS System Options: Reference*.

The TAGSORT option is not supported by the threaded sort. Specifying the TAGSORT option prevents threaded processing.

See "Threaded Sorting" on page 2358 and "Support for Parallel Processing" in *SAS Language Reference: Concepts*.

UNIQUEOUT= *SAS-data-set*

specifies the output data set for observations eliminated by the NOUNIQUEKEY option.

Alias UNIOUT=

Interaction The DUPOUT= and UNIOUT= options are not compatible and cannot be specified simultaneously.

Note When options NODUPKEY or NOUNIKEY are specified and the DATA= option refers to a CAS table, and the OUT=, DUPOUT=, or UNIOUT= options refer to a CAS table, PROC SORT invokes the CAS deduplicate action on a CAS server. For more information, see the deduplicate Action .

Tip The UNIQUEOUT= option can be used with the NOUNIQUEKEY option. It cannot be combined with the NODUPKEY option.

See "NOUNIQUEKEY" on page 2380

SAS Data Set Options: Reference

BY Statement

Specifies the sorting variables.

Examples: "Example 1: Sorting by the Values of Multiple Variables" on page 2391
"Example 2: Sorting in Descending Order" on page 2394
"Example 4: Retaining the First Observation of Each BY Group" on page 2399

Syntax

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...>;

Required Argument

variable
specifies the variable by which PROC SORT sorts the observations. PROC SORT first arranges the data set by the values in ascending order, by default, of the first BY variable. PROC SORT then arranges any observations that have the same value of the first BY variable by the values of the second BY variable in ascending order. This sorting continues for every specified BY variable.

Tip When using the Google BigQuery data source, columns in the BY statement in PROC SORT cannot be of data type FLOAT64 for in-database processing.

Optional Argument

DESCENDING
reverses the sort order for the variable that immediately follows in the statement so that observations are sorted from the largest value to the smallest value. The DESCENDING keyword modifies the variable that follows it.

Tips In a PROC SORT BY statement, the DESCENDING keyword modifies the variable that follows it.

The THREADS SAS system option is the default as long as the PROC SORT THREADS | NOTHREADS option is unspecified.

Example "Example 2: Sorting in Descending Order" on page 2394

KEY Statement

Specifies sorting keys and variables. The KEY statement is an alternative to the BY statement. The KEY statement syntax allows for the future possibility of specifying different collation options for each KEY variable. Currently, the only options allowed are ASCENDING and DESCENDING.

Restriction: The BY statement cannot be used with the KEY statement.

Tip: Multiple KEY statements can be specified.

Syntax

KEY *variable(s)* </ *option*> ;

Required Argument

variable(s)

specifies the variable by which PROC SORT orders the observations. Multiple variables can be specified. Each of these variables must be separated by a space. A range of variables can also be specified. For example, the following code shows how to specify multiple variables and a range of variables:

```
data sortKeys;
   input x1 x2 x3 x4 ;
cards;
   7 8 9 8
   0 0 0 0
   1 2 3 4 ;
run;
proc sort data=sortKeys out=sortedOutput;
   key x1 x2-x4;
run;
```

Multiple KEY statements can also be specified. The first sort key encountered from among all sort keys is considered the primary sort key. Sorting continues for every specified KEY statement and its variables. For example, the following code shows how to specify multiple KEY statements:

```
proc sort data=sortKeys out=sortedOutput;
   key x2;
   key x3;
run;
```

The following code example uses the BY statement to accomplish the same type of sort as the previous example:

```
proc sort data=sortKeys out=sortedOutput;
   by x2 x3;
run;
```

Optional Arguments

ASCENDING

sorts in ascending order the variable or variables that it follows. Observations are sorted from the smallest value to the largest value. The ASCENDING keyword modifies all the variables that precede it in the KEY statement.

Alias ASC

Default ASCENDING is the default sort order.

Tip In a PROC SORT KEY statement, the ASCENDING option modifies all the variables that it follows. The option must follow the /. In the following example, the x1 variable in the input data set is sorted in ascending order.

```
proc sort data=sortVar out=sortedOutput;
   key x1 / ascending;
```

```
run;
```

DESCENDING

reverses the sort order for the variable that it follows in the statement so that observations are sorted from the largest value to the smallest value. The DESCENDING keyword modifies all the variables that it precedes in the KEY statement.

Alias DESC

Default ASCENDING (ASC) is the default sort order.

Tip In a PROC SORT KEY statement, the DESCENDING option modifies the variables that follows it. The option must follow the /. In the following example, the x1 and x2 variables in the input data set is sorted in descending order:

```
proc sort data=sortVar out=sortedOutput;
   key x1 x2 / descending;
run;
```

The following example uses the BY statement to accomplish the same type of sort as the previous example:

```
proc sort data=sortVar out=sortedOutput;
   by descending x1 descending x2 ;
run;
```

Usage: SORT Procedure

In-Database Processing: PROC SORT

In-database processing has several advantages over processing within SAS. These advantages include increased security, reduced network traffic, and the potential for faster processing. Increased security is possible because sensitive data does not have to be extracted from the DBMS. Faster processing is possible because data is manipulated locally, on the DBMS, using high-speed secondary storage devices instead of being transported across a relatively slow network connection, because the DBMS might have more processing resources at its disposal, and because the DBMS might be capable of optimizing a query for execution in a highly parallel and scalable fashion.

When the DATA= input data set is stored as a table or view in a database management system (DBMS), the PROC SORT procedure can use in-database processing to sort the data. In-database processing can provide the advantages of

faster processing and reduced data transfer between the database and SAS software.

In-database processing for PROC SORT supports the following database management systems:

- Amazon Redshift
- Aster
- DB2
- Google BigQuery
- Greenplum
- Hadoop
- HAWQ
- Impala
- Microsoft SQL Server
- Netezza
- Oracle
- PostgreSQL
- SAP HANA
- Snowflake
- Teradata
- Vertica
- Yellowbrick

Note: When using the Google BigQuery data source, columns in the BY statement in PROC SORT cannot be of data type FLOAT64 for in-database processing.

PROC SORT performs in-database processing using SQL explicit pass-through. The pass-through facility uses SAS/ACCESS to connect to a DBMS and to send statements directly to the DBMS for execution. This facility lets you use the SQL syntax of your DBMS. For details, see "Pass-Through Facility for Relational Databases" in *SAS/ACCESS for Relational Databases: Reference*.

In-database processing is used by PROC SORT when a combination of procedure and system options are properly set. When system option SORTPGM=BEST, system option SQLGENERATION= is set to cause in-database processing, and when the PROC SORT NODUPKEY option is specified, PROC SORT generates a DBMS SQL query that sorts the data. The sorted results can either remain as a new table within the DBMS or can be returned to SAS. To view the SQL queries generated, set the SASTRACE= option.

The SAS system option SORTPGM= can also be used without setting the SQLGENERATION option to instruct PROC SORT to use either the DBMS, SAS, or the HOST to perform the sort. If SORTPGM=BEST is specified, then either the DBMS, SAS, or HOST performs the sort. The observation ordering that is produced by PROC SORT depends on whether the DBMS or SAS performs the sorting.

If the DBMS performs the sort, then the configuration and characteristics of the DBMS sorting program affects the resulting data order. The DBMS configuration settings and characteristics that can affect data order include character collation, ordering of NULL values, and sort stability. Most database management systems do not guarantee sort stability, and the sort might be performed by the DBMS regardless of the state of the SORTEQUALS/NOSORTEQUALS system option and EQUALS/NOEQUALS procedure option.

If you set the SAS system option SORTPGM= to SAS, then unordered data is delivered from the DBMS to SAS and SAS performs the sorting. However, consistency in the delivery order of observations from a DBMS is not guaranteed. Therefore, even though SAS can perform a stable sort on the DBMS data, SAS cannot guarantee that the ordering of observations within output BY groups is the same from one PROC SORT execution to the next. To achieve consistency in the ordering of observations within BY groups, first populate a SAS data set with the DBMS data, and then use the EQUALS or SORTEQUALS option to perform a stable sort.

In-database processing is affected by the following circumstances:

- When PROC SORT options, SORTSEQ=, or DUPOUT=, are specified, no in-database processing occurs.
- For in-database processing, the OUT= procedure option must be specified and the output data set cannot refer to the input table on the DBMS.
- LIBNAME options and data set options can also affect whether in-database processing occurs and what type of query is generated. See "In-Database Procedures" in *SAS/ACCESS for Relational Databases: Reference* for a complete list of these options. The user can also set OPTIONS MSGLEVEL=I in SAS to see which options prevent or affect in-database processing.

SAS Cloud Analytic Services Processing for PROC SORT

Starting in SAS Viya 3.5, PROC SORT supports the ability to run the duplicate detection and manipulation options (NODUPKEY, NOUNIKEY, DUPOUT=, UNIOUT=) in CAS. This functionality is provided to facilitate the migration of code for users of SAS Viya. PROC SORT provides the capability to eliminate duplicate entries in data sets when running in SAS 9. CAS also needs the ability to eliminate duplicate entries in data sets. This task is performed by using the deduplicate action available in SAS Viya 3.5.

When the input data set references the CAS view or an in-memory table, the SORT procedure uses the CAS deduplicate action to perform the equivalent functionality of the NODUPKEY or NOUNIKEY options of PROC SORT. When options NODUPKEY or NOUNIKEY are specified in the PROC SORT statement and input to PROC SORT is read by CAS, and all output from PROC SORT (including the optional DUPOUT= and UNIOUT= data sets) is written to a CAS table, PROC SORT invokes the CAS deduplicate action on the CAS server. Under these conditions, the

action is invoked and the work is performed in CAS with no data moved into or out of the CAS server.

See the deduplicate Action for information about the CAS aAction.

For conceptual information about procedures that run in CAS, see Chapter 5, "CAS Processing of Base Procedures," on page 93.

Integrity Constraints: SORT Procedure

Sorting the input data set and replacing it with the sorted data set preserves both referential and general integrity constraints, as well as any indexes that they might require. A sort that creates a new data set does not preserve any integrity constraints or indexes. For more information about implicit replacement, explicit replacement, and no replacement with and without the OUT= option, see "Output Data Set" on page 2390. For more information about integrity constraints, see the chapter on "SAS Data Files" in *SAS Language Reference: Concepts*.

Results: SORT Procedure

Procedure Output

PROC SORT produces only an output data set. To see the output data set, you can use PROC PRINT, PROC REPORT, or another of the many available methods of printing in SAS.

Output Data Set

Without the OUT= option, PROC SORT replaces the original data set with the sorted observations when the procedure executes without errors. When you specify the OUT= option using a new data set name, PROC SORT creates a new data set that contains the sorted observations.

Table 64.7 *Data Set Replacement Options*

Task	Options
implicit replacement of input data set	proc sort data=names;

Task	Options
explicit replacement of input data set	proc sort data=names out=names;
no replacement of input data set	proc sort data=names out=namesbyid;

With all three replacement options (implicit replacement, explicit replacement, and no replacement) there must be at least enough space in the output library for a copy of the original data set.

You can also sort compressed data sets. If you specify a compressed data set as the input data set and omit the OUT= option, then the input data set is sorted and remains compressed. If you specify an OUT= data set, then the resulting data set is compressed only if you choose a compression method with the COMPRESS= data set option. For more information, see "COMPRESS= Data Set Option" in *SAS Data Set Options: Reference* .

Also note that PROC SORT manipulates the uncompressed observation in memory and, if there is insufficient memory to complete the sort, stores the uncompressed data in a utility file. For these reasons, sorting compressed data sets might be intensive and require more storage than anticipated. Consider using the TAGSORT option when sorting compressed data sets.

Note: If the SAS system option NOREPLACE is in effect, then you cannot replace an original permanent data set with a sorted version. You must either use the OUT= option or specify the SAS system option REPLACE in an OPTIONS statement. The SAS system option NOREPLACE does not affect temporary SAS data sets.

Examples: SORT Procedure

Example 1: Sorting by the Values of Multiple Variables

Features:

PROC SORT statement option
OUT=

BY statement

PROC PRINT

Details

This example does the following:

- sorts the observations by the values of two variables
- creates an output data set for the sorted observations
- prints the results

Program

```
data account;
   input Company $ 1-22 Debt 25-30 AccountNumber 33-36
         Town $ 39-51;
   datalines;
Paul's Pizza              83.00  1019  Apex
World Wide Electronics   119.95  1122  Garner
Strickland Industries    657.22  1675  Morrisville
Ice Cream Delight        299.98  2310  Holly Springs
Watson Tabor Travel       37.95  3131  Apex
Boyd & Sons Accounting   312.49  4762  Garner
Bob's Beds               119.95  4998  Morrisville
Tina's Pet Shop           37.95  5108  Apex
Elway Piano and Organ     65.79  5217  Garner
Tim's Burger Stand       119.95  6335  Holly Springs
Peter's Auto Parts        65.79  7288  Apex
Deluxe Hardware          467.12  8941  Garner
Pauline's Antiques       302.05  9112  Morrisville
Apex Catering             37.95  9923  Apex
;

proc sort data=account out=bytown;

   by town company;
run;

proc print data=bytown;

   var company town debt accountnumber;

   title  'Customers with Past-Due Accounts';
   title2 'Listed Alphabetically within Town';
run;
```

Program Description

Create the input data set ACCOUNT. ACCOUNT contains the name of each business that owes money, the amount of money that it owes on its account, the account number, and the town where the business is located.

```
data account;
   input Company $ 1-22 Debt 25-30 AccountNumber 33-36
         Town $ 39-51;
   datalines;
Paul's Pizza              83.00  1019  Apex
World Wide Electronics   119.95  1122  Garner
Strickland Industries    657.22  1675  Morrisville
Ice Cream Delight        299.98  2310  Holly Springs
Watson Tabor Travel       37.95  3131  Apex
Boyd & Sons Accounting   312.49  4762  Garner
Bob's Beds               119.95  4998  Morrisville
Tina's Pet Shop           37.95  5108  Apex
Elway Piano and Organ     65.79  5217  Garner
Tim's Burger Stand       119.95  6335  Holly Springs
Peter's Auto Parts        65.79  7288  Apex
Deluxe Hardware          467.12  8941  Garner
Pauline's Antiques       302.05  9112  Morrisville
Apex Catering             37.95  9923  Apex
;
```

Create the output data set BYTOWN. OUT= creates a new data set for the sorted observations.

```
proc sort data=account out=bytown;
```

Sort by two variables. The BY statement specifies that the observations should be first ordered alphabetically by town and then by company.

```
   by town company;
run;
```

Print the output data set BYTOWN. PROC PRINT prints the data set BYTOWN.

```
proc print data=bytown;
```

Specify the variables to be printed. The VAR statement specifies the variables to be printed and their column order in the output.

```
   var company town debt accountnumber;
```

Specify the titles.

```
   title  'Customers with Past-Due Accounts';
   title2 'Listed Alphabetically within Town';
run;
```

Output: HTML

Output 64.3 *Sorting by the Values of Multiple Variables*

Customers with Past-Due Accounts
Listed Alphabetically within Town

Obs	Company	Town	Debt	AccountNumber
1	Apex Catering	Apex	37.95	9923
2	Paul's Pizza	Apex	83.00	1019
3	Peter's Auto Parts	Apex	65.79	7288
4	Tina's Pet Shop	Apex	37.95	5108
5	Watson Tabor Travel	Apex	37.95	3131
6	Boyd & Sons Accounting	Garner	312.49	4762
7	Deluxe Hardware	Garner	467.12	8941
8	Elway Piano and Organ	Garner	65.79	5217
9	World Wide Electronics	Garner	119.95	1122
10	Ice Cream Delight	Holly Springs	299.98	2310
11	Tim's Burger Stand	Holly Springs	119.95	6335
12	Bob's Beds	Morrisville	119.95	4998
13	Pauline's Antiques	Morrisville	302.05	9112
14	Strickland Industries	Morrisville	657.22	1675

Example 2: Sorting in Descending Order

Features: This example BY statement option
DESCENDING
PROC PRINT

Data set: Account

Details

This example does the following:

- sorts the observations by the values of three variables
- sorts one of the variables in descending order

- prints the results

Program

```
proc sort data=account out=sorted;
   by town descending debt accountnumber;
run;
proc print data=sorted;
   var company town debt accountnumber;
   title  'Customers with Past-Due Accounts';
   title2 'Listed by Town, Amount, Account Number';
run;
```

Program Description

Create the output data set SORTED. OUT= creates a new data set for the sorted observations.

```
proc sort data=account out=sorted;
```

Sort by three variables with one in descending order. The BY statement specifies that observations should be first ordered alphabetically by town, then by descending value of amount owed, then by ascending value of the account number.

```
   by town descending debt accountnumber;
run;
```

Print the output data set SORTED. PROC PRINT prints the data set SORTED.

```
proc print data=sorted;
```

Specify the variables to be printed. The VAR statement specifies the variables to be printed and their column order in the output.

```
   var company town debt accountnumber;
```

Specify the titles.

```
   title  'Customers with Past-Due Accounts';
   title2 'Listed by Town, Amount, Account Number';
run;
```

Output: HTML

Note that sorting last by AccountNumber puts the businesses in Apex with a debt of $37.95 in order of account number.

Output 64.4 *Sorting in Descending Order*

Customers with Past-Due Accounts
Listed by Town, Amount, Account Number

Obs	Company	Town	Debt	AccountNumber
1	Paul's Pizza	Apex	83.00	1019
2	Peter's Auto Parts	Apex	65.79	7288
3	Watson Tabor Travel	Apex	37.95	3131
4	Tina's Pet Shop	Apex	37.95	5108
5	Apex Catering	Apex	37.95	9923
6	Deluxe Hardware	Garner	467.12	8941
7	Boyd & Sons Accounting	Garner	312.49	4762
8	World Wide Electronics	Garner	119.95	1122
9	Elway Piano and Organ	Garner	65.79	5217
10	Ice Cream Delight	Holly Springs	299.98	2310
11	Tim's Burger Stand	Holly Springs	119.95	6335
12	Strickland Industries	Morrisville	657.22	1675
13	Pauline's Antiques	Morrisville	302.05	9112
14	Bob's Beds	Morrisville	119.95	4998

Example 3: Maintaining the Relative Order of Observations in Each BY Group

Features: PROC SORT statement option
EQUALS | NOEQUALS
PROC PRINT

Details

This example does the following:

- sorts the observations by the value of the first variable
- maintains the relative order with the EQUALS option
- does not maintain the relative order with the NOEQUALS option

Program

```
data insurance;
   input YearsWorked 1 InsuranceID 3-5;
   datalines;
5 421
5 336
1 209
1 564
3 711
3 343
4 212
4 616
;

proc sort data=insurance out=byyears1 equals;

   by yearsworked;
run;

proc print data=byyears1;

   var yearsworked insuranceid;

   title 'Sort with EQUALS';
run;

proc sort data=insurance out=byyears2 noequals;

   by yearsworked;
run;

proc print data=byyears2;

   var yearsworked insuranceid;

   title 'Sort with NOEQUALS';
run;
```

Program Description

Create the input data set INSURANCE. INSURANCE contains the number of years worked by all insured employees and their insurance IDs.

```
data insurance;
   input YearsWorked 1 InsuranceID 3-5;
   datalines;
5 421
5 336
1 209
1 564
3 711
3 343
4 212
4 616
;
```

Create the output data set BYYEARS1 with the EQUALS option. OUT= creates a new data set for the sorted observations. The EQUALS option maintains the order of the observations relative to each other.

```
proc sort data=insurance out=byyears1 equals;
```

Sort by the first variable. The BY statement specifies that the observations should be ordered numerically by the number of years worked.

```
   by yearsworked;
run;
```

Print the output data set BYYEARS1. PROC PRINT prints the data set BYYEARS1.

```
proc print data=byyears1;
```

Specify the variables to be printed. The VAR statement specifies the variables to be printed and their column order in the output.

```
   var yearsworked insuranceid;
```

Specify the title.

```
   title 'Sort with EQUALS';
run;
```

Create the output data set BYYEARS2. OUT= creates a new data set for the sorted observations. The NOEQUALS option does not maintain the order of the observations relative to each other.

```
proc sort data=insurance out=byyears2 noequals;
```

Sort by the first variable. The BY statement specifies that the observations should be ordered numerically by the number of years worked.

```
   by yearsworked;
run;
```

Print the output data set BYYEARS2. PROC PRINT prints the data set BYYEARS2.

```
proc print data=byyears2;
```

Specify the variables to be printed. The VAR statement specifies the variables to be printed and their column order in the output.

```
   var yearsworked insuranceid;
```

Specify the title.

```
   title 'Sort with NOEQUALS';
run;
```

Output: HTML

Note that sorting with the EQUALS option versus sorting with the NOEQUALS option causes a different sort order for the observations where YearsWorked=3.

Output 64.5 *Sorting with the EQUALS Option*

Sort with EQUALS

Obs	YearsWorked	InsuranceID
1	1	209
2	1	564
3	3	711
4	3	343
5	4	212
6	4	616
7	5	421
8	5	336

Output 64.6 *Sorting with the NOEQUALS Option*

Sort with NOEQUALS

Obs	YearsWorked	InsuranceID
1	1	209
2	1	564
3	3	343
4	3	711
5	4	212
6	4	616
7	5	421
8	5	336

Example 4: Retaining the First Observation of Each BY Group

Features: PROC SORT statement option
NODUPKEY

BY statement

PROC PRINT

Data set: Account

Note: The EQUALS option must be in effect to ensure that the first observation for each BY group is the one that is retained by the NODUPKEY option. The EQUALS option is the default. If the NOEQUALS option has been specified, then one observation for each BY group is retained by the NODUPKEY option, but not necessarily the first observation.

Details

For this example, we are assuming that the Base SAS engine is being used. The Base SAS engine provides a consistent ordering where the first observation (the first observation that was written and stored) is generally the first one that is read by PROC SORT. The sorted data set contains only the first observation of each BY group.

Sorting causes observations that have equal BY variable values to be grouped together for output. Normally, PROC SORT writes all observations for each BY group that it assembles to the output data set. The NODUPKEY option instructs the SORT procedure to write only the first observation of each BY group to the output data set and discard any additional observations contained within that BY group. The resulting report in this example contains one observation for each town where the businesses are located.

Program

```
proc sort data=account out=towns nodupkey;
   by town;
run;
proc print data=towns;
   var town company debt accountnumber;
   title 'Towns of Customers with Past-Due Accounts';
run;
```

Program Description

Create the output data set TOWNS but include only the first observation of each BY group. NODUPKEY writes only the first observation of each BY group to the new data set TOWNS.

```
proc sort data=account out=towns nodupkey;
```

Sort by one variable. The BY statement specifies that observations should be ordered by town.

```
   by town;
run;
```

Print the output data set TOWNS. PROC PRINT prints the data set TOWNS.

```
proc print data=towns;
```

Specify the variables to be printed. The VAR statement specifies the variables to be printed and their column order in the output.

```
   var town company debt accountnumber;
```

Specify the title.

```
   title 'Towns of Customers with Past-Due Accounts';
run;
```

Output: HTML

The output data set contains only four observations, one for each town in the input data set.

Output 64.7 *Retaining the First Observation of Each BY Group*

Towns of Customers with Past-Due Accounts

Obs	Town	Company	Debt	AccountNumber
1	Apex	Paul's Pizza	83.00	1019
2	Garner	World Wide Electronics	119.95	1122
3	Holly Springs	Ice Cream Delight	299.98	2310
4	Morrisville	Strickland Industries	657.22	1675

Example 5: Linguistic Sorting Using ALTERNATE_HANDLING=

Features:

PROC SORT statement option
sortseq=linguistic
ALTERNATE_HANDLING=SHIFTED
STRENGTH=3

BY statement

VAR statement

PROC PRINT

PROC CONTENTS

Note: For more information about strengthening the linguistic sort of strings, see "Example 6: Linguistic Sorting Using ALTERNATE_HANDLING= and STRENGTH=" on page 2405.

Details

In this example, PROC SORT creates an output data set that contains only the first observation of each BY group. You have specified ALTERNATE_HANDLING=SHIFTED because you want "a-b" to sort close to "ab" and "aB". That is, you do not want "a-b" to appear somewhere far away from "ab" and "aB" by virtue of its hyphen.

Note: In this example, the default STRENGTH for this locale is 3.

Notice how "a-b" and "ab" are treated equivalently in the following example. To order them beyond the first three levels of comparison (alphabetic, diacritic, and case), you can use the fourth level of comparison and specify STRENGTH=4. "Example 6: Linguistic Sorting Using ALTERNATE_HANDLING= and STRENGTH=" on page 2405 shows how to distinguish the strings further.

PROC CONTENTS shows a Sort Information section in the output. The ICU version is also shown in the sort information. In SAS 9.4, the ICU library incorporated by SAS and used by PROC SORT is ICU version 4.8.1. In SAS Viya, the ICU library version incorporated by SAS and used by PROC SORT is ICU 56.

Program

```
data a;
   length x $ 10;
   x='a-b'; output;
   x='ab'; output;
   x='a-b'; output;
   x='aB'; output;
run;

proc sort data=a sortseq=linguistic( ALTERNATE_HANDLING=SHIFTED );
   by x;
run;

title1 "Linguistic Collation with ALTERNATE_HANDLING=SHIFTED";
proc print data=a;
run;

title1 "Linguistic Collation with ALTERNATE_HANDLING=SHIFTED and BY
Processing";
proc print data=a;
   var x;
   by x;
run;
```

```
proc contents data=a;
run;
```

Program Description

Create the data set.

```
data a;
   length x $ 10;
   x='a-b'; output;
   x='ab'; output;
   x='a-b'; output;
   x='aB'; output;
run;
```

Sort the data set using linguistic sorting. Use linguistic sorting and the ALTERNATE_HANDLING=SHIFTED option to sort the data set. Note that the default STRENGTH for this locale is 3. Also use the BY statement to order observations by x.

```
proc sort data=a sortseq=linguistic( ALTERNATE_HANDLING=SHIFTED );
   by x;
run;
```

Print data set A. The TITLE1 statement tells the PRINT procedure the title to use for the output. PROC PRINT then prints data set A.

```
title1 "Linguistic Collation with ALTERNATE_HANDLING=SHIFTED";
proc print data=a;
run;
```

Print data set A using By processing. The TITLE1 statement tells the PRINT procedure the title to use for the output. PROC PRINT then prints data set A using By processing.

```
title1 "Linguistic Collation with ALTERNATE_HANDLING=SHIFTED and BY
Processing";
proc print data=a;
   var x;
   by x;
run;
```

Print the Sort Information when linguistic sorting is being used. The PROC CONTENTS output contains a Sort Information section when PROC SORT is used with linguistic collation. This sort information also includes the ICU version being used.

```
proc contents data=a;
run;
```

Output: HTML

The first PROC PRINT shows that the order of "a-b" and "ab" is not well defined. The second PROC PRINT uses BY processing to show that these values are considered

equivalent. “Example 6: Linguistic Sorting Using ALTERNATE_HANDLING= and STRENGTH=” on page 2405 shows how to distinguish the strings more.

Output 64.8 *Linguistic Sorting Using the ALTERNATE_HANDLING Option*

Linguistic Collation with ALTERNATE_HANDLING=SHIFTED

Obs	x
1	a-b
2	ab
3	a-b
4	aB

Linguistic Collation with ALTERNATE_HANDLING=SHIFTED and BY Processing

x=a-b

Obs	x
1	a-b
2	ab
3	a-b

x=aB

Obs	x
4	aB

PROC CONTENTS prints out sort information when linguistic sorting is used. Information about the ICU version that is being used is also provided.

Sort Information	
Sortedby	x
Validated	YES
Character Set	ANSI
Collating Sequence	LINGUISTIC
Locale	en_US
Strength	3
Alternate Handling	SHIFTED
ICU Version Number	48

Example 6: Linguistic Sorting Using ALTERNATE_HANDLING= and STRENGTH=

Features:

PROC SORT statement option
sortseq=linguistic
ALTERNATE_HANDLING=SHIFTED
STRENGTH=4

BY statement

VAR statement

PROC PRINT

Details

In this example, PROC SORT creates an output data set that contains only the first observation of each BY group. In this example, ALTERNATE_HANDLING=SHIFTED is specified because you want "a-b" to sort close to "ab" and "aB" regardless of the hyphen.

Notice how "a-b" and "ab" are treated equivalently in the following example. However, if you want to further distinguish between them and have them appear in two separate BY groups, you must order the strings further. To order them beyond the first three levels of comparison (alphabetic, diacritic, and case), use the fourth level of comparison, STRENGTH=4.

Program

```
data a;
   length x $ 10;
   x='a-b'; output;
   x='ab'; output;
   x='a-b'; output;
   x='aB'; output;
run;

proc sort data=a sortseq=linguistic( ALTERNATE_HANDLING=SHIFTED
STRENGTH=4);
   by x;
run;

title1 "Linguistic Collation with STRENGTH=4";
proc print data=a;
run;

Title1 "Linguistic Collation with STRENGTH=4 and BY Processing";
proc print data=a;
   var x;
   by x;
run;
```

Program Description

Create the data set.

```
data a;
   length x $ 10;
   x='a-b'; output;
   x='ab'; output;
   x='a-b'; output;
   x='aB'; output;
run;
```

Sort the data set using linguistic sorting. Use linguistic sorting and the ALTERNATE_HANDLING=SHIFTED option to sort the data set. Note that the default STRENGTH for this locale is 4. The BY statement specifies that observations should be ordered by x.

```
proc sort data=a sortseq=linguistic( ALTERNATE_HANDLING=SHIFTED
STRENGTH=4);
   by x;
run;
```

Print the output data set A. The TITLE1 statement tells the PRINT procedure the title to use for the output. PROC PRINT then prints data set A.

```
title1 "Linguistic Collation with STRENGTH=4";
proc print data=a;
run;
```

Print the output data set A using By processing. The TITLE statement tells the PRINT procedure what title to use for this output. PROC PRINT then prints data set A using By processing.

```
Title1 "Linguistic Collation with STRENGTH=4 and BY Processing";
proc print data=a;
   var x;
   by x;
run;
```

Output: HTML

The first PROC PRINT shows that the order of "a-b" and "ab" is not well defined. Differentiate between the two by setting STRENGTH=4. The second PROC PRINT uses BY processing to show the order of precedence and how they are differentiated.

Output 64.9 *Linguistic Sorting Using the ALTERNATE_HANDLING and STRENGTH Options*

Linguistic Collation with STRENGTH=4

Obs	x
1	a-b
2	a-b
3	ab
4	aB

Linguistic Collation with STRENGTH=4 and BY Processing

x=a-b

Obs	x
1	a-b
2	a-b

x=ab

Obs	x
3	ab

x=aB

Obs	x
4	aB

Example 7: Eliminate All Duplicate Observations Using NODUPKEY

Features:

PROC SORT statement option
- NODUPKEY
- OUT=

BY statement

PROC PRINT

KEEP= data set option

Details

In this example, PROC SORT with NODUPKEY creates an output data set that has no duplicate observations. Each of these observations is unique. There is only one observation in the output data set for a given set of variable values. The BY _ALL_ variable sorts by the kept variables (KEEP= option), DIVISION and LEAGUE.

Program

```
proc sort data=sashelp.baseball(keep=division league)out=DL NODUPKEY;
   by _ALL_;
run;
```

```
proc print data=DL;
title 'Baseball Leagues and Divisions';
run;
```

Program Description

Processing only the division and league variables from the input data set (KEEP=), create the DL output data set and remove all duplicate entries.

```
proc sort data=sashelp.baseball(keep=division league)out=DL NODUPKEY;
```

Sort by all variables.

```
   by _ALL_;
run;
```

Print the output data set DL.

```
proc print data=DL;
title 'Baseball Leagues and Divisions';
run;
```

Output: HTML

The output data set contains only four observations, one for each unique division and league in baseball. No duplicate entries for Division and League are kept.

Output 64.10 *Remove all Duplicate observations from a Data Set*

Baseball Leagues and Divisions

Obs	League	Division
1	American	East
2	American	West
3	National	East
4	National	West

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SQL Procedure

A Brief Overview

The SQL procedure is the Base SAS implementation of Structured Query Language. PROC SQL is part of Base SAS software, and you can use it with any SAS data set (table). Often, PROC SQL can be an alternative to other SAS procedures or the DATA step. You can use SAS language elements such as global statements, data set options, functions, informats, and formats with PROC SQL just as you can with other SAS procedures. PROC SQL enables you to perform the following tasks:

- generate reports
- generate summary statistics
- retrieve data from tables or views
- combine data from tables or views
- create tables, views, and indexes
- update the data values in PROC SQL tables
- update and retrieve data from database management system (DBMS) tables
- modify a PROC SQL table by adding, modifying, or dropping columns

For more information, see *SAS SQL Procedure User's Guide*

Example: Using the SQL Procedure

The following example selects all rows where Type="Sports" and the MSRP is greater than 100,000 from the Cars data set.

```
proc sql;
   select * from sashelp.cars
      where Type='Sports' and MSRP>100000;
quit;
```

Output 65.1 *SQL Procedure Result*

Make	Model	Type	Origin	DriveTrain	MSRP	Invoice	Engine Size (L)	Cylinders	Horsepower	MPG (City)	MPG (Highway)	Weight (LBS)	Wheelbase (IN)	Length (IN)
Mercedes-Benz	SL55 AMG 2dr	Sports	Europe	Rear	$121,770	$113,388	5.5	8	493	14	21	4235	101	179
Mercedes-Benz	SL600 convertible 2dr	Sports	Europe	Rear	$126,670	$117,854	5.5	12	493	13	19	4429	101	179
Porsche	911 GT2 2dr	Sports	Europe	Rear	$192,465	$173,560	3.6	6	477	17	24	3131	93	175

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SQOOP Procedure

Overview: SQOOP Procedure

What Does the SQOOP Procedure Do?

You can use Apache Sqoop (pronounced *scoop*) to transfer data between Hadoop and relational database management systems (RDBMSs). You can use the SQOOP procedure to access Apache Sqoop from a SAS session to transfer data between a database and HDFS. It lets you submit Sqoop commands from within your SAS application to your Hadoop cluster.

Sqoop commands are passed to the cluster using the Apache Oozie Workflow Scheduler for Hadoop. PROC SQOOP defines an Oozie workflow for your Sqoop task, which is then submitted to an Oozie server using a RESTful API.

PROC SQOOP works similarly to the Apache Sqoop command-line interface (CLI). Using the same syntax, a user who has licensed SAS/ACCESS Interface to Hadoop can transfer data between a database and HDFS. The user can submit Sqoop CLI

commands in the COMMAND statement for the SQOOP procedure. The procedure provides feedback as to whether the job completed successfully and where to get more details from your Hadoop cluster if the Sqoop task failed.

Some Hadoop distributions support different versions of the Sqoop command. Refer to the documentation for your distribution for specific Sqoop command syntax.

For more information about Apache Sqoop, see the online documentation at http://sqoop.apache.org and http://sqoop.apache.org/docs/1.4.5/index.html.

For Sqoop considerations and usage, refer to the *Apache Sqoop Cookbook*.

You can find more information about Oozie at http://oozie.apache.org.

Syntax: SQOOP Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Requirements: To use this procedure requires a separate license to SAS/ACCESS Interface to Hadoop.

Specify the --username or --password options separately with the DBUSER= and DBPWD= options in the PROC SQOOP statement rather than in the Sqoop command.

Supports: Kerberos only on Linux

Notes: By default, the SQOOP procedure uses the hive-site.xml file to locate the Zookeeper service discovery. If the Zookeeper service discovery is not available, in the SQOOP procedure you can set a server name and port with the HIVE_SERVER= option or a JDBC URI with the HIVE_URI= option.

Support for HIVE_SERVER= and HIVE_URI= options was added in SAS Viya 3.5

See: SERVER= LIBNAME connection option, URI= LIBNAME connection option

Example: Importing from Teradata to HDFS Using an SQL Query

PROC SQOOP <*sqoop-options*>;

Statement	Task	Example
PROC SQOOP	Allow access to Apache Sqoop for data transfer	Ex. 1

PROC SQOOP Statement

Allows access to Apache Sqoop using options to allow data transfer between a database and HDFS.

Syntax

PROC SQOOP
COMMAND='*command-to-sqoop*'
DBPWD='*database-password*'
DBUSER='*database-user-name*'
<DELETEWF>
HADOOPUSER='*hadoop-user-name*'
HADOOPPWD='*hadoop-password*'
<HIVE_SERVER='*server-name-and-port*'>
<HIVE_URI='*JDBC-URI*'>
<JOBTRACKER='*job-tracker-URL*'>
<NAMENODE='*name-node-URL*'>
OOZIEURL='*oozie-URL*'
<PASSWORDFILE='*password-file*'>
<WFHDFSPATH='*Oozie-workflow-path*'>;

run;

Required Arguments

COMMAND='*command-to-sqoop*'
specifies the Apache Sqoop command. Here is how you must specify the command:

```
SQOOP-command --option … --option
```

Restriction Do not use the `sqoop` invocation command.

Note The escape character, a forward slash (\), in $CONDITIONS is not required when you submit Sqoop commands using the SQOOP procedure.

Tip For more information about Apache Sqoop commands, see the online documentation at http://sqoop.apache.org.

DBPWD='*database-password*'
specifies the database password that is associated with the DBUSER option. Because this option is mutually exclusive with the PASSWORDFILE option, you must specifiy only one or the other.

DBUSER='*database-user-name*'
specifies the database user name to use for import or export.

HADOOPPWD='*hadoop-password*'
specifies the Hadoop password that is associated with the HADOOPUSER= option.

Restriction Do not provide this option when connecting to a cluster that is enabled for Kerberos.

HADOOPUSER='*hadoop-user-name*'
specifies the Hadoop user name to use for import or export.

Restriction Do not provide this option when connecting to a cluster that is enabled for Kerberos.

OOZIEURL='*oozie-URL*'
specifies the URL to the Oozie server.

Optional Arguments

DELETEWF
specifies that, if an Oozie workflow file exists as specified by the location in WFHDFSPATH, it should be deleted. The SQOOP procedure then creates a new workflow file at that location.

HIVE_SERVER='*server-name-and-port*'
specifies the Hive server name that runs the Hive service and the port number to use to connect to the specified Hive service.

Restriction You can specify only one option at a time: HIVE_SERVER= or HIVE_URI=.

Requirements If the server name contains spaces or nonalphanumeric characters, you must enclose it in quotation marks.

This option is required when connecting to a Kerberized HDP 3.1 cluster when the hive-site.xml file does not contain the Zookeeper service.

HIVE_URI=jdbc:hive2://*HiveServerHost*:*HiveServerPort*</Schema:*Property1=Value*;...><*PropertyN=Value*;>
specifies the JDBC URI.

Restriction You can specify only one option at a time: HIVE_SERVER= or HIVE_URI=.

Requirement This option is required when connecting to a Kerberized HDP 3.1 cluster when the hive-site.xml file does not contain the Zookeeper service.

Example `jdbc:hive2://MyHiveServer:10000`

JOBTRACKER='*job-tracker-URL*'
specifies the URL to the JobTracker or ResourceManager services.

Default SAS_HADOOP_CONFIG_PATH determines the value for this option if you do not specify one.

NAMENODE='*name-node-URL*'
specifies the URL to the NameNode services.

Default SAS_HADOOP_CONFIG_PATH determines the value for this option if you do not specify one.

PASSWORDFILE='*password-file*'
specifies the name of the file that is located in HDFS that contains the database password for import or export. This separate password file must exist before you can run this procedure, and care should be taken to keep this file secure.

WFHDFSPATH='*Oozie-workflow-path-and-filename*'
specifies the path and filename for where to upload the Oozie workflow, as shown below.

```
/user/myID/mydir/myfile.xml
```

Default A generated path is used if you do not provide a value.

Tip You can use hdfs://server syntax, although it is not required.

Usage: SQOOP Procedure

General Usage

Because the Oracle JDBC Connector requires it, you must specify the value to be used for the --table option in Sqoop in uppercase letters. For details about case sensitivity for tables, see the documentation for your specific DBMS.

Connection strings should include the character set option that is appropriate for the data to be imported. For details, refer to your connector documentation.

Using Workflows

Workflows are created only when they are required. Some SQOOP jobs can use Oozie proxy submission, which generates no workflow file. Proxy submission is selected if you are running Oozie 4.1 or later and are not using a Hive table as the destination. The SAS log contains a note if PROC SQOOP uses proxy submission.

Requirements for Using the SQOOP Procedure

Here is what you need before you can begin using the SQOOP procedure.

What You Need	PROC SQOOP Option	Where to Find It
database connector	COMMAND: Sqoop syntax requires a --connection option that is specific to your database.	Refer to the documentation for your Hadoop distribution.
database user ID	DBUSER	Contact your database administrator.
database password	DBPWD	
HDFS file that contains the database password	PASSWORDFILE	Contact your database administrator and your Hadoop cluster administrator.
Hadoop user ID	HADOOPUSER	Contact your Hadoop cluster administrator.
Hadoop password	HADOOPPWD	
Oozie URL	OOZIEURL	
name node	NAMENODE	
Job Tracker (MR1) or Resource Manager (MR2)	JOBTRACKER	
Oozie workflow output path	WFHDFSPATH	Contact your Hadoop cluster administrator. Generally, the Oozie workflow can be written to your user directory in HDFS.
Sqoop Command	COMMN	Refer to the Sqoop documentation for your Hadoop distribution.

Example: Importing from Teradata to HDFS Using an SQL Query

In this example, DELETEWF is included to replace an existing workflow with a new workflow for this task.

Note: For proper default NAMENODE and JOBTRACKER port values for your environment, check the configuration for your particular distribution or refer to your Hadoop documentation.

```
proc sqoop dbuser='mydbusr1' dbpwd='mydbpwd1'
   hadoopuser='sashdpusr1' hadooppwd='sashdppwd1'
   oozieurl='http://myoozie-04:55000/oozie'
   namenode='hdfs://myoozie-04.unx.srvr.com:8020'
   jobtracker='myoozie-04.unx.srvr.com:8032'
   wfhdfspath='hdfs://myoozie-04.unx.srvr.com:8020/user/mydbusr1/
myworkflow.xml'
   deletewf
   command='import
      --connection-manager
com.cloudera.connector.teradata.TeradataManager
      --connect jdbc:teradata://myconnecti/Database=sqoop
      --query "SELECT * FROM sales where ($CONDITIONS and I < 25)" -m 1
      --split-by i --delete-target-dir
      --target-dir /user/mydbusr1/sales2';
run;
```

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STANDARD Procedure

Overview: STANDARD Procedure

What Does the STANDARD Procedure Do?

The STANDARD procedure standardizes variables in a SAS data set to a given mean and standard deviation, and it creates a new SAS data set containing the standardized values.

Standardizing Data

The following output shows a simple standardization where the output data set contains standardized student exam scores. The statements that produce the output follow:

```
proc standard data=score mean=75 std=5
              out=stndtest;
run;

proc print data=stndtest;
run;
```

Output 67.1 *Standardized Test Scores Using PROC STANDARD*

```
                        The SAS System                          1

                Obs    Student       Test1

                  1    Capalleti    80.5388
                  2    Dubose       64.3918
                  3    Engles       80.9143
                  4    Grant        68.8980
                  5    Krupski      75.2816
                  6    Lundsford    79.7877
                  7    McBane       73.4041
                  8    Mullen       78.6612
                  9    Nguyen       74.9061
                 10    Patel        71.9020
                 11    Si           73.4041
                 12    Tanaka       77.9102
```

The following output shows a more complex example that uses BY-group processing. PROC STANDARD computes Z scores separately for two BY groups by standardizing life-expectancy data to a mean of 0 and a standard deviation of 1. The data are 1950 and 1993 life expectancies at birth for 16 countries. The birth rates for each country, classified as stable or rapid, form the two BY groups. The statements that produce the analysis also do the following:

- print statistics for each variable to standardize
- replace missing values with the given mean
- calculate standardized values using a given mean and standard deviation
- print the data set with the standardized values

For an explanation of the program that produces this output, see "Example 2: Standardizing BY Groups and Replacing Missing Values" on page 2435.

Output 67.2 *Z Scores for Each BY Group Using PROC STANDARD*

```
               Life Expectancies by Birth Rate                2

-------------------- PopulationRate=Stable ---------------------

                    The STANDARD Procedure

                                 Standard
    Name              Mean       Deviation               N
    Label

    Life50       67.400000        1.854724               5
    1950 life expectancy
    Life93       74.500000        4.888763               6
    1993 life expectancy


--------------------- PopulationRate=Rapid ----------------------

                                 Standard
    Name              Mean       Deviation               N
    Label

    Life50       42.000000        5.033223               8
    1950 life expectancy
    Life93       59.100000        8.225300              10
    1993 life expectancy
```

```
          Standardized Life Expectancies at Birth            3
                 by a Country's Birth Rate

     Population
        Rate       Country            Life50      Life93

       Stable      France            -0.21567     0.51138
       Stable      Germany            0.32350     0.10228
       Stable      Japan             -1.83316     0.92048
       Stable      Russia             0.00000    -1.94323
       Stable      United Kingdom     0.86266     0.30683
       Stable      United States      0.86266     0.10228
       Rapid       Bangladesh         0.00000    -0.74161
       Rapid       Brazil             1.78812     0.96045
       Rapid       China             -0.19868     1.32518
       Rapid       Egypt              0.00000     0.10942
       Rapid       Ethiopia          -1.78812    -1.59265
       Rapid       India             -0.59604    -0.01216
       Rapid       Indonesia         -0.79472    -0.01216
       Rapid       Mozambique         0.00000    -1.47107
       Rapid       Philippines        1.19208     0.59572
       Rapid       Turkey             0.39736     0.83888
```

Syntax: STANDARD Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Tip: You can use the ATTRIB, FORMAT, LABEL, and WHERE statements. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

PROC STANDARD <*options*>;

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...> <NOTSORTED>;

FREQ *variable*;

VAR *variable(s)*;

WEIGHT *variable*;

Statement	Task	Example
PROC STANDARD	Standardize variables to a given mean and standard deviation	Ex. 1, Ex. 2
BY	Calculate separate standardized values for each BY group	Ex. 2
FREQ	Identify a variable whose values represent the frequency of each observation	
VAR	Select the variables to standardize and determine the order in which they appear in the printed output	Ex. 1
WEIGHT	Identify a variable whose values weight each observation in the statistical calculations	

PROC STANDARD Statement

Standardizes variables in a SAS data set to a given mean and standard deviation, and it creates a new SAS data set containing the standardized values.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Examples: "Example 2: Standardizing BY Groups and Replacing Missing Values" on page 2435

"Example 1: Standardizing to a Given Mean and Standard Deviation" on page 2432

Syntax

PROC STANDARD <*options*>;

Summary of Optional Arguments

DATA=*SAS-data-set*
: specifies the input data set.

EXCLNPWGT
: excludes observations with nonpositive weights.

MEAN=*mean-value*
: specifies the mean value.

OUT=*SAS-data-set*
: specifies the output data set.

REPLACE
: replace missing values with a variable mean or MEAN= value.

STD=*std-value*
: specifies the standard deviation value.

VARDEF=*divisor*
: specifies the divisor for variance calculations.

Control printed output

NOPRINT
: suppresses all printed output.

PRINT
: prints statistics for each variable to standardize.

Preserve values

PRESERVERAWBYVALUES
: preserves raw by values.

Without Arguments

If you do not specify MEAN=, REPLACE, or STD=, the output data set is an identical copy of the input data set.

Optional Arguments

DATA=*SAS-data-set*
: specifies the input SAS data set.

Restriction: You cannot use PROC STANDARD with an engine that supports concurrent access if another user is updating the data set at the same time.

See: "Input Data Sets" on page 26

EXCLNPWGT
excludes observations with nonpositive weight values (zero or negative). The procedure does not use the observation to calculate the mean and standard deviation, but the observation is still standardized. By default, the procedure treats observations with negative weights like those with zero weights and counts them in the total number of observations.

Alias EXCLNPWGTS

MEAN=*mean-value*
standardizes variables to a mean of *mean-value*.

Default mean of the input values

Example "Example 1: Standardizing to a Given Mean and Standard Deviation" on page 2432

NOPRINT
suppresses the printing of the procedure output. NOPRINT is the default value.

OUT=*SAS-data-set*
specifies the output data set. If *SAS-data-set* does not exist, PROC STANDARD creates it. If you omit OUT=, the data set is named Data*n*, where *n* is the smallest integer that makes the name unique.

Default Data*n*

Example "Example 1: Standardizing to a Given Mean and Standard Deviation" on page 2432

PRESERVERAWBYVALUES
preserves raw by values. of all BY variables when those variables are propagated to the output data set.

PRINT
prints the original frequency, mean, and standard deviation for each variable to standardize.

Example "Example 2: Standardizing BY Groups and Replacing Missing Values" on page 2435

REPLACE
replaces missing values with the variable mean.

Interaction If you use MEAN=, PROC STANDARD replaces missing values with the given mean.

Example "Example 2: Standardizing BY Groups and Replacing Missing Values" on page 2435

STD=*std-value*
standardizes variables to a standard deviation of *std-value*.

Default standard deviation of the input values

Example "Example 1: Standardizing to a Given Mean and Standard Deviation" on page 2432

VARDEF=*divisor*

specifies the divisor to use in the calculation of variances and standard deviation. The following table shows the possible values for *divisor* and the associated divisors.

Table 67.1 *Possible Values for VARDEF=*

Value	Divisor	Formula for Divisor
DF	Degrees of freedom	$n - 1$
N	Number of observations	n
WDF	Sum of weights minus one	$(\Sigma_i w_i) - 1$
WEIGHT|WGT	Sum of weights	$\Sigma_i w_i$

The procedure computes the variance as $CSS/divisor$, where CSS is the corrected sums of squares and equals $\Sigma (x_i - \overline{x})^2$. When you weight the analysis variables, CSS equals $\Sigma w_i(x_i - \overline{x}_w)^2$ where $\overline{x}_w$ is the weighted mean.

Default DF

Tips When you use the WEIGHT statement and VARDEF=DF, the variance is an estimate of σ^2 , where the variance of the *i*th observation is $var(x_i) = \sigma^2/w_i$ and w_i is the weight for the *i*th observation. This yields an estimate of the variance of an observation with unit weight.

When you use the WEIGHT statement and VARDEF=WGT, the computed variance is asymptotically (for large *n*) an estimate of $\sigma^2/\overline{w}$, where $\overline{w}$ is the average weight. This yields an asymptotic estimate of the variance of an observation with average weight.

See "WEIGHT" on page 82

"Keywords and Formulas" on page 2700

BY Statement

Calculates standardized values separately for each BY group.

See: "BY" on page 74

Example: "Example 2: Standardizing BY Groups and Replacing Missing Values" on page 2435

Syntax

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...> <NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, then the observations in the data set must either be sorted by all the variables that you specify. Otherwise, they must be indexed appropriately. These variables are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the data set is sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The data are grouped in another way, such as chronological order.

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, the procedure treats each contiguous set as a separate BY group.

FREQ Statement

Specifies a numeric variable whose values represent the frequency of the observation.

Tip: The effects of the FREQ and WEIGHT statements are similar except when calculating degrees of freedom.

See: For an example that uses the FREQ statement, see "FREQ" on page 79

Syntax

FREQ *variable*;

Required Argument

variable
specifies a numeric variable whose value represents the frequency of the observation. If you use the FREQ statement, the procedure assumes that each observation represents *n* observations, where *n* is the value of *variable*. If *n* is not an integer, SAS truncates it. If *n* is less than 1 or is missing, the procedure does not use that observation to calculate statistics but the observation is still standardized.

The sum of the frequency variable represents the total number of observations.

VAR Statement

Specifies the variables to standardize and their order in the printed output.

Default: If you omit the VAR statement, PROC STANDARD standardizes all numeric variables not listed in the other statements.

Example: "Example 1: Standardizing to a Given Mean and Standard Deviation" on page 2432

Syntax

VAR *variable(s)*;

Required Argument

variable(s)
identifies one or more variables to standardize.

WEIGHT Statement

Specifies weights for analysis variables in the statistical calculations.

See: For information about calculating weighted statistics and for an example that uses the WEIGHT statement, see "WEIGHT" on page 82.

Syntax

WEIGHT *variable*;

Required Argument

variable

specifies a numeric variable whose values weight the values of the analysis variables. The values of the variable do not have to be integers. The table below shows what the action will be based on the weight value.

Table 67.2 *WEIGHT Statement Value and PROC STANDARD Action*

Weight Value	PROC STANDARD Action
0	Counts the observation in the total number of observations
Less than 0	Converts the weight value to zero and counts the observation in the total number of observations
Missing	Excludes the observation from the calculation of mean and standard deviation

To exclude observations that contain negative and zero weights from the calculation of mean and standard deviation, use EXCLNPWGT. Note that most SAS/STAT procedures, such as PROC GLM, exclude negative and zero weights by default.

Tip When you use the WEIGHT statement, consider which value of the VARDEF= option is appropriate. For more information, see "VARDEF=*divisor* " on page 2427 and the calculation of weighted statistics in "Keywords and Formulas" on page 2700.

Details

Note: Prior to Version 7 of SAS, the procedure did not exclude the observations with missing weights from the count of observations.

Usage: STANDARD Procedure

Statistical Computations: STANDARD Procedure

Standardizing values removes the location and scale attributes from a set of data. The formula to compute standardized values is

$$x_i' = \frac{S * (x_i - \overline{x})}{s_x} + M$$

where

x_i'
is a new standardized value.

S
is the value of STD=.

M
is the value of MEAN=.

x_i
is an observation's value.

$\overline{x}$
is a variable's mean.

s_x
is a variable's standard deviation.

PROC STANDARD calculates the mean ($\overline{x}$) and standard deviation (s_x) from the input data set. The resulting standardized variable has a mean of **M** and a standard deviation of **S**.

If the data are normally distributed, standardizing is also studentizing since the resulting data have a Student's **t** distribution.

Results: STANDARD Procedure

Missing Values

By default, PROC STANDARD excludes missing values for the analysis variables from the standardization process, and the values remain missing in the output data set. When you specify the REPLACE option, the procedure replaces missing values with the variable's mean or the MEAN= value.

If the value of the WEIGHT variable or the FREQ variable is missing, then the procedure does not use the observation to calculate the mean and the standard deviation. However, the observation is standardized.

Output Data Set

PROC STANDARD always creates an output data set that stores the standardized values in the VAR statement variables, regardless of whether you specify the OUT= option. The output data set contains all the input data set variables, including those not standardized. PROC STANDARD does not print the output data set. Use PROC PRINT, PROC REPORT, or another SAS reporting tool to print the output data set.

Examples: STANDARD Procedure

Example 1: Standardizing to a Given Mean and Standard Deviation

Features: PROC STANDARD statement options
- MEAN=
- OUT=
- STD=

VAR statement
PRINT procedure

Details

This example does the following:

- standardizes two variables to a mean of 75 and a standard deviation of 5
- specifies the output data set
- combines standardized variables with original variables
- prints the output data set

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

data score;
   length Student $ 9;
   input Student $ StudentNumber Section $
         Test1 Test2 Final @@;
   format studentnumber z4.;
   datalines;
Capalleti 0545 1 94 91 87  Dubose    1252 2 51 65 91
Engles    1167 1 95 97 97  Grant     1230 2 63 75 80
Krupski   2527 2 80 69 71  Lundsford 4860 1 92 40 86
McBane    0674 1 75 78 72  Mullen    6445 2 89 82 93
Nguyen    0886 1 79 76 80  Patel     9164 2 71 77 83
Si        4915 1 75 71 73  Tanaka    8534 2 87 73 76
;

proc standard data=score mean=75 std=5 out=stndtest;

   var test1 test2;
run;

proc sql;
   create table combined as
   select old.student, old.studentnumber,
          old.section,
          old.test1, new.test1 as StdTest1,
          old.test2, new.test2 as StdTest2,
          old.final
   from score as old, stndtest as new
   where old.student=new.student;

proc print data=combined noobs round;
   title 'Standardized Test Scores for a College Course';
run;
```

Program Description

Set the SAS system options. The NODATE option specifies to omit the date and time at which the SAS job began. The PAGENO= option specifies the page number for the next page of output that SAS produces. The LINESIZE= option specifies the line size. The PAGESIZE= option specifies the number of lines for a page of SAS output.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Create the Score data set. This data set contains test scores for students who took two tests and a final exam. The FORMAT statement assigns the Z*w.d* format to StudentNumber. This format pads right-justified output with 0s instead of blanks. The LENGTH statement specifies the number of bytes to use to store values of Student.

```
data score;
   length Student $ 9;
   input Student $ StudentNumber Section $
         Test1 Test2 Final @@;
   format studentnumber z4.;
   datalines;
Capalleti 0545 1 94 91 87  Dubose    1252 2 51 65 91
Engles    1167 1 95 97 97  Grant     1230 2 63 75 80
Krupski   2527 2 80 69 71  Lundsford 4860 1 92 40 86
McBane    0674 1 75 78 72  Mullen    6445 2 89 82 93
Nguyen    0886 1 79 76 80  Patel     9164 2 71 77 83
Si        4915 1 75 71 73  Tanaka    8534 2 87 73 76
;
```

Generate the standardized data and create the Stndtest output data set. PROC STANDARD uses a mean of 75 and a standard deviation of 5 to standardize the values. OUT= identifies Stndtest as the data set to contain the standardized values.

```
proc standard data=score mean=75 std=5 out=stndtest;
```

Specify the variables to standardize. The VAR statement specifies the variables to standardize and their order in the output.

```
   var test1 test2;
run;
```

Create a data set that combines the original values with the standardized values. PROC SQL joins Score and Stndtest to create the Combined data set (table) that contains standardized and original test scores for each student. Using AS to rename the standardized variables NEW.TEST1 to StdTest1 and NEW.TEST2 to StdTest2 makes the variable names unique.

```
proc sql;
   create table combined as
   select old.student, old.studentnumber,
          old.section,
          old.test1, new.test1 as StdTest1,
          old.test2, new.test2 as StdTest2,
          old.final
   from score as old, stndtest as new
   where old.student=new.student;
```

Print the data set. PROC PRINT prints the Combined data set. ROUND rounds the standardized values to two decimal places. The TITLE statement specifies a title.

```
proc print data=combined noobs round;
   title 'Standardized Test Scores for a College Course';
run;
```

Output: Listing

The following data set contains variables with both standardized and original values. StdTest1 and StdTest2 store the standardized test scores that PROC STANDARD computes.

Output 67.3 *Standardized Test Scores for a College Course*

Standardized Test Scores for a College Course 1

Student	Student Number	Section	Test1	Std Test1	Test2	Std Test2	Final
Capalleti	0545	1	94	80.54	91	80.86	87
Dubose	1252	2	51	64.39	65	71.63	91
Engles	1167	1	95	80.91	97	82.99	97
Grant	1230	2	63	68.90	75	75.18	80
Krupski	2527	2	80	75.28	69	73.05	71
Lundsford	4860	1	92	79.79	40	62.75	86
McBane	0674	1	75	73.40	78	76.24	72
Mullen	6445	2	89	78.66	82	77.66	93
Nguyen	0886	1	79	74.91	76	75.53	80
Patel	9164	2	71	71.90	77	75.89	83
Si	4915	1	75	73.40	71	73.76	73
Tanaka	8534	2	87	77.91	73	74.47	76

Example 2: Standardizing BY Groups and Replacing Missing Values

Features:

PROC STANDARD statement options
- PRINT
- REPLACE

BY statement

FORMAT procedure

PRINT procedure

SORT procedure

Details

This example does the following:

- calculates Z scores separately for each BY group using a mean of 0 and standard deviation of 1
- replaces missing values with the given mean
- prints the mean and standard deviation for the variables to standardize
- prints the output data set

Program

```
options nodate pageno=1 linesize=80 pagesize=60;

proc format;
   value popfmt 1='Stable'
                2='Rapid';
run;

data lifexp;
   input PopulationRate Country $char14. Life50 Life93 @@;
   label life50='1950 life expectancy'
         life93='1993 life expectancy';
   datalines;
2 Bangladesh     .  53 2 Brazil         51 67
2 China          41 70 2 Egypt          42 60
2 Ethiopia       33 46 1 France         67 77
1 Germany        68 75 2 India          39 59
2 Indonesia      38 59 1 Japan          64 79
2 Mozambique      . 47 2 Philippines    48 64
1 Russia          . 65 2 Turkey         44 66
1 United Kingdom 69 76 1 United States  69 75
;

proc sort data=lifexp;
   by populationrate;
run;

proc standard data=lifexp mean=0 std=1 replace
              print out=zscore;

   by populationrate;

   format populationrate popfmt.;
   title1 'Life Expectancies by Birth Rate';
run;

proc print data=zscore noobs;
   title 'Standardized Life Expectancies at Birth';
   title2 'by a Country''s Birth Rate';
run;
```

Program Description

Set the SAS system options. The NODATE option specifies to omit the date and time at which the SAS job began. The PAGENO= option specifies the page number for the next page of output that SAS produces. The LINESIZE= option specifies the line size. The PAGESIZE= option specifies the number of lines for a page of SAS output.

```
options nodate pageno=1 linesize=80 pagesize=60;
```

Assign a character string format to a numeric value. PROC FORMAT creates the format POPFMT to identify birth rates with a character value.

```
proc format;
   value popfmt 1='Stable'
                2='Rapid';
run;
```

Create the Lifeexp data set. Each observation in this data set contains information about 1950 and 1993 life expectancies at birth for 16 nations. The birth rate for each nation is classified as stable (1) or rapid (2). The nations with missing data obtained independent status after 1950. Data are from Vital Signs 1994: The Trends That Are Shaping Our Future, Lester R. Brown, Hal Kane, and David Malin Roodman, eds. Copyright © 1994 by Worldwatch Institute. Reprinted by permission of W.W. Norton & Company, Inc.

```
data lifexp;
   input PopulationRate Country $char14. Life50 Life93 @@;
   label life50='1950 life expectancy'
         life93='1993 life expectancy';
   datalines;
2 Bangladesh     .  53 2 Brazil         51 67
2 China          41 70 2 Egypt          42 60
2 Ethiopia       33 46 1 France         67 77
1 Germany        68 75 2 India          39 59
2 Indonesia      38 59 1 Japan          64 79
2 Mozambique      . 47 2 Philippines    48 64
1 Russia          . 65 2 Turkey         44 66
1 United Kingdom 69 76 1 United States  69 75
;
```

Sort the Lifeexp data set. PROC SORT sorts the observations by the birth rate.

```
proc sort data=lifexp;
   by populationrate;
run;
```

Generate the standardized data for all numeric variables and create the Z-score output data set. PROC STANDARD standardizes all numeric variables to a mean of 1 and a standard deviation of 0. REPLACE replaces missing values. PRINT prints statistics.

```
proc standard data=lifexp mean=0 std=1 replace
              print out=zscore;
```

Create the standardized values for each BY group. The BY statement standardizes the values separately by birth rate.

```
   by populationrate;
```

Assign a format to a variable and specify a title for the report. The FORMAT statement assigns a format to PopulationRate. The output data set contains formatted values. The TITLE statement specifies a title.

```
   format populationrate popfmt.;
   title1 'Life Expectancies by Birth Rate';
run;
```

Print the data set. PROC PRINT prints the ZSCORE data set with the standardized values. The TITLE statements specify two titles to be printed.

```
proc print data=zscore noobs;
   title 'Standardized Life Expectancies at Birth';
   title2 'by a Country''s Birth Rate';
run;
```

Output: Listing

PROC STANDARD prints the variable name, mean, standard deviation, input frequency, and label of each variable to standardize for each BY group. Life expectancies for Bangladesh, Mozambique, and Russia are no longer missing. The missing values are replaced with the given mean (0).

Output 67.4 *Life Expectancies by Birth Rate*

Life Expectancies by Birth Rate 1

PopulationRate=Stable

Name	Mean	Standard Deviation	N	Label
Life50	67.400000	1.854724	5	1950 life expectancy
Life93	74.500000	4.888763	6	1993 life expectancy

PopulationRate=Rapid

Name	Mean	Standard Deviation	N	Label
Life50	42.000000	5.033223	8	1950 life expectancy
Life93	59.100000	8.225300	10	1993 life expectancy

Standardized Life Expectancies at Birth 2
by a Country's Birth Rate

Population Rate	Country	Life50	Life93
Stable	France	-0.21567	0.51138
Stable	Germany	0.32350	0.10228
Stable	Japan	-1.83316	0.92048
Stable	Russia	0.00000	-1.94323
Stable	United Kingdom	0.86266	0.30683
Stable	United States	0.86266	0.10228
Rapid	Bangladesh	0.00000	-0.74161
Rapid	Brazil	1.78812	0.96045
Rapid	China	-0.19868	1.32518
Rapid	Egypt	0.00000	0.10942
Rapid	Ethiopia	-1.78812	-1.59265
Rapid	India	-0.59604	-0.01216
Rapid	Indonesia	-0.79472	-0.01216
Rapid	Mozambique	0.00000	-1.47107
Rapid	Philippines	1.19208	0.59572
Rapid	Turkey	0.39736	0.83888

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STREAM Procedure

Overview: STREAM Procedure

What Does the STREAM Procedure Do?

The STREAM procedure enables you to process an input stream that consists of arbitrary text that can contain SAS macro specifications. The macros are executed and expanded while the other text in the input stream is preserved. The text stream is not validated as SAS syntax. The output stream is sent to an external file that is referenced by a fileref and that can be defined to use any traditional SAS output destination.

The STREAM procedure is valid in SAS Viya. Support for the STREAM procedure with SAS Viya was added in SAS 9.4M5.

Concepts: STREAM Procedure

How Text and Macro Code Are Interpreted

The following example uses a macro called %DOIT to produce an HTML stream that contains a table:

```
%macro doit(nrows,ncols);
<table>
%do i=1 %to &nrows;
<tr>
%do j=1 %to &ncols;
<td>&j</td>
%end;
</tr>
%end;
</table>
%mend doit;
```

If this macro is executed within a SAS code stream, then HTML output will be produced but the output will be syntactically invalid because it is not valid SAS syntax. However, if this macro is executed through PROC STREAM, the HTML output will instead be written to a file and not validated as SAS syntax. The following is an example:

```
proc stream outfile=myfile; begin
%doit(2,3)
;;;;
```

The following output is written to *myfile*:

```
<table> <tr> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>1</td> <td>2</td> <td>3</td> </tr>
</table>
```

You can use the %INCLUDE statement in the input stream. The types of input files that you can use include HTML files, RTF files, or any other type of text-based file. Note that you would not likely use %INCLUDE to include actual SAS code except for macro definitions and invocations. Any actual SAS code beyond macros is not executed, but is treated like any other text.

Text that follows a % and that is recognized by a macro is executed. Examples include %LET, %INCLUDE, and %SYSFUNC. Any other macros, such as user-defined macros, are also executed.

All macro variable references are resolved, but warnings are issued if the macro name is not recognized. Macro statements such as %PUT and %LIST send output to the log and do not produce tokens. You should avoid using these statements in an input stream, although they are allowed.

Tokenizer Limitations

The SAS tokenizer or word-scanner has a number of limitations that can be a problem for correctly processing syntax input streams other than SAS syntax input streams. These limitations are described in the following list.

- Input records that come from the %INCLUDE statement cannot exceed a record size of 32,767 bytes, which is the default value.
- The tokenizer does not provide accurate information about record size to PROC STREAM if the input record from %INCLUDE exceeds 32,767 bytes.
- %INCLUDE and %LET statements must begin on a statement boundary. That is, a semicolon must precede the statements, and the statements must end with a semicolon. Macro invocations do not have this requirement.
- Macro statements are completely consumed and executed by the tokenizer, and PROC STREAM is not aware of them. For example, `%let xyz=2;` is completely consumed. This behavior also holds true for macro statements that are not global in scope, such as %IF and %GOTO. These macro statements are flagged as errors but PROC STREAM is not aware of the error.
- Any token that starts with the letters a-z (uppercase or lowercase), or an underscore that is preceded by an &, is assessed by the macro processor to determine whether it is a macro variable to be resolved. If it is not a macro variable, a warning is issued. Currently, this warning cannot be suppressed.
- PL/I programming language comments (/* *comment* */) are typically completely absorbed by the tokenizer and are not seen by PROC STREAM. You can use the NOABSSCMT option in the PROC STREAM statement so that all text between and including the /* and */ are seen. This option is also needed if the input stream can contain occurrences of /* that are not enclosed in quotation marks. An example of this is `/tmp/xyz/*`, which is a UNIX wildcard specification.
- No single token can exceed 32,767 characters.
- If the last token in a record is followed by a line feed that is preceded by an optional carriage return, and the first token in the next record begins in column 1, then the tokenizer introduces an artificial blank between these tokens. The blank allows for valid SAS syntax, because these tokens are not concatenated unless they are part of a string that is enclosed in quotation marks. For example, a record is 80 characters long. The string *abc*, preceded by a blank, is located in columns 78–80. In the next record, the string *def* , followed by a blank, appears in columns 1–3. In this case, PROC STREAM receives *abc* followed by *def*, which has a leading blank, even though a leading blank did not appear in the token

stream. If, instead, *'abc*, preceded by a blank, appears in columns 77-80, and *def'*, followed by a blank, appears in columns 1-4, then PROC STREAM receives *'abcdef'*.

- Non-printable characters (except for carriage return (CR) and line feed (LF)) cannot be properly tokenized.
- The input stream cannot be a binary stream such as a PDF or a JPG file.
- The normal behavior for the tokenizer is to provide a string, either with single or double quotation marks, as a single token. This is a problem if text, such as *don't do this*, is not enclosed in quotation marks, or if text has an escape sequence, as in *don''t do this*. The QUOTING= option can be used to allow for quotation marks to be treated like any other special character, such a hyphen or a slash.
- A single macro variable can expand into no more than 64,000 characters. However, there is no limit to what a macro can return as model text, apart from resource limitations such as memory and disk space.

Syntax: STREAM Procedure

PROC STREAM OUTFILE=*fileref* <*options*>; BEGIN
text-1
<*text-n*>
;;;;

Statement	Task
PROC STREAM	Process an input stream that consists of arbitrary text that can contain SAS macro specifications

PROC STREAM Statement

Enables you to process an input stream that consists of arbitrary text that can contain SAS macro specifications.

Syntax

PROC STREAM OUTFILE= *fileref* <*options*>; BEGIN
text-1
<*text-n*>
;;;;

Summary of Optional Arguments

MOD
: Specifies that the output file is appended to instead of being overwritten.

NOABSSCMT
: Specifies whether comments are written to the output stream.

PRESCOL
: Indicates that an attempt is made to preserve the columns of the original input file.

QUOTING=SINGLE | DOUBLE | BOTH
: Specifies how quotation marks are handled.

RESETDELIM='*label*'
: Indicates a special marker token.

Required Arguments

OUTFILE=*fileref*
specifies the file where all tokens are written.

The LRECL specification for the fileref is used. If no LRECL is given, then the default value for the global LRECL= option, which is 32,767 bytes, is used. Unless you use the PRESCOL option, all tokens are streamed out with the proper number of intervening blanks between tokens. No token is broken between records. Also, no stream of tokens is broken between records unless there is at least one blank within them. For example, <table>X</table> will not be broken between records, but <table> X </table> can be broken where you see the blanks (before and after the X).

text
specifies the SAS statements or macros to use with PROC STREAM.

Optional Arguments

MOD
specifies that the output file is appended to instead of being overwritten.

NOABSSCMT
specifies whether comments are written to the output stream.

If PL/I programming language style comments appear (`/* comments */`), all text between the comment characters (/* and */) appears in the output stream. If this option is omitted, the PL/I-style comments do not appear in the output stream. Note that if NOABSSCMT is set, it is strongly suggested that QUOTING= also be set, because single quotation marks (such as in the word don't) can commonly appear in comments.

PRESCOL
indicates that an attempt is made to preserve the columns of the original input file.

Using this option is not as successful if there is macro substitution or if the record size exceeds 32,767 bytes. In this case, macro expansion might affect column location.

The PRESCOL option improves the validity of RTF files that are included with the %INCLUDE macro.

QUOTING=SINGLE | DOUBLE | BOTH
specifies how quotation marks are handled.

SINGLE
specifies that single quotation marks are treated like any other character. If you use the SINGLE option and macro references occur within single quotation marks, such as '&hello', the macro references are expanded.

DOUBLE
specifies that double quotation marks are treated like any other character.

BOTH
specifies that both SINGLE and DOUBLE options are used.

RESETDELIM='*label*'
indicates a special marker token.

This option is used when there is a need for statements to be expanded, such as the %INCLUDE and %LET statements. These statements must begin on a statement boundary. If your syntax does not allow for a statement boundary, then the given label, followed by a semicolon, can be introduced in the input stream to satisfy the tokenizer requirements. The label and semicolon are not sent to the output file.

In the following example, %INCLUDE is not preceded by a semicolon, and the code is not correct:

```
x y %include myfile; z
```

However, if you use the RESETDELIM= option, the expansion occurs as expected:

```
resetdelim='mylabel'
x y mylabel;
%include myfile; z
```

Mylabel; is not seen in the output file.

Mylabel must be a valid SAS name, that is, it must begin with a letter or underscore, and all subsequent characters must be letters, underscores, or digits. The length of *mylabel* must not exceed 32 characters.

The specification and usage is not case-sensitive. There is no default value for RESETDELIM=.

PROC STREAM checks for the existence of a macro variable called &STREAMDELIM. If that macro variable exists, it is used as is. If it does not exist, PROC STREAM verifies whether the RESETDELIM= option was given. If this is the case, the macro variable &STREAMDELIM is set to the value of the RESETDELIM= option. If the RESETDELIM= option is not given, PROC STREAM constructs a unique value for the &STREAMDELIM macro variable based on the current datetime value.

With this consideration, you can add &STREAMDELIM into the input for PROC STREAM. When this macro variable is seen, it is assumed that optional keywords will follow. A closing semicolon is then expected. All tokens from the

&STREAMDELIM value up to and including the semicolon are not emitted to the output stream, but are instead special control information items for PROC STREAM.

If you need to provide a %INCLUDE statement in your input, but a semicolon does not precede it, then you must add the following statement before the %INCLUDE statement:

```
&STREAMDELIM;
```

This statement forces a semicolon to be seen by the tokenizer, but it is absorbed by PROC STREAM.

The following optional keywords can follow &STREAMDELIM:

NEWLINE
specifies that a new line is emitted to the output file.

READFILE *filename*
specifies that the given filename is opened, and its contents are read as is and written to the output file. There is no macro expansion of the contents of this file, and new lines are preserved. This differs from %INCLUDE, where macro expansion occurs and new lines are ignored. For an example of how to use the READFILE keyword, see "Using the READFILE Keyword" on page 2450.

Usage: STREAM Procedure

Using Macro-Based Code in the Input Stream

Any macro-based code in the input stream is expanded, as shown in this example:

```
%let abc=123;
proc stream outfile=out; begin
<title>Run &abc</title>
<table>
<tr> <td>1<td>2</tr>
<tr> <td>3<td>4</tr>
</table>
;;;;
```

The output file contains the following results:

```
<title>Run 123</title> <table> <tr> <td>1<td>2</tr> <tr> <td>3<td>4</tr> </table>
```

Note that there are no line breaks, but blanks are preserved, and a blank is inserted for each line break.

The fact that the occurrence of % and & in the input stream are not enclosed in quotation marks and are not escape sequences can cause problems. For example, *&* appears in HTML streams as an escape sequence for an ampersand. If you have a macro variable called *&AMP*, then its value is substituted for *&amp*. If this type of macro variable is not present, then SAS issues a warning. You can avoid these problems by using the & as an escape character, as in %STR(&), as the following example shows:

```
<title>A %str(&)amp; B</title>
```

The following output is written to the output stream:

```
<title>A &amp; B</title>
```

Likewise, for %, any occurrence that is not to be misinterpreted by a macro should appear as `%STR(%)`, as the following example shows:

```
<a href="www.sas.com/x%str(%20y)">the link</a>
```

The following output is written to the output stream:

```
<a href="www.sas.com/x%20y">the link</a>
```

If the escape sequence for %STR occurs within single quotation marks, then either use the QUOTING= option, or use the escape sequence with a single quotation mark, %STR(%').

Beginning an Input Stream with Brackets or Parentheses

When you start your input stream with brackets or parentheses, specifically {, [, or (, this causes the BEGIN keyword to be treated as a name. This is true even when the first input character is on the line after BEGIN in your code. For example, the following code would treat BEGIN as a name rather than as the keyword that identifies the start of an input stream:

```
filename dheader "c:\temp\dheader.txt";
proc stream outfile=dheader; begin
[SAS version 9.4]
;;;;
```

To prevent this, use the &STREAMDELIM; statement. You can always use the &STREAMDELIM; statement after BEGIN to indicate the beginning of any input stream.

When you include this statement, the starting point of the input stream is interpreted correctly:

```
filename dheader "c:\temp\dheader.txt"
proc stream outfile=dheader; begin &streamdelim;
[SAS version 9.4]
;;;;
```

Executing SAS Code

As described in a previous section, any SAS code that is encountered is not executed. The tokens are streamed out like any other tokens. An exception to this occurs when the %SYSFUNC or %SYSCALL macro functions are encountered. These macro functions do execute the specified function, as shown in the following example:

```
%let abc=%sysfunc(getoption(obs));
&abc
```

This statement causes the GETOPTION function to be called, which obtains the value of the OBS option. GETOPTION returns the value as a character string to be placed into the ABC macro variable. That value is then written to the output stream.

It is possible to execute a stream of SAS code by using the DOSUB function in %SYSFUNC. The DOSUB function is provided a fileref, and all of the SAS code within that file is executed.

In this example, the fileref MYCODE points to the following SAS code:

```
filename myhtml "c:\temp\temp.txt";

data _null_;
   file myhtml;
   put '<table>';
   put '<tr><td>1</td></tr>';
   put '<tr><td>2</td></tr>';
   put '</table>';
run;
```

If you then execute the following STREAM procedure, you can see that PROC STREAM uses *mycode* as an argument to DOSUB in the %SYSFUNC function:

```
filename myhtml "c:\temp\temp.txt";
filename new "c:\temp\new.html";

proc stream outfile=new; begin
%let abc=%sysfunc(dosub(mycode));
%include myhtml;
;;;;
```

The output stream contains the following results:

```
<table><tr><td>1</td></tr><tr><td>2</td></tr></table>
```

Note: The DOSUB function is similar to the DOSUBL function, but DOSUB is passed a fileref for a file that contains SAS code. DOSUBL is passed a text string and executes the value as SAS code. For more information, see "DOSUBL Function" in *SAS Functions and CALL Routines: Reference*.

Rich Text Format (RTF) File Output

You can use Microsoft Word to input data and create RTF output. If you enter `Today is &sysdate..` and `My name is &name..`, Microsoft Word saves the data as an RTF file called Mytest.rtf. This file is approximately 30K in size, and contains a large amount of markup data. A section of that data contains the actual text that was entered, as seen here:

```
\fs20\lang1033\langfe1033\cgrid\langnp1033\langfenp1033 {\rtlch\fcs1 \af0 \ltrch\fcs0
\insrsid8922096
Today is &sysdate.. }{\rtlch\fcs1 \af0 \ltrch\fcs0 \insrsid14092174
\par }{\rtlch\fcs1 \af0 \ltrch\fcs0 \insrsid8922096
\par My name is &name..
\par
```

Note that the text as entered has macro substitutions.

When you execute this SAS program, a new RTF file is created called Newrtf.rtf. The difference in this output file is that the macro substitutions have taken place, but the markup language remains intact:

```
%let name=John;
filename oldrtf 'mytest.rtf' recfm=v lrecl=32767;
filename newrtf 'newrtf.rtf' recfm=v lrecl=32767;
proc stream outfile=newrtf quoting=both asis; begin
&streamdelim;
%include oldrtf;
;;;;
```

Then when the Newrtf.rtf file is read by Microsoft Word, this is what is displayed:

```
Today is 30NOV12.

My name is John.
```

Using the READFILE Keyword

In HTML, the <PRE> ... </PRE> tags encapsulate a stream of text that has been pre-formatted, and is displayed as is, honoring new lines and spacing. You can read the contents of a file and have it preserved as is by using the READFILE keyword. The READFILE keyword follows the &STREAMDELIM macro variable:

```
filename fixed temp;
data _null_; file fixed;
     input; put _infile_;
     datalines4;
This is the first line of fixed text.
This is another line to be fixed.
This is the last line of fixed text.
```

```
;;;;

%macro doit(nrows,ncols);
<table>
%do i=1 %to &nrows;
<tr>
%do j=1 %to &ncols;
<td>&j</td>
%end;
</tr>
%end;
%mend;

filename new temp;
proc stream outfile=new; begin
<PRE>
&streamdelim readfile fixed;
</PRE>
%doit(2,3)
;;;;

data _null_; infile new; input; put _infile_; run;
filename fixed temp;
data _null_; file fixed;
     input; put _infile_;
     datalines4;
This is the first line of fixed text.
This is another line to be fixed.
This is the last line of fixed text.
;;;;

%macro doit(nrows,ncols);
<table>
%do i=1 %to &nrows;
<tr>
%do j=1 %to &ncols;
<td>&j</td>
%end;
</tr>
%end;
%mend;

filename new temp;
proc stream outfile=new; begin
<PRE>
&streamdelim readfile fixed;
</PRE>
%doit(2,3)
;;;;

data _null_; infile new; input; put _infile_; run;
```

This is the resulting file:

```
<PRE>
This is the first line of fixed text.
This is another line to be fixed.
This is the last line of fixed text.
</PRE> <table> <tr> <td>1</td> <td>2</td> <td>3</dt> </tr>
<tr> <td>1</td> <td>2</td> <td>3</dt> </tr> </table>
```

Using %INCLUDE to Include a File in PROC STREAM

To stream complex HTML and Javascript code, you can create the code in a separate file. Then use the %INCLUDE statement to include the file in your program.

The following example shows this approach.

```
filename temp1 temp;

data _null_;
   infile datalines;
   file temp1;
   input;
   l=length(_infile_);
   put @1 _infile_ $varying200. l;
   datalines4;
<table>
<tr>
<td>abc</td><td>def</td>
</tr>
<tr>
<td>ghi</td><td>jkl</td>
</tr>
</table>
;;;;

filename myfile "c:\temp\test1.html";

proc stream outfile=myfile prescol resetdelim='label'; begin
<html>
<h2>Test Example</h2>
label;
%include temp1;
</html>
;;;;
```

Inserting a New Line into the Output Stream

To insert a new line into the output stream, add the keyword NEWLINE after the delimiter and before the semicolon, as shown in the following example:

```
proc stream outfile=abc resetdelim='mylabel'; begin
my item here;
mylabel newline;
my next item here
;;;;
```

This example produces the following output:

```
my item here;
my next item here
```

There is no other way to ensure a predictable new line.

Ending the STREAM Procedure

The end of the PROC STREAM step is indicated by four semicolons with no blanks between them, written as the last line of the procedure. If the last item in the input stream ends with a semicolon, use the label that is specified in RESETDELIM=, followed by a semicolon, immediately after the last item.

The following example is not coded correctly because the semicolon after `here` is not recognized:

```
proc stream outfile=abc; begin
my item here;
;;;;
```

The following example is coded correctly:

```
proc stream outfile=abc resetdelim='mylabel'; begin
my item here;
mylabel;
;;;;
```

RESETDELIM= is used in this example because it recognizes the semicolon after `here`.

69

SUMMARY Procedure

Overview: SUMMARY Procedure

What Does the SUMMARY Procedure Do?

The SUMMARY procedure provides data summarization tools that compute descriptive statistics for variables across all observations or within groups of observations. The SUMMARY procedure is very similar to the MEANS procedure; for full syntax details, see Chapter 40, “MEANS Procedure,” on page 1463. Except for the differences that are discussed here, all the PROC MEANS information also applies to PROC SUMMARY.

PROC SUMMARY can be used in SAS Cloud Analytic Services (CAS). Running PROC SUMMARY with CAS actions has several advantages over processing within SAS. See Chapter 40, “MEANS Procedure,” on page 1463 for information about running PROC MEANS and PROC SUMMARY in CAS.

Calculated statistics can vary slightly, depending on the order in which observations are processed. Such variations are due to numerical errors that are introduced by floating–point arithmetic, the results of which should be considered approximate and not exact. The order of observation processing can be affected by nondeterministic effects of multithreaded or parallel processing. The order of processing can also be affected by inconsistent or nondeterministic ordering of

observations that are produced by a data source, such as a DBMS that delivers query results through an ACCESS engine. For more information, see "Numerical Accuracy in SAS Software" in *SAS Language Reference: Concepts* and "Threading in Base SAS" in *SAS Language Reference: Concepts*.

Syntax: SUMMARY Procedure

Tips:

Supports the Output Delivery System. For details, see "Output Delivery System: Basic Concepts" in *SAS Output Delivery System: User's Guide*.

You can use the ATTRIB, FORMAT, LABEL, and WHERE statements.

Full syntax descriptions are in "Syntax" on page 1475.

PROC SUMMARY <*options*> <*statistic-keyword(s)*>;

BY <DESCENDING> *variable-1*<<DESCENDING> *variable-2* ...> <NOTSORTED>;

CLASS *variable(s)* </ *options*>;

FREQ *variable*;

ID *variable(s)*;

OUTPUT <OUT=*SAS-data-set*> <*output-statistic-specification(s)*> <*id-group-specification(s)*> <*maximum-id-specification(s)*> <*minimum-id-specification(s)*> </ *options*> ;

TYPES *request(s)*;

VAR *variable(s)* </ WEIGHT=*weight-variable*>;

WAYS *list*;

WEIGHT *variable*;

Statement	Task
PROC SUMMARY	Compute descriptive statistics for variables across all observations or within groups of observations
BY	Calculate separate statistics for each BY group
CLASS	Identify variables whose values define subgroups for the analysis
FREQ	Identify a variable whose values represent the frequency of each observation
ID	Include additional identification variables in the output data set
OUTPUT	Create an output data set that contains specified statistics and identification variables

Statement	Task
TYPES	Identify specific combinations of class variables to use to subdivide the data
VAR	Identify the analysis variables and their order in the results
WAYS	Specify the number of ways to make unique combinations of class variables
WEIGHT	Identify a variable whose values weight each observation in the statistical calculations

PROC SUMMARY Statement

Computes descriptive statistics for variables across all observations or within groups of observations.

See: For full syntax details, see "PROC MEANS Statement" on page 1476.

Details

PRINT | NOPRINT
specifies whether PROC SUMMARY displays the descriptive statistics. By default, PROC SUMMARY does not display output, but PROC MEANS does display output.

Default NOPRINT

VAR Statement

Identifies the analysis variables and their order in the results.

Default: If you omit the VAR statement, then PROC SUMMARY produces a simple count of observations, whereas PROC MEANS tries to analyze all the numeric variables that are not listed in the other statements.

Interaction: If you specify statistics in the PROC SUMMARY statement and the VAR statement is omitted or if a numeric variable is not associated with a statistic in the OUTPUT statement , then PROC SUMMARY stops processing and an error message is written to the SAS log.

Note: See the VAR Statement in PROC MEANS for a full description of the VAR statement.

See: For complete syntax, see “VAR Statement” on page 1507.

70

TABULATE Procedure

Overview: TABULATE Procedure

What Does the TABULATE Procedure Do?

The TABULATE procedure displays descriptive statistics in tabular format, using some or all of the variables in a data set. You can create a variety of tables ranging from simple to highly customized.

PROC TABULATE computes many of the same statistics that are computed by other descriptive statistical procedures such as MEANS, FREQ, and REPORT. PROC TABULATE provides the following features:

- simple but powerful methods to create tabular reports
- flexibility in classifying the values of variables and establishing hierarchical relationships between the variables
- mechanisms for labeling and formatting variables and procedure-generated statistics
- the ability to create accessible output tables when used with the ACCESSIBLETABLE system option. PROC TABULATE also provides the ability to add captions to tables.

  For more information about creating accessible tables with PROC TABULATE, see "Overview of Table Accessibility " in *Creating Accessible SAS Output Using ODS and ODS Graphics* . This feature applies to SAS 9.4M6 and to later releases.

Simple Tables

The following output shows a simple table that was produced by PROC TABULATE. The data set "ENERGY" on page 2788 contains data on expenditures of energy by two types of customers, residential and business, in individual states in the Northeast (1) and West (4) regions of the United States. The table sums expenditures for states within a geographic division. The RTS option provides enough space to display the column headings without hyphenating them.

```
proc tabulate data=energy;
   class region division type;
   var expenditures;
   table region*division, type*expenditures /
         rts=20;
run;
```

Output 70.1 *Simple Table Produced by PROC TABULATE*

The SAS System

		Type	
		1	2
		Expenditures	Expenditures
		Sum	Sum
Region	Division		
1	1	7477.00	5129.00
	2	19379.00	15078.00
4	3	5476.00	4729.00
	4	13959.00	12619.00

Complex Tables

The following output is a more complicated table using the same data set that was used to create Output 70.346 on page 2461. The statements that create this report do the following:

- customize column and row headings
- apply a format to all table cells
- sum expenditures for residential and business customers
- compute subtotals for each division
- compute totals for all regions

For an explanation of the program that produces this report, see "Example 6: Summarizing Information with the Universal Class Variable ALL" on page 2566.

Output 70.2 *Complex Table Produced by PROC TABULATE*

Energy Expenditures for Each Region
(millions of dollars)

		Customer Base		All Customers
		Residential Customers	Business Customers	
Region	Division			
Northeast	New England	7,477	5,129	12,606
	Middle Atlantic	19,379	15,078	34,457
	Subtotal	26,856	20,207	47,063
West	Division			
	Mountain	5,476	4,729	10,205
	Pacific	13,959	12,619	26,578
	Subtotal	19,435	17,348	36,783
Total for All Regions		$46,291	$37,555	$83,846

PROC TABULATE and the Output Delivery System

The following output shows a table that is created in Hypertext Markup Language (HTML). You can use the Output Delivery System with PROC TABULATE to create customized output in HTML, Rich Text Format (RTF), Portable Document Format (PDF), and other output formats. For an explanation of the program that produces this table, see "Example 14: Specifying Style Overrides for ODS Output" on page 2607.

Output 70.3 *HTML Table Produced by PROC TABULATE*

Energy Expenditures
(millions of dollars)

Region=Northeast

Region by Division by Type		Type		Total
		Residential Customers	Business Customers	
		Expenditures	Expenditures	Expenditures
		Sum	Sum	Sum
Region	Division			
Northeast	New England	$7,477	$5,129	$12,606
	Middle Atlantic	$19,379	$15,078	$34,457
	Total	$26,856	$20,207	$47,063
Total	Division			
	New England	$7,477	$5,129	$12,606
	Middle Atlantic	$19,379	$15,078	$34,457
	Total	$26,856	$20,207	$47,063

Concepts: TABULATE Procedure

Terminology: TABULATE Procedure

The following figures illustrate some of the terms that are commonly used in discussions of PROC TABULATE.

Figure 70.1 *Parts of a PROC TABULATE Table*

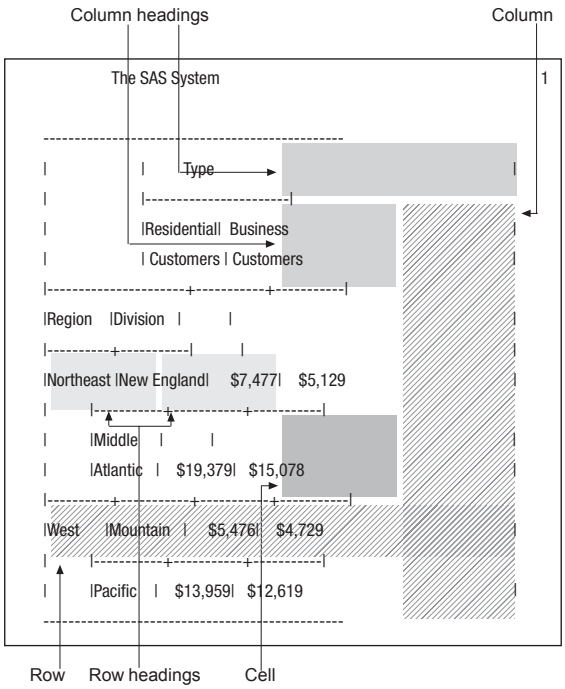
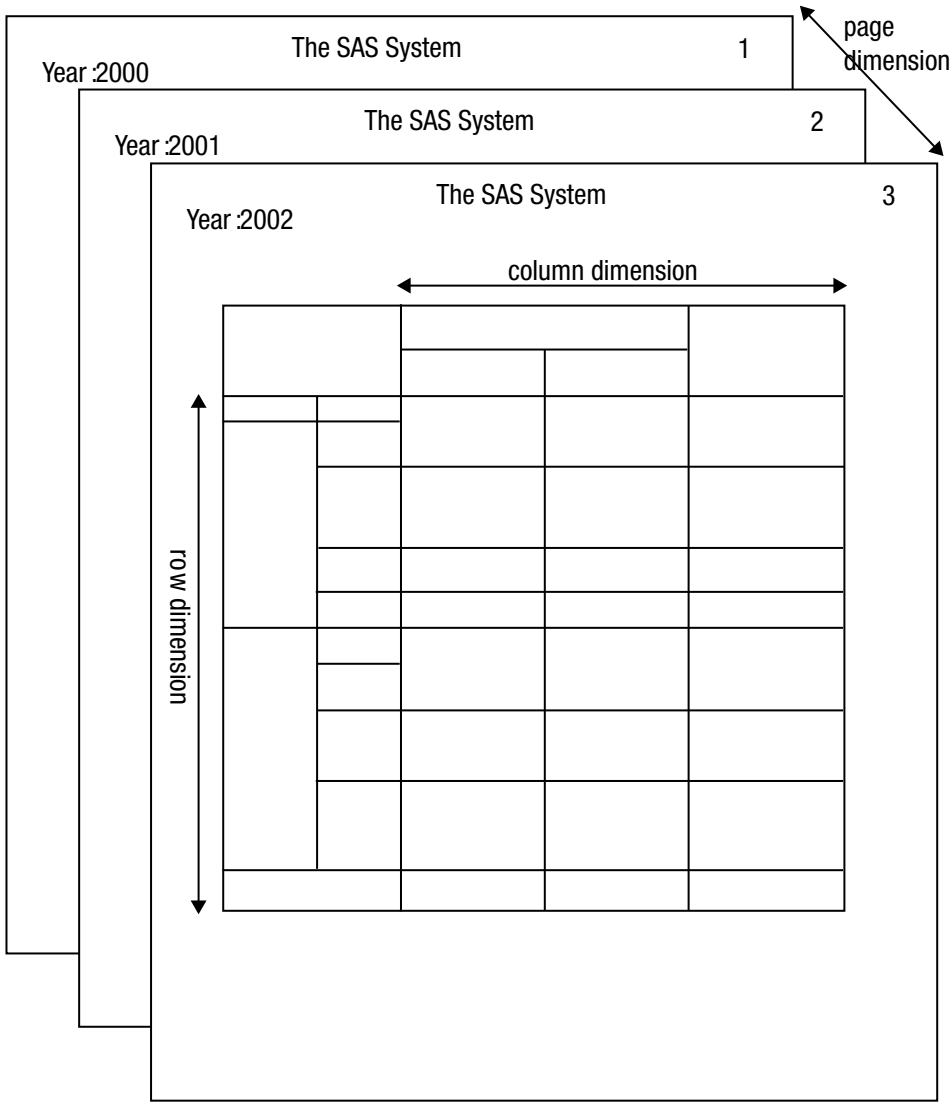


Figure 70.2 *PROC TABULATE Table Dimensions*



In addition, the following terms frequently appear in discussions of PROC TABULATE:

category
: the combination of unique values of class variables. The TABULATE procedure creates a separate category for each unique combination of values that exists in the observations of the data set. Each category that is created by PROC TABULATE is represented by one or more cells in the table where the pages, rows, and columns that describe the category intersect.

  The table in Figure 70.88 on page 2464 contains three class variables: Region, Division, and Type. These class variables form the eight categories listed in the following table. (For convenience, the categories are described in terms of their formatted values.)

Table 70.1 *Categories Created from Three Class Variables*

Region	Division	Type
Northeast	New England	Residential Customers
Northeast	New England	Business Customers
Northeast	Middle Atlantic	Residential Customers
Northeast	Middle Atlantic	Business Customers
West	Mountain	Residential Customers
West	Mountain	Business Customers
West	Pacific	Residential Customers
West	Pacific	Business Customers

continuation message
: the text that appears below the table if it spans multiple physical pages.

nested variable
: a variable whose values appear in the table with each value of another variable.

  In Figure 70.88 on page 2464, Division is nested under Region.

page dimension text
: the text that appears above the table if the table has a page dimension. However, if you specify BOX=_PAGE_ in the TABLE statement, then the text that would appear above the table appears in the box. In Figure 70.89 on page 2465, the word **`Year:`**, followed by the value, is the page dimension text.

  Page dimension text has a style. The default style is *Beforecaption*. For more information about using styles, see "Using ODS Styles with PROC TABULATE" on page 2522.

subtable
: the group of cells that is produced by crossing a single element from each dimension of the TABLE statement when one or more dimensions contain concatenated elements.

  Figure 70.88 on page 2464 contains no subtables. For an illustration of a table that consists of multiple subtables, see "Example 13: Using Denominator Definitions to Display Basic Frequency Counts and Percentages" on page 2593.

Threaded Processing of Input DATA Sets

The THREADED option enables or disables parallel processing of the input data set. Threaded processing achieves a degree of parallelism in the processing operations. This parallelism is intended to reduce the real time to completion for a given operation and therefore limit the cost of additional CPU resources. For more information, see "Support for Parallel Processing" in *SAS Language Reference: Concepts*.

The value of the SAS system option CPUCOUNT= affects the performance of the threaded sort. CPUCOUNT= suggests how many system CPUs are available for use by the threaded procedures.

For more information, see the "THREADS System Option" in *SAS System Options: Reference* and the "CPUCOUNT= System Option" in *SAS System Options: Reference*.

Calculated statistics can vary slightly, depending on the order in which observations are processed. Such variations are due to numerical errors that are introduced by floating–point arithmetic, the results of which should be considered approximate and not exact. The order of observation processing can be affected by nondeterministic effects of multithreaded or parallel processing. The order of processing can also be affected by inconsistent or nondeterministic ordering of observations that are produced by a data source, such as a DBMS that delivers query results through an ACCESS engine. For more information, see "Numerical Accuracy in SAS Software" in *SAS Language Reference: Concepts* and "Threading in Base SAS" in *SAS Language Reference: Concepts*.

Syntax: TABULATE Procedure

Requirements: At least one TABLE statement is required in a PROC TABULATE procedure step.

Depending on the variables that appear in the TABLE statement, a CLASS statement, a VAR statement, or both are required.

Accessibility note: Starting with SAS 9.4M6, you can use the ACCESSIBLECHECK and ACCESSIBLETABLE system options to check for and create accessible tables. For information about creating accessible PROC TABULATE tables, see "Overview of Table Accessibility " in *Creating Accessible SAS Output Using ODS and ODS Graphics*. in *Creating Accessible SAS Output Using ODS and ODS Graphics*.

Tips: You can use the ATTRIB, FORMAT, LABEL, and WHERE statements with the PROC TABULATE procedure. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73.

For in-database processing to occur, your data must reside within a supported version of a DBMS that has been properly configured for SAS in-database processing. For more information, see "In-Database Processing for PROC TABULATE" on page 2537.

PROC TABULATE <*options*> <STYLE=*style-override(s)*>;

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...> <NOTSORTED>;

CLASS *variable(s)* </ *options*> <STYLE=*style-override(s)* >;

CLASSLEV *variable(s)* </ STYLE=*style-override(s)*>;

FREQ *variable*;

KEYLABEL *keyword-1*='*description-1*' <*keyword-2*='*description-2*' ...>;

KEYWORD *keyword(s)* </ STYLE=*style-override(s)*>;

TABLE <<*page-expression*,> *row-expression*,>
column-expression </ *table-options*>;

VAR *analysis-variable(s)* </ *options*> <STYLE=*style-override(s)*>;

WEIGHT *variable*;

Statement	Task	Example
PROC TABULATE	Display descriptive statistics in tabular format	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 6, Ex. 8, Ex. 12, Ex. 14, Ex. 15
BY	Create a separate table for each BY group	
CLASS	Identify variables in the input data set as class variables	Ex. 3, Ex. 4
CLASSLEV	Specify a style for class variable level value headings	Ex. 14, Ex. 15
FREQ	Identify a variable in the input data set whose values represent the frequency of each observation	
KEYLABEL	Specify a label for a keyword	
KEYWORD	Specify a style for keyword headings	Ex. 14
TABLE	Describe the table to create	Ex. 1, Ex. 3, Ex. 4, Ex. 5, Ex. 6, Ex. 7, Ex. 8, Ex. 9, Ex. 10, Ex. 11, Ex. 12, Ex. 13, Ex. 14, Ex. 15
VAR	Identify variables in the input data set as analysis variables	Ex. 14
WEIGHT	Identify a variable in the input data set whose values weight each observation in the statistical calculations	

PROC TABULATE Statement

Displays descriptive statistics in tabular format.

Syntax

PROC TABULATE <*options*>;

Summary of Optional Arguments

CONTENTS=*link-text* <#BYLINE> <#BYVAL> < #BYVAR>
: specifies the text for the entries in the table of contents.

DATA=*SAS-data-set*
: specifies the input data set.

NOTHREADS
: disables parallel processing of the input data set.

OUT=*SAS-data-set*
: specifies the output data set.

THREADS

NOTHREADS
: overrides the SAS system option THREADS | NOTHREADS.

TRAP
: enables floating point exception recovery.

Control the statistical analysis

ALPHA=*value*
: specifies the confidence level for the confidence limits.

EXCLNPWGT
: excludes observations with nonpositive weights.

QMARKERS=*number*
: specifies the sample size to use for the P^2 quantile estimation method.

QMETHOD=OS | P2
: specifies the quantile estimation method.

QNTLDEF=1 | 2 | 3 | 4 | 5
: specifies the mathematical definition to calculate quantiles.

VARDEF=*divisor*
: specifies the variance divisor.

Customize the appearance of the table

FORMAT=*format-name*
: specifies a default format for each cell in the table.

FORMCHAR <(*position(s)*)>='*formatting-character(s)*'
: defines the characters to use to construct the table outlines and dividers.

NOSEPS
: eliminates horizontal separator lines from the row titles and the body of the table.

ORDER=DATA | FORMATTED | FREQ | UNFORMATTED
: orders the values of a class variable according to the specified order.

STYLE=*style-override(s)*
: specifies one or more style overrides to use for specific areas of the table.

Identify categories of data that are of interest

CLASSDATA=*SAS-data-set*
: specifies a secondary data set that contains the combinations of values of class variables to include in tables and output data sets.

EXCLUSIVE
: excludes from tables and output data sets all combinations of class variable values that are not in the CLASSDATA= data set.

MISSING
: considers missing values as valid values for class variables.

Optional Arguments

ALPHA=*value*
specifies the confidence level to compute the confidence limits for the mean. The percentage for the confidence limits is (1–*value*)×100. For example, `ALPHA=.05` results in a 95% confidence limit.

Default .05

Range 0-1

Interaction To compute confidence limits specify the *statistic-keyword* LCLM or UCLM.

CLASSDATA=*SAS-data-set*
specifies a data set that contains the combinations of values of the class variables that must be present in the output. Any combination of values of the class variables appear in each table or output data set and have a frequency of zero if they meet the following criteria:

1. occur in the CLASSDATA= data set
2. but not in the input data set

Restriction The CLASSDATA= data set must contain all class variables. Their data type and format must match the corresponding class variables in the input data set.

Interaction If you use the EXCLUSIVE option, then PROC TABULATE excludes any observations in the input data set whose combinations of values of class variables are not in the CLASSDATA= data set.

Tip Use the CLASSDATA= data set to filter or supplement the input data set.

Example "Example 2: Specifying Class Variable Combinations to Appear in a Table" on page 2553

CONTENTS=*link-text* <#BYLINE> <#BYVAL> < #BYVAR>
specifies the text for the entries in the table of contents created by default or by options settings in ODS destinations that support the STYLE= option.

Starting with SAS 9.4M6, these options are available if a BY statement is in effect:

#BYLINE
substitutes the entire BY line without leading or trailing blanks for #BYLINE in the text string. The BY line uses the format *variable-name=value*.

#BYVAL*n*
#BYVAL(*BY-variable-name*)
substitutes the current value of the specified BY variable for #BYVAL in the text string.

Specify the variable with one of the following:

n
specifies a variable by its position in the BY statement. For example, #BYVAL2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAL(YEAR) specifies the BY variable, YEAR. *Variable-name* is not case sensitive.

#BYVAR*n*
#BYVAR(*BY-variable-name*)
substitutes the name of the BY-variable or the label associated with the variable (whatever the BY line would normally display) for #BYVAR in the text string.

Specify the variable with one of the following:

n
specifies a variable by its position in the BY statement. For example, #BYVAR2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAR(SITES) specifies the BY variable, SITES. *Variable-name* is not case sensitive.

See "Substituting BY Line Values in a Text String" on page 2538

DATA=*SAS-data-set*
specifies the input data set.

See "Input Data Sets" on page 26

EXCLNPWGT
excludes observations with nonpositive weight values (zero or negative) from the analysis. By default, PROC TABULATE treats observations with negative weights like observations with zero weights and counts them in the total number of observations.

Alias EXCLNPWGTS

See "WEIGHT=*weight-variable*" on page 2513 and "WEIGHT Statement" on page 2514

EXCLUSIVE
excludes from the tables and the output data sets all combinations of the class variable that are not found in the CLASSDATA= data set.

Requirement If a CLASSDATA= data set is not specified, then the EXCLUSIVE option is ignored.

Example "Example 2: Specifying Class Variable Combinations to Appear in a Table" on page 2553

FORMAT=*format-name*
specifies a default format for the value in each table cell. You can use any SAS or user-defined format.

Alias F=

Default If you omit FORMAT=, then PROC TABULATE uses BEST12.2 as the default format.

Interaction Formats that are specified in a TABLE statement override the format that is specified with FORMAT=.

Tip The FORMAT= option is especially useful for controlling the number of print positions that are used to print a table.

Examples "Example 1: Creating a Basic Two-Dimensional Table" on page 2550

"Example 6: Summarizing Information with the Universal Class Variable ALL" on page 2566

FORMCHAR <(*position(s)*)>='*formatting-character(s)*'
defines the characters to use for constructing the table outlines and dividers.

position(s)
identifies the position of one or more characters in the SAS formatting-character string. A space or a comma separates the positions.

Default Omitting *position(s)* is the same as specifying all 20 possible SAS formatting characters, in order.

formatting-character(s)
lists the characters to use for the specified positions.

PROC TABULATE assigns characters in *formatting-character(s)* to *position(s)*, in the order in which they are listed. For example, the following

option assigns the asterisk (*) to the third formatting character, the number sign (#) to the seventh character, and does not alter the remaining characters:

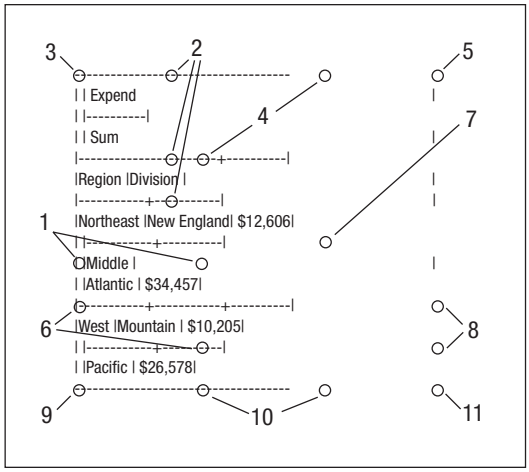
```
formchar(3,7)='*#'
```

PROC TABULATE uses 11 of the 20 formatting characters that SAS provides. Table 70.128 on page 2473 shows the formatting characters that PROC TABULATE uses. Figure 70.90 on page 2474 illustrates the use of each formatting character in the output from PROC TABULATE.

Table 70.2 *Formatting Characters Used by PROC TABULATE*

Position	Default	Used to Draw
1	|	Right and left borders and the vertical separators between columns
2	-	Top and bottom borders and the horizontal separators between rows
3	-	Top character in the left border
4	-	Top character in a line of characters that separate columns
5	-	Top character in the right border
6	|	Leftmost character in a row of horizontal separators
7	+	Intersection of a column of vertical characters and a row of horizontal characters
8	|	Rightmost character in a row of horizontal separators
9	-	Bottom character in the left border
10	-	Bottom character in a line of characters that separate columns
11	-	Bottom character in the right border

Figure 70.3 *Formatting Characters in PROC TABULATE Output*



Restriction The FORMCHAR= option affects only the traditional SAS monospace output destination.

Interaction The SAS system option FORMCHAR= specifies the default formatting characters. The system option defines the entire string of formatting characters. The FORMCHAR= option in a procedure can redefine selected characters.

Tips You can use any character in *formatting-characters*, including hexadecimal characters. If you use hexadecimal characters, then you must put `x` after the closing quotation mark. For example, the following option assigns the hexadecimal character 2-D to the third formatting character, assigns the hexadecimal character 7C to the seventh character, and does not alter the remaining characters:

```
formchar(3,7)='2D7C'x
```

Specifying all blanks for *formatting-character(s)* produces tables with no outlines or dividers.

```
formchar(1,2,3,4,5,6,7,8,9,10,11)          ='           '
```

(11 blanks)

See For more examples using formatting output, see *PROC TABULATE by Example, Second Edition*.

For information about which hexadecimal codes to use for which characters, consult the documentation for your hardware.

MISSING

considers missing values as valid values to create the combinations of class variables. Special missing values that are used to represent numeric values (the letters A through Z and the underscore (_) character) are each considered as a separate value. A heading for each missing value appears in the table.

Default If you omit MISSING, then PROC TABULATE does not include observations with a missing value for any class variable in the report.

See "Including Observations with Missing Class Variables" on page 2543

"Creating Special Missing Values" in *SAS Language Reference: Concepts* for a discussion of missing values that have special meaning.

NOSEPS
eliminates horizontal separator lines from the row titles and the body of the table. Horizontal separator lines remain between nested column headings.

Restriction The NOSEPS option affects only the traditional SAS monospace output destination.

Tip If you want to replace the separator lines with blanks rather than remove them, then use option "FORMCHAR <(*position(s)*)>='*formatting-character(s)*' " on page 2472.

Example "Example 8: Indenting Row Headings and Eliminating Horizontal Separators" on page 2571

NOTHREADS
disables parallel processing of the input data set. See "THREADS | NOTHREADS" on page 2480.

ORDER=DATA | FORMATTED | FREQ | UNFORMATTED
specifies the sort order to create the unique combinations of the values of the class variables, which form the headings of the table, according to the specified order.

DATA
orders values according to their order in the input data set.

Interaction If you use PRELOADFMT in the CLASS statement, then the order for the values of each class variable matches the order that PROC FORMAT uses to store the values of the associated user-defined format. If you use the CLASSDATA= option, then PROC TABULATE uses the order of the unique values of each class variable in the CLASSDATA= data set to order the output levels. If you use both options, then PROC TABULATE first uses the user-defined formats to order the output. If you omit EXCLUSIVE, then PROC TABULATE appends after the user-defined format and the CLASSDATA= values the unique values of the class variables in the input data set in the same order in which they are encountered.

Tips By default, PROC FORMAT stores a format definition in sorted order. Use the NOTSORTED option to store the values or ranges of a user-defined format in the order in which you define them.

When you are using in-database procedures with the ORDER=DATA option, the results can vary. DBMS tables have no inherent order for the rows. The order of rows written to a database table from a SAS procedure is not likely to be preserved.

FORMATTED
orders values by their ascending formatted values. If no format has been assigned to a numeric class variable, then the default format, BEST12., is used. This order depends on your operating environment.

Aliases FMT

EXTERNAL

FREQ
orders values by descending frequency count.

Interaction Use the ASCENDING option in the CLASS statement to order values by ascending frequency count.

UNFORMATTED
orders values by their unformatted values. This order depends on your operating environment. This sort sequence is particularly useful for displaying dates chronologically.

Specifying ORDER=UNFORMATTED usually, but not always, produces the same results as PROC SORT. For more information about ordering data, see "Controlling the Order of Data Values" on page 27.

Aliases UNFMT

INTERNAL

Default UNFORMATTED

Interaction If you use the PRELOADFMT option in the CLASS statement, then PROC TABULATE orders the levels by the order of the values in the user-defined format.

Example "Understanding the Order of Headings with ORDER=DATA" on page 2548

OUT=*SAS-data-set*
names the output data set. If *SAS-data-set* does not exist, then PROC TABULATE creates it.

The number of observations in the output data set depends on the number of categories of data that are used in the tables and the number of subtables that are generated. The output data set contains these variables (in the following order):

by variables	variables that are listed in the BY statement.
class variables	variables that are listed in the CLASS statement.
TYPE	a character variable that shows which combination of class variables produced the summary statistics in that observation. Each position in _TYPE_ represents one variable in the CLASS statement. If that variable is in the category

that produced the statistic, then the position contains a 1. Otherwise, the position contains a 0. In simple PROC TABULATE steps that do not use the universal class variable ALL, all values of _TYPE_ contain only 1s because the only categories that are being considered involve all class variables. If you use the variable ALL, then your tables will contain data for categories that do not include all the class variables, and positions of _TYPE_ will, therefore, include both 1s and 0s.

PAGE The logical page that contains the observation.

TABLE The number of the table that contains the observation.

statistics statistics that are calculated for each observation in the data set.

Example "Example 3: Using Preloaded Formats with Class Variables" on page 2556

QMARKERS=*number*

specifies the default number of markers to use for the P^2 quantile estimation method. The number of markers controls the size of fixed memory space.

Default The default value depends on which quantiles you request. For the median (P50), *number* is 7. For the quartiles (P25 and P75), *number* is 25. For the quantiles P1, P5, P10, P90, P95, or P99, *number* is 105. If you request several quantiles, then PROC TABULATE uses the largest default value of *number*.

Range any odd integer greater than 3

Tip Increase the number of markers above the default settings to improve the accuracy of the estimates; reduce the number of markers to conserve memory and computing time.

See "Quantiles" on page 1512

QMETHOD=OS | P2

specifies the method PROC TABULATE uses to process the input data when it computes quantiles. If the number of observations is less than or equal to the QMARKERS= value and QNTLDEF=5, then both methods produce the same results.

OS

uses order statistics. PROC UNIVARIATE uses this technique.

Note: This technique can be very memory-intensive.

P2

uses the P^2 method to approximate the quantile.

Alias HIST

Default OS

Restriction When QMETHOD=P2, PROC TABULATE will not compute MODE or weighted quantiles.

Tip When QMETHOD=P2, reliable estimates of some quantiles (P1, P5, P95, P99) might not be possible for some types of data.

See "Quantiles" on page 1512

QNTLDEF=1 | 2 | 3 | 4 | 5
specifies the mathematical definition that the procedure uses to calculate quantiles when QMETHOD=OS is specified. When QMETHOD=P2, you must use QNTLDEF=5.

Alias PCTLDEF=

Default 5

See "Quantile and Related Statistics" on page 2706

STYLE=*style-override(s)*
specifies one or more style overrides to use for the data cells of a table. For example, the following statement specifies that the background color for data cells is red:

```
proc tabulate data=one style=[backgroundcolor=red];
```

style-override
specifies one or more style attributes or style elements to override the default style element and attributes in a specific area of a report.

You can specify a style override in three ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.
- Specify the PARENT value. The PARENT value specifies that the data cell use the style element of its parent heading.

style-override has the following form:

PARENT | *style-element-name* | [*style-attribute-name-1=style-attribute-value-1*

<*style-attribute-name-2=style-attribute-value-2* ...>]

<PARENT>
specifies that the data cell use the style element of its parent heading.

The parent style element of a data cell is one of the following:

- the style element of the leaf heading above the column that contains the data cell, if the table specifies no row dimension, or if the table specifies the style element in the column dimension expression

- the style element of the leaf heading above the row that contains the cell, if the table specifies the style element in the row dimension expression
- the Beforecaption style element, if the table specifies the style element in the page dimension expression
- undefined, otherwise

Note: In this usage, the angle brackets around the word PARENT are required. Braces or square brackets cannot be substituted in the syntax.

Note: The parent of a heading (not applicable to STYLE= in the PROC TABULATE statement) is the heading under which the current heading is nested.

style-attribute-name
specifies the attribute to change.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-attribute-value
specifies a value for the attribute. Each attribute has a different set of valid values. A SAS format can also be used as an attribute value for conditional formatting.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For information about using SAS formats as style attribute values, see "Using a Format to Assign a Style Attribute" on page 2534.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-element-name
is the name of a style element that is part of an ODS style template.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

Alias S=

Tips The STYLE= option can be used in other statements, or in dimension expressions, to specify style elements for other parts of a table.

To specify a style element for data cells with missing values, use STYLE= in the TABLE statement MISSTEXT= option.

You can use braces ({ and }) instead of square brackets ([and]).

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

Example "Example 14: Specifying Style Overrides for ODS Output" on page 2607

THREADS | NOTHREADS

enables or disables parallel processing of the input data set. This option overrides the SAS system option THREADS | NOTHREADS unless the system option is restricted. (For more information, see "Support for Parallel Processing" in *SAS Language Reference: Concepts*.)

Default value of SAS system option THREADS | NOTHREADS.

Restriction Your site administrator can create a restricted options table. A restricted options table specifies SAS system option values that are established at start-up and cannot be overridden. If the THREADS | NOTHREADS system option is listed in the restricted options table, any attempt to set these system options is ignored and a warning message is written to the SAS log.

Interaction PROC TABULATE uses the value of the SAS system option THREADS except when a BY statement is specified or the value of the SAS system option CPUCOUNT is less than 2. In those cases, you can specify the THREADS option in the PROC TABULATE statement to force PROC TABULATE to use parallel processing. When multi-threaded processing, also known as parallel processing, is in effect, observations might be returned in an unpredictable order. However, the observations are sorted correctly if a BY statement is specified.

TRAP

enables floating point exception (FPE) recovery during data processing beyond the recovery that is provided by normal SAS FPE handling. Note that without the TRAP option, normal SAS FPE handling is still in effect so that PROC TABULATE terminates in the case of math exceptions.

VARDEF=*divisor*

specifies the divisor to use in the calculation of the variance and standard deviation. The following table shows the possible values for *divisor* and the associated divisors.

Table 70.3 Possible Values for VARDEF=

Value	Divisor	Formula for Divisor
DF	Degrees of freedom	$n - 1$
N	Number of observations	n
WDF	Sum of weights minus one	$(\Sigma_i w_i) - 1$
WEIGHT | WGT	Sum of weights	$\Sigma_i w_i$

The procedure computes the variance as $CSS/divisor$, where CSS is the corrected sums of squares and equals $\Sigma (x_i - \overline{x})^2$. When you weight the analysis variables, CSS equals $\Sigma w_i(x_i - \overline{x}_w)^2$ where $\overline{x}_w$ is the weighted mean.

Default DF

Requirement To compute standard error of the mean, use the default value of VARDEF=.

Tips When you use the WEIGHT statement and VARDEF=DF, the variance is an estimate of σ^2, where the variance of the *i*th observation is $var(x_i) = \sigma^2/w_i$, and w_i is the weight for the *i*th observation. This yields an estimate of the variance of an observation with unit weight.

When you use the WEIGHT statement and VARDEF=WGT, the computed variance is asymptotically (for large *n*) an estimate of $\sigma^2/\overline{w}$, where $\overline{w}$ is the average weight. This yields an asymptotic estimate of the variance of an observation with average weight.

See "Weighted Statistics Example" on page 84

BY Statement

Creates a separate table for each BY group.

Accessibility note: When BY statements are specified, default labels for the BY group tables are displayed in the table of contents in PDF and RTF output, the contents file in HTML output, the trace record created by the ODS TRACE statement, and the entry list created by the LIST statement in PROC DOCUMENT. The labels are based on the values of the BY variable. For an example of creating a table with default BY group labels, see "Overview of Table Accessibility " in *Creating Accessible SAS Output Using ODS and ODS Graphics* .

See: "BY" on page 74

Syntax

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...> <NOTSORTED>;

Required Argument

variable
You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, then the observations in the data set must either be sorted by all the variables that you specify, or they must be indexed appropriately. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the observations are sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. For example, the observations are grouped in chronological order.

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

CLASS Statement

Identifies class variables for the table. Class variables determine the categories that PROC TABULATE uses to calculate statistics.

Note: CLASS statements without options use the internal default or the value specified by an option in the PROC TABULATE statement. For example, in the following code, variables c and d would use the internal default. If an ORDER= option had been specified in the PROC TABULATE statement, then variables c and d would use the value specified by the ORDER= option in the PROC TABULATE statement.

```
class a b / order=data;
class c d;
```

Tips: You can use multiple CLASS statements.

Some CLASS statement options are also available in the PROC TABULATE statement. They affect all CLASS variables rather than just the ones that you specify in a CLASS statement.

Examples: "Example 3: Using Preloaded Formats with Class Variables" on page 2556
"Example 4: Using Multilabel Formats" on page 2560

Syntax

CLASS *variable(s)* </ *options*>;

Summary of Optional Arguments

ASCENDING
: specifies to sort the class variable values in ascending order.

DESCENDING
: specifies to sort the class variable values in descending order.

EXCLUSIVE
: excludes from tables and output data sets all combinations of class variables that are not found in the preloaded range of user-defined formats.

GROUPINTERNAL
: specifies not to apply formats to the class variables when PROC TABULATE groups the values to create combinations of class variables.

MISSING
: considers missing values as valid class variable levels. Special missing values that represent numeric values (the letters A through Z and the underscore (_) character) are each considered as a separate value.

MLF
: enables PROC TABULATE to use the format label or labels for a given range or overlapping ranges to create subgroup combinations when a multilabel format is assigned to a class variable.

ORDER=DATA | FORMATTED | FREQ | UNFORMATTED
: specifies the order to group the levels of the class variables in the output.

PRELOADFMT
: specifies that all formats are preloaded for the class variables.

STYLE=*style-override*
: specifies one or more style overrides to use for page dimension text and class variable name headings.

Required Argument

variable(s)
: specifies one or more variables that the procedure uses to group the data. Variables in a CLASS statement are referred to as *class variables*. Class variables can be numeric or character. Class variables can have continuous

values, but they typically have a few discrete values that define the classifications of the variable. You do not have to sort the data by class variables.

Interaction If a variable name and a statistic name are the same, enclose the statistic name in single or double quotation marks.

Optional Arguments

ASCENDING
specifies to sort the class variable values in ascending order.

Alias ASCEND

Interaction PROC TABULATE issues a warning message if you specify both ASCENDING and DESCENDING and ignores both options.

DESCENDING
specifies to sort the class variable values in descending order.

Alias DESCEND

Default ASCENDING

Interaction PROC TABULATE issues a warning message if you specify both ASCENDING and DESCENDING and ignores both options.

EXCLUSIVE
excludes from tables and output data sets all combinations of class variables that are not found in the preloaded range of user-defined formats.

Requirement You must specify the PRELOADFMT option in the CLASS statement to preload the class variable formats.

Example "Example 3: Using Preloaded Formats with Class Variables" on page 2556

GROUPINTERNAL
specifies not to apply formats to the class variables when PROC TABULATE groups the values to create combinations of class variables.

Interactions If you specify the PRELOADFMT option in the CLASS statement, then PROC TABULATE ignores the GROUPINTERNAL option and uses the formatted values.

If you specify the ORDER=FORMATTED option, then PROC TABULATE ignores the GROUPINTERNAL option and uses the formatted values.

Tip The GROUPINTERNAL option saves computer resources when the class variables contain discrete numeric values.

MISSING
considers missing values as valid class variable levels. Special missing values that represent numeric values (the letters A through Z and the underscore (_) character) are each considered as a separate value.

Default If you omit the MISSING option, then PROC TABULATE excludes the observations with any missing CLASS variable values from tables and output data sets.

See "Creating Special Missing Values" in *SAS Language Reference: Concepts* for a discussion of missing values with special meanings.

MLF
enables PROC TABULATE to use the format label or labels for a given range or overlapping ranges to create subgroup combinations when a multilabel format is assigned to a class variable.

Note: When the formatted values overlap, one internal class variable value maps to more than one class variable subgroup combination. Therefore, the sum of the N statistics for all subgroups is greater than the number of observations in the data set (the overall N statistic).

Requirement You must use PROC FORMAT and the MULTILABEL option in the VALUE statement to create a multilabel format.

Interactions Using MLF with ORDER=FREQ might not produce the order that you expect for the formatted values.

When you specify MLF, the formatted values of the class variable become internal values. Therefore, specifying ORDER=FORMATTED produces the same results as specifying ORDER=UNFORMATTED.

Tip If you omit MLF, then PROC TABULATE uses the primary format labels, which correspond to the first external format value, to determine the subgroup combinations.

See "MULTILABEL" on page 1124 in the VALUE statement of the FORMAT procedure.

Example "Example 4: Using Multilabel Formats" on page 2560

ORDER=DATA | FORMATTED | FREQ | UNFORMATTED
specifies the order to group the levels of the class variables in the output.

DATA
orders values according to their order in the input data set.

Interaction If you use PRELOADFMT, then the order for the values of each class variable matches the order that PROC FORMAT uses to store the values of the associated user-defined format. If you use the CLASSDATA= option in the PROC statement, then PROC TABULATE uses the order of the unique values of each class variable in the CLASSDATA= data set to order the output levels.

If you use both options, then PROC TABULATE first uses the user-defined formats to order the output. If you omit EXCLUSIVE in the PROC statement, then PROC TABULATE places, in the order in which they are encountered, the unique values of the class variables that are in the input data set after the user-defined format and the CLASSDATA= values.

Tip By default, PROC FORMAT stores a format definition in sorted order. Use the NOTSORTED option to store the values or ranges of a user-defined format in the order in which you define them.

FORMATTED
orders values by their ascending formatted values. This order depends on your operating environment.

Aliases FMT

EXTERNAL

FREQ
orders values by descending frequency count.

Interaction Use the ASCENDING option to order values by ascending frequency count.

UNFORMATTED
orders values by their unformatted values. This order depends on your operating environment. This sort sequence is particularly useful for displaying dates chronologically.

Specifying ORDER=UNFORMATTED usually, but not always, produces the same results as PROC SORT. For more information about ordering data, see "Controlling the Order of Data Values" on page 27.

Aliases UNFMT

INTERNAL

Default UNFORMATTED

Interaction If you use the PRELOADFMT option in the CLASS statement, then PROC TABULATE orders the levels by the order of the values in the user-defined format.

Tip By default, all orders except FREQ are ascending. For descending orders, use the DESCENDING option.

Example "Understanding the Order of Headings with ORDER=DATA" on page 2548

PRELOADFMT
specifies that all formats are preloaded for the class variables.

Requirement PRELOADFMT has no effect unless you specify EXCLUSIVE, ORDER=DATA, or PRINTMISS and you assign formats to the class

variables. If you specify PRELOADFMT without also specifying EXCLUSIVE, ORDER=DATA, or PRINTMISS, then SAS writes a warning message to the SAS log.

Interactions To limit PROC TABULATE output to the combinations of formatted class variable values present in the input data set, use the EXCLUSIVE option in the CLASS statement.

To include all ranges and values of the user-defined formats in the output, use the PRINTMISS option in the TABLE statement. Use care when you use PRELOADFMT with PRINTMISS. This feature creates all possible combinations of formatted class variables. Some of these combinations might not make sense.

Note When preloading a character format, there must be at least one representative raw value that produces the label. If a range does not have any raw values, the range is considered unreachable and an error is generated. For example, you cannot preload a multi-label character format with both Other= and Low-High ranges. Other is a special keyword that refers to values or ranges that remain after all labels have been defined. For character formats, missing values are included in the low range so that there are no raw values left to occupy the Other range.

Example "Example 3: Using Preloaded Formats with Class Variables" on page 2556

STYLE=*style-override*

specifies one or more style overrides to use for page dimension text and class variable name headings. For example, the following statement specifies that the background color for page dimension text and class variable name headings is light green:

```
class region division prodtype / style=[background=lightgreen];
```

style-override

specifies one or more style attributes or style elements to override the default style element and attributes in a specific area of a report.

You can specify a style override in three ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.
- Specify the PARENT value. The PARENT value specifies that the data cell use the style element of its parent heading.

style-override has the following form:

PARENT | *style-element-name* | [*style-attribute-name-1=style-attribute-value-1*

<*style-attribute-name-2=style-attribute-value-2* ...>]

<PARENT>
specifies that the data cell use the style element of its parent heading.

The parent style element of a data cell is one of the following:

- the style element of the leaf heading above the column that contains the data cell, if the table specifies no row dimension, or if the table specifies the style element in the column dimension expression
- the style element of the leaf heading above the row that contains the cell, if the table specifies the style element in the row dimension expression
- the Beforecaption style element, if the table specifies the style element in the page dimension expression
- undefined, otherwise

Note: In this usage, the angle brackets around the word PARENT are required. Braces or square brackets cannot be substituted in the syntax.

Note: The parent of a heading (not applicable to STYLE= in the PROC TABULATE statement) is the heading under which the current heading is nested.

style-attribute-name
specifies the attribute to change.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-attribute-value
specifies a value for the attribute. Each attribute has a different set of valid values. A SAS format can also be used as an attribute value for conditional formatting.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For information about using SAS formats as style attribute values, see "Using a Format to Assign a Style Attribute" on page 2534.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-element-name
is the name of a style element that is part of an ODS style template.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

Alias S=

Tips To override a style element that is specified for page dimension text in the CLASS statement, you can specify a style element in the TABLE statement page dimension expression.

To override a style element that is specified for a class variable name heading in the CLASS statement, you can specify a style element in the related TABLE statement dimension expression.

If a page dimension expression contains multiple nested elements, then the Beforecaption style element is the style element of the first element in the nesting.

The use of STYLE= in the CLASS statement differs slightly from its use in the PROC TABULATE statement. In the CLASS statement, inheritance is different for rows and columns. For rows, the parent heading is located to the left of the current heading. For columns, the parent heading is located above the current heading.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

Example "Example 14: Specifying Style Overrides for ODS Output" on page 2607

Details

How PROC TABULATE Handles Missing Values for Class Variables

By default, if an observation contains a missing value for any class variable, then PROC TABULATE excludes that observation from all tables that it creates. CLASS statements apply to all TABLE statements in the PROC TABULATE step. Therefore, if you define a variable as a class variable, then PROC TABULATE omits observations that have missing values for that variable from every table even if the variable does not appear in the TABLE statement for one or more tables.

If you specify the MISSING option in the PROC TABULATE statement, then the procedure considers missing values as valid levels for all class variables. If you specify the MISSING option in a CLASS statement, then PROC TABULATE considers missing values as valid levels for the class variables that are specified in that CLASS statement.

CLASSLEV Statement

Specifies a style element for class variable level value headings.

Examples: "Example 14: Specifying Style Overrides for ODS Output" on page 2607
"Example 15: Style Precedence" on page 2612

Syntax

CLASSLEV *variable(s)* </ STYLE=*style-override(s)*>;

Required Argument

variable(s)
specifies one or more class variables from the CLASS statement for which you want to specify a style element.

Optional Argument

STYLE=*style-override*
specifies one or more style overrides for class variable level value headings. For example, the following statement specifies that the background color for class variable level name headings is yellow:

```
classlev region division prodtype  / style=[background=yellow];
```

style-override
specifies one or more style attributes or style elements to override the default style element and attributes in a specific area of a report.

You can specify a style override in three ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.
- Specify the PARENT value. The PARENT value specifies that the data cell use the style element of its parent heading.

style-override has the following form:

PARENT | *style-element-name* | [*style-attribute-name-1=style-attribute-value-1*

<*style-attribute-name-2=style-attribute-value-2* ...>]

<PARENT>
specifies that the data cell use the style element of its parent heading.

The parent style element of a data cell is one of the following:

- the style element of the leaf heading above the column that contains the data cell, if the table specifies no row dimension, or if the table specifies the style element in the column dimension expression
- the style element of the leaf heading above the row that contains the cell, if the table specifies the style element in the row dimension expression
- the Beforecaption style element, if the table specifies the style element in the page dimension expression
- undefined, otherwise

Note: In this usage, the angle brackets around the word PARENT are required. Braces or square brackets cannot be substituted in the syntax.

Note: The parent of a heading (not applicable to STYLE= in the PROC TABULATE statement) is the heading under which the current heading is nested.

style-attribute-name
specifies the attribute to change.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-attribute-value
specifies a value for the attribute. Each attribute has a different set of valid values. A SAS format can also be used as an attribute value for conditional formatting.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For information about using SAS formats as style attribute values, see "Using a Format to Assign a Style Attribute" on page 2534.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-element-name
is the name of a style element that is part of an ODS style template.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

Alias S=

Tips The use of STYLE= in the CLASSLEV statement differs slightly from its use in the PROC TABULATE statement. In the CLASSLEV statement, inheritance is different for rows and columns. For rows, the parent heading is located to the left of the current heading. For columns, the parent heading is located above the current heading.

To override a style element that is specified in the CLASSLEV statement, you can specify a style element in the related TABLE statement dimension expression.

You can use braces ({ and }) instead of square brackets ([and]).

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

Example "Example 14: Specifying Style Overrides for ODS Output" on page 2607

FREQ Statement

Specifies a numeric variable that contains the frequency of each observation.

Tip: The effects of the FREQ and WEIGHT statements are similar except when calculating degrees of freedom.

Example: "FREQ" on page 79

Syntax

FREQ *variable*;

Required Argument

variable
specifies a numeric variable whose value represents the frequency of the observation.

If you use the FREQ statement, then the procedure assumes that each observation represents *n* observations, where *n* is the value of *variable*. If *n* is not an integer, then SAS truncates it. If *n* is less than 1 or is missing, then the procedure does not use that observation to calculate statistics.

The sum of the frequency variable represents the total number of observations.

KEYLABEL Statement

Labels a keyword for the duration of the PROC TABULATE step. PROC TABULATE uses the label anywhere that the specified keyword would otherwise appear.

Syntax

KEYLABEL *keyword-1*='*description-1*' <*keyword-2*='*description-2*' ...>;

Required Arguments

keyword
specifies a statistic keyword.

keyword can be one of the keywords for statistics that is discussed in "Statistics That Are Available in PROC TABULATE" on page 2515 or is the universal class variable ALL. (See "Elements That You Can Use in a Dimension Expression" on page 2507.)

description
specifies the keyword label.

Length	256 characters
Restriction	Each keyword can have only one label in a particular PROC TABULATE step. If you request multiple labels for the same keyword, then PROC TABULATE uses the last one that is specified in the step.
Requirement	You must enclose *description* in quotation marks

KEYWORD Statement

Specifies a style element for keyword headings.

Example: "Example 14: Specifying Style Overrides for ODS Output" on page 2607

Syntax

KEYWORD *keyword(s)* </ STYLE=*style-override(s)*>;

Required Argument

keyword
specifies the keyword statistic.

keyword can be one of the keywords for statistics that is discussed in "Statistics That Are Available in PROC TABULATE" on page 2515 or is the universal class variable ALL. (See "Elements That You Can Use in a Dimension Expression" on page 2507.)

Optional Argument

STYLE=*style-override*
specifies one or more style overrides for the keyword headings.

For example, the following statement specifies that the background color for keyword headings is linen:

```
keyword all sum / style=[background=linen];
```

style-override
specifies one or more style attributes or style elements to override the default style element and attributes in a specific area of a report.

You can specify a style override in three ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.
- Specify the PARENT value. The PARENT value specifies that the data cell use the style element of its parent heading.

style-override has the following form:

PARENT | *style-element-name* | [*style-attribute-name-1=style-attribute-value-1*

<*style-attribute-name-2=style-attribute-value-2* ...>]

<PARENT>
specifies that the data cell use the style element of its parent heading.

The parent style element of a data cell is one of the following:

- the style element of the leaf heading above the column that contains the data cell, if the table specifies no row dimension, or if the table specifies the style element in the column dimension expression
- the style element of the leaf heading above the row that contains the cell, if the table specifies the style element in the row dimension expression
- the Beforecaption style element, if the table specifies the style element in the page dimension expression
- undefined, otherwise

Note: In this usage, the angle brackets around the word PARENT are required. Braces or square brackets cannot be substituted in the syntax.

Note: The parent of a heading (not applicable to STYLE= in the PROC TABULATE statement) is the heading under which the current heading is nested.

style-attribute-name
specifies the attribute to change.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-attribute-value
specifies a value for the attribute. Each attribute has a different set of valid values. A SAS format can also be used as an attribute value for conditional formatting.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For information about using SAS formats as style attribute values, see "Using a Format to Assign a Style Attribute" on page 2534.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-element-name
is the name of a style element that is part of an ODS style template.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

Alias S=

Tips The use of STYLE= in the KEYWORD statement differs slightly from its use in the PROC TABULATE statement. In the KEYWORD statement, inheritance is different for rows and columns. For rows, the parent heading is located to the left of the current heading. For columns, the parent heading is located above the current heading.

To override a style element that is specified in the KEYWORD statement, you can specify a style element in the related TABLE statement dimension expression.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

Example "Example 14: Specifying Style Overrides for ODS Output" on page 2607

TABLE Statement

Describes a table to be printed.

Requirement: All variables in the TABLE statement must appear in either the VAR statement or the CLASS statement.

Tips: To create several tables use multiple TABLE statements.

Use of variable name list shortcuts is now supported within the TABLE statement. For more information, see "Shortcuts for Specifying Lists of Variable Names" on page 62.

Syntax

TABLE <<*page-expression*,> *row-expression*,>
column-expression </ *table-options*>;

Summary of Optional Arguments

BOX={<*label=value*> <**STYLE=*style-override(s)***>}
: specifies text and a style override for the empty box above the row titles.

BOX=*value*
: specifies text for the empty box above the row titles.

CAPTION= *text*<#BYLINE> <#BYVAL><#BYVAR>
: specifies a caption text string to add before each table.

CONDENSE
: prints as many complete logical pages as possible on a single printed page or, if possible, prints multiple pages of tables that are too wide to fit on a page one below the other on a single page, instead of on separate pages.

CONTENTS=*link-text* <#BYLINE> <#BYVAL> <#BYVAR>
: enables you to name the link in the HTML table of contents that points to the ODS output of the table that is produced by using the TABLE statement.

FORMAT_PRECEDENCE=PAGE | ROW | COLUMN
: specifies whether the format that is specified for the page dimension (PAGE), row dimension (ROW), or column dimension (COLUMN) is applied to the contents of the table cells.

FUZZ=*number*
: supplies a numeric value against which analysis variable values and table cell values other than frequency counts are compared to eliminate trivial values (absolute values less than the FUZZ= value) from computation and printing.

INDENT=*number-of-spaces*
: specifies the number of spaces to indent nested row headings, and suppresses the row headings for class variables.

MISSTEXT='*text*'
: supplies up to 256 characters of text to be printed for table cells that contain missing values.

MISSTEXT={<*label*='*text*'> <STYLE=*style-override(s)*>}
: supplies up to 256 characters of text to be printed and specifies a style override for table cells that contain missing values.

NOCELLMERGE
: specifies that data cells are not merged with other data cells in the table.

NOCONTINUED
: suppresses the continuation message, **continued**, that is displayed at the bottom of tables that span multiple pages.

page-expression
: defines the pages in a table.

PRINTMISS
: prints all values that occur for a class variable each time headings for that variable are printed, even if there are no data for some of the cells that these headings create.

ROW=CONSTANT | FLOAT
: specifies whether all title elements in a row crossing are allotted space even when they are blank.

row-expression
: defines the rows in the table.

RTSPACE=*number*
: specifies the number of print positions to allot to all of the headings in the row dimension, including spaces that are used to print outlining characters for the row headings.

STYLE_PRECEDENCE=PAGE | ROW | COLUMN
: specifies whether the style that is specified for the page dimension (PAGE), row dimension (ROW), or column dimension (COLUMN or COL) is applied to the contents of the table cells.

STYLE=*style-override*
: specifies one or more style overrides to use for parts of the table other than table cells.

Required Argument

column-expression
defines the columns in the table. For information about constructing dimension expressions, see "Details" on page 2507.

Restriction A column dimension is the last dimension in a TABLE statement. A row dimension or a row dimension and a page dimension can precede a column dimension.

Optional Arguments

page-expression
defines the pages in a table. For information about constructing dimension expressions, see "Details" on page 2507.

Restrictions A page dimension is the first dimension in a table statement. Both a row dimension and a column dimension must follow a page dimension.

If the ACCESSIBLETABLE=ON system option is specified and the TABULATE table has page dimension text, then that text is the accessible caption. Otherwise use the CAPTION=/ CONTENTS= text.

Accessibility note Starting with SAS 9.4M6, you can use the ACCESSIBLECHECK and ACCESSIBLETABLE system options to check for and create accessible tables. For information about creating accessible PROC TABULATE tables, see "Overview of Table Accessibility " in *Creating Accessible SAS Output Using ODS and ODS Graphics* . If the ACCESSIBLETABLE=ON system option is specified and the TABULATE table has page dimension text, then that text is the accessible caption.

Example "Example 9: Creating Multipage Tables" on page 2574

row-expression
defines the rows in the table. For information about constructing dimension expressions, see "Details" on page 2507.

Restriction A row dimension is the next to last dimension in a table statement. A column dimension must follow a row dimension. A page dimension can precede a row dimension.

Table Options

BOX=*value*
specifies text for the empty box above the row titles.

Value can be one of the following:

PAGE
writes the page-dimension text in the box. If the page-dimension text does not fit, then it is placed in its default position above the box, and the box remains empty.

BOX={<*label*=*value*> <STYLE=*style-override(s)*>}
specifies text and a style override for the empty box above the row titles.

Value can be one of the following:

PAGE
writes the page-dimension text in the box. If the page-dimension text does not fit, then it is placed in its default position above the box, and the box remains empty.

'string'
writes the quoted string in the box. Any string that does not fit in the box is truncated.

variable
writes the name (or label, if the variable has one) of a variable in the box. Any name or label that does not fit in the box is truncated.

For details about the arguments of the STYLE= option and how it is used, see STYLE= on page 2504 in the TABLE statement.

Examples "Example 9: Creating Multipage Tables" on page 2574

"Example 14: Specifying Style Overrides for ODS Output" on page 2607

CAPTION= *text*<#BYLINE> <#BYVAL><#BYVAR>
specifies a caption text string to add before each table. If no string is specified, then the caption defaults to the text specified by the CONTENTS= option in the TABLE statement.

This option makes table captions both visual and accessible if the ACCESSIBLETABLE system option is specified.

If the NOACCESSIBLETABLE system option is specified, then no caption is displayed, however the caption text is still accessible.

Starting with SAS 9.4M6, these options are available if a BY statement is in effect:

#BYLINE
substitutes the entire BY line without leading or trailing blanks for #BYLINE in the text string. The BY line uses the format *variable-name=value*.

#BYVAL*n*
#BYVAL(*BY-variable-name*)
substitutes the current value of the specified BY variable for #BYVAL in the text string.

Specify the variable with one of the following:

n
specifies a variable by its position in the BY statement. For example, #BYVAL2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAL(YEAR) specifies the BY variable, YEAR. *Variable-name* is not case sensitive.

#BYVAR*n*
#BYVAR(*BY-variable-name*)
substitutes the name of the BY-variable or the label associated with the variable (whatever the BY line would normally display) for #BYVAR in the text string.

Specify the variable with one of the following:

n
specifies a variable by its position in the BY statement. For example, #BYVAR2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAR(SITES) specifies the BY variable, SITES. *Variable-name* is not case sensitive.

Restrictions The ACCESSIBLETABLE system option must be specified to enable captions.

The CAPTION= option is not valid in the LISTING destination.

Note This feature applies to SAS 9.4M6 and to later releases.

Tip You can use the PROC DOCUMENT OBBNOTE option to display or edit the caption.

See Creating Accessible Tables with the TABULATE Procedure in *Creating Accessible SAS Output Using ODS and ODS Graphics*

CONDENSE
prints as many complete logical pages as possible on a single printed page or, if possible, prints multiple pages of tables that are too wide to fit on a page one below the other on a single page, instead of on separate pages. A *logical page* is all the rows and columns that fall within one of the following:

- a page-dimension category (with no BY-group processing)
- a BY group with no page dimension
- a page-dimension category within a single BY group

Restriction The CONDENSE option has no effect on the pages that are generated by the BY statement. The first table for a BY group always begins on a new page.

Example “Example 9: Creating Multipage Tables” on page 2574

CONTENTS=*link-text* <#BYLINE> <#BYVAL> <#BYVAR>
enables you to name the link in the HTML table of contents that points to the ODS output of the table that is produced by using the TABLE statement.

Starting with SAS 9.4M6, these options are available if a BY statement is in effect:

#BYLINE
substitutes the entire BY line without leading or trailing blanks for #BYLINE in the text string. The BY line uses the format *variable-name=value*.

#BYVAL*n*
#BYVAL(*BY-variable-name*)
substitutes the current value of the specified BY variable for #BYVAL in the text string.

Specify the variable with one of the following:

n
specifies a variable by its position in the BY statement. For example, #BYVAL2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAL(YEAR) specifies the BY variable, YEAR. *Variable-name* is not case sensitive.

#BYVAR*n*
#BYVAR(*BY-variable-name*)
substitutes the name of the BY-variable or the label associated with the variable (whatever the BY line would normally display) for #BYVAR in the text string.

Specify the variable with one of the following:

n
specifies a variable by its position in the BY statement. For example, #BYVAR2 specifies the second variable in the BY statement.

BY-variable-name
specifies a variable from the BY statement by its name. For example, #BYVAR(SITES) specifies the BY variable, SITES. *Variable-name* is not case sensitive.

See "Substituting BY Line Values in a Text String" on page 2538

Creating Accessible Tables with the TABULATE Procedure in *Creating Accessible SAS Output Using ODS and ODS Graphics*

FORMAT_PRECEDENCE=PAGE | ROW | COLUMN
specifies whether the format that is specified for the page dimension (PAGE), row dimension (ROW), or column dimension (COLUMN) is applied to the contents of the table cells.

PAGE
specifies that the format that is specified for the page dimension is applied to the contents of the table cells.

ROW
specifies that the format that is specified for the row dimension is applied to the contents of the table cells.

COLUMN
specifies that the format that is specified for the column dimension is applied to the contents of the table cells.

Alias COL

Default COLUMN

FUZZ=*number*
supplies a numeric value against which analysis variable values and table cell values other than frequency counts are compared to eliminate trivial values (absolute values less than the FUZZ= value) from computation and printing. A number whose absolute value is less than the FUZZ= value is treated as zero in computations and printing. The default value is the smallest representable floating-point number on the computer that you are using.

INDENT=*number-of-spaces*
specifies the number of spaces to indent nested row headings, and suppresses the row headings for class variables.

Restriction In the HTML, RTF, and Printer destinations, the INDENT= option suppresses the row headings for class variables but does not indent nested row headings.

Tip When there are no crossings in the row dimension, there is nothing to indent, so the value of *number-of-spaces* has no effect. However, in such cases INDENT= still suppresses the row headings for class variables.

See "Example 8: Indenting Row Headings and Eliminating Horizontal Separators" on page 2571 (with crossings) "Example 9: Creating Multipage Tables" on page 2574 (without crossings)

MISSTEXT='*text*'
supplies up to 256 characters of text to be printed for table cells that contain missing values.

MISSTEXT={<*label*='*text*'> <STYLE=*style-override(s)*>}
supplies up to 256 characters of text to be printed and specifies a style override for table cells that contain missing values. For details about the arguments of the STYLE= option and how it is used, see STYLE= on page 2504 in the TABLE statement.

Interaction A style element that is specified in a dimension expression overrides a style element that is specified in the MISSTEXT= option for any given cells.

Examples "Providing Text for Cells That Contain Missing Values" on page 2546

"Example 14: Specifying Style Overrides for ODS Output" on page 2607

NOCELLMERGE
specifies that data cells are not merged with other data cells in the table.

Note: The NOCELLMERGE option works with the ODS formatted destinations. These include the ODS MARKUP family, ODS RTF, and the ODS PRINTER family destinations.

Restriction The NOCELLMERGE option does not work with the traditional monospace output.

Interactions If you specify ROW=FLOAT or INDENT=0, PROC TABULATE produces single unmerged data rows. The NOCELLMERGE option is then ignored because there are no rows that need to be merged.

If the NOCELLMERGE option is in effect, the style of the empty data cells will be the default style of the data cell. The style of the empty data cells might not be the same style as the style of the formatted data cells.

Example "Example 16: Using the NOCELLMERGE Option" on page 2616

NOCONTINUED

suppresses the continuation message, **`continued`**, that is displayed at the bottom of tables that span multiple pages. The text is rendered with the AFTERCAPTION style element.

Note: Because HTML browsers do not break pages, NOCONTINUED has no effect on the HTML destination.

PRINTMISS

prints all values that occur for a class variable each time headings for that variable are printed, even if there are no data for some of the cells that these headings create. Consequently, PRINTMISS creates row and column headings that are the same for all logical pages of the table, within a single BY group.

Default If you omit the PRINTMISS option, then PROC TABULATE suppresses a row or column for which there are no data, unless you use the CLASSDATA= option in the PROC TABULATE statement.

Restriction If an entire logical page contains only missing values, then that page is not printed regardless of the PRINTMISS option.

See "CLASSDATA=*SAS-data-set*" on page 2470

Example "Providing Headings for All Categories" on page 2545

ROW=CONSTANT | FLOAT

specifies whether all title elements in a row crossing are allotted space even when they are blank.

CONSTANT

allots space to all row titles even if the title has been blanked out. (For example, N=' '.)

Alias CONST

FLOAT
divides the row title space equally among the nonblank row titles in the crossing.

Default CONSTANT

Example "Example 7: Eliminating Row Headings" on page 2569

RTSPACE=*number*
specifies the number of print positions to allot to all of the headings in the row dimension, including spaces that are used to print outlining characters for the row headings. PROC TABULATE divides this space equally among all levels of row headings.

Alias RTS=

Default one-fourth of the value of the SAS system option LINESIZE=

Restriction The RTSPACE= option affects only the traditional SAS monospace output destination.

Interaction By default, PROC TABULATE allots space to row titles that are blank. Use ROW=FLOAT in the TABLE statement to divide the space among only nonblank titles.

See For more examples of controlling the space for row titles, see *PROC TABULATE by Example, Second Edition*.

Example "Example 1: Creating a Basic Two-Dimensional Table" on page 2550

STYLE=*style-override*
specifies one or more style overrides to use for parts of the table other than table cells. For example, the following statement specifies that the background color for missing values is red and the background color the box is orange:

```
table (region all)*(division all),
         (prodtype all)*(actual*f=dollar10.) /
         misstext=[label='Missing' style=[background=red]]
         box=[label='Region by Division and Type'  style=[backgroundcolor=orange]];
```

style-override
specifies one or more style attributes or style elements to override the default style element and attributes in a specific area of a report.

You can specify a style override in three ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.
- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.
- Specify the PARENT value. The PARENT value specifies that the data cell use the style element of its parent heading.

style-override has the following form:

PARENT | *style-element-name* | [*style-attribute-name-1=style-attribute-value-1*

<style-attribute-name-2=style-attribute-value-2 ...>]

<PARENT>
specifies that the data cell use the style element of its parent heading.

The parent style element of a data cell is one of the following:

- the style element of the leaf heading above the column that contains the data cell, if the table specifies no row dimension, or if the table specifies the style element in the column dimension expression
- the style element of the leaf heading above the row that contains the cell, if the table specifies the style element in the row dimension expression
- the Beforecaption style element, if the table specifies the style element in the page dimension expression
- undefined, otherwise

Note: In this usage, the angle brackets around the word PARENT are required. Braces or square brackets cannot be substituted in the syntax.

Note: The parent of a heading (not applicable to STYLE= in the PROC TABULATE statement) is the heading under which the current heading is nested.

style-attribute-name
specifies the attribute to change.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-attribute-value
specifies a value for the attribute. Each attribute has a different set of valid values. A SAS format can also be used as an attribute value for conditional formatting.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For information about using SAS formats as style attribute values, see "Using a Format to Assign a Style Attribute" on page 2534.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-element-name
is the name of a style element that is part of an ODS style template.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

Alias S=

Tips To override a style element specification that is made as an option in the TABLE statement, specify STYLE= in a dimension expression of the TABLE statement.

You can use braces ({ and }) instead of square brackets ([and]).

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

Example "Example 14: Specifying Style Overrides for ODS Output" on page 2607

STYLE_PRECEDENCE=PAGE | ROW | COLUMN
specifies whether the style that is specified for the page dimension (PAGE), row dimension (ROW), or column dimension (COLUMN or COL) is applied to the contents of the table cells.

PAGE
specifies that the style that is specified for the page dimension is applied to the contents of the table cells.

ROW
specifies that the style that is specified for the row dimension is applied to the contents of the table cells.

COLUMN
specifies that the style that is specified for the column dimension is applied to the contents of the table cells.

Alias COL

Default COLUMN

Example "Example 15: Style Precedence" on page 2612

Details

What Are Dimension Expressions?

A dimension expression defines the content and appearance of a dimension (the columns, rows, or pages in the table) by specifying the combination of variables, variable values, and statistics that make up that dimension. A TABLE statement consists of from one to three dimension expressions separated by commas. Options can follow the dimension expressions.

If all three dimensions are specified, then the leftmost dimension expression defines pages, the middle dimension expression defines rows, and the rightmost dimension expression defines columns. If two dimensions are specified, then the left dimension expression defines rows, and the right dimension expression defines columns. If a single dimension is specified, then the dimension expression defines columns.

A dimension expression consists of one or more elements and operators.

Elements That You Can Use in a Dimension Expression

analysis variables
(See the VAR statement on page 2511.)

class variables
(See the CLASS statement on page 2482.)

the universal class variable ALL
summarizes all of the categories for class variables in the same parenthetical group or dimension (if the variable ALL is not contained in a parenthetical group).

Note: If the input data set contains a variable named ALL, then enclose the name of the universal class variable in quotation marks.

Examples
"Example 6: Summarizing Information with the Universal Class Variable ALL" on page 2566

"Example 9: Creating Multipage Tables" on page 2574

"Example 13: Using Denominator Definitions to Display Basic Frequency Counts and Percentages" on page 2593

keywords for statistics
See "Statistics That Are Available in PROC TABULATE" on page 2515 for a list of available statistics. Use the asterisk (*) operator to associate a statistic keyword with a variable. The N statistic (number of nonmissing values) can be specified in a dimension expression without associating it with a variable.

Default
For analysis variables, the default statistic is SUM. Otherwise, the default statistic is N.

Restriction Statistic keywords other than N must be associated with an analysis variable.

Interaction Statistical keywords should be enclosed by single or double quotation marks to ensure that the keyword element is treated as a statistical keyword and not treated as a variable. By default, SAS treats these keywords as variables.

Example
```
n
Region*n
Sales*max
```

Examples "Example 10: Reporting on Multiple-Response Survey Data" on page 2577

"Example 13: Using Denominator Definitions to Display Basic Frequency Counts and Percentages" on page 2593

format modifiers

define how to format values in cells. Use the asterisk (*) operator to associate a format modifier with the element (an analysis variable or a statistic) that produces the cells that you want to format. Format modifiers have the form

`f=format`

Tip Format modifiers have no effect on CLASS variables.

See For more information about specifying formats in tables, see "Formatting Values in Tables" on page 2518.

Example `Sales*f=dollar8.2`

Example "Example 6: Summarizing Information with the Universal Class Variable ALL" on page 2566

labels

temporarily replace the names of variables and statistics. Labels affect only the variable or statistic that immediately precedes the label. Labels have the form

`statistic-keyword-or-variable-name='label-text'`

Tip PROC TABULATE eliminates the space for blank column headings from a table but by default does not eliminate the space for blank row headings unless all row headings are blank. Use ROW=FLOAT in the TABLE statement to remove the space for blank row headings.

Example
```
Region='Geographical Region'
Sales*max='Largest Sale'
```

Examples "Example 5: Customizing Row and Column Headings" on page 2564

"Example 7: Eliminating Row Headings" on page 2569

style specifications
specify style elements and style attributes for page dimension text, headings, or data cells. For details, see " Specifying Style Attributes and Style Elements in Dimension Expressions" on page 2510.

Operators That You Can Use in a Dimension Expression

asterisk *
creates categories from the combination of values of the class variables and constructs the appropriate headings for the dimension. If one of the elements is an analysis variable, then the statistics for the analysis variable are calculated for the categories that are created by the class variables. This process is called crossing.

Example
```
Region*Division
Quarter*Sales*f=dollar8.2
```

Example "Example 1: Creating a Basic Two-Dimensional Table" on page 2550

(blank)
places the output for each element immediately after the output for the preceding element. This process is called concatenation.

Example
```
n Region*Sales ALL
```

Example "Example 6: Summarizing Information with the Universal Class Variable ALL" on page 2566

parentheses ()
group elements and associate an operator with each concatenated element in the group.

Example
```
Division*(Sales*max Sales*min)
(Region ALL)*Sales
```

Example "Example 6: Summarizing Information with the Universal Class Variable ALL" on page 2566

angle brackets <>
specify denominator definitions, which determine the value of the denominator in the calculation of a percentage. For a discussion of how to construct denominator definitions, see "Calculating Percentages " on page 2519.

Examples "Example 10: Reporting on Multiple-Response Survey Data" on page 2577

"Example 13: Using Denominator Definitions to Display Basic Frequency Counts and Percentages" on page 2593

Specifying Style Attributes and Style Elements in Dimension Expressions

You can specify one or more style elements or style attributes in a dimension expression to control the appearance of non-LISTING output. You can modify the appearance of the following areas:

- analysis variable name headings
- class variable name headings
- class variable level value headings
- data cells
- keyword headings
- page dimension text

Specifying a style attribute or style element in a dimension expression is useful when you want to override a style attribute or style element that you have specified in another statement, such as the PROC TABULATE, CLASS, CLASSLEV, KEYWORD, TABLE, or VAR statements.

The syntax for specifying style elements and style attributes in a dimension expression is

[STYLE<(CLASSLEV)>=<*style-element-name* | PARENT>

[*style-attribute-name-1=style-attribute-value-1< style-attribute-name-2=style-attribute-value-2 ...*>]]

These are some examples of style attributes in dimension expressions:

-
```
dept={label='Department'
      style=[color=red]}, N
```
- `dept*[style=MyDataStyle], N`
- `dept*[format=12.2 style=MyDataStyle], N`

Note: When used in a dimension expression, the STYLE= option must be enclosed within square brackets ([and]) or braces ({ and }).

(CLASSLEV)
assigns a style element to a class variable level value heading. For example, the following TABLE statement specifies that the level value heading for the class variable, DEPT, has a foreground color of yellow:

```
table dept=[style(classlev)=
            [color=yellow]]*sales;
```

Note: The CLASSLEV option is used only in dimension expressions.

For an example that shows how to specify style elements within dimension expressions, see "Example 14: Specifying Style Overrides for ODS Output" on page

2607. For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

VAR Statement

Identifies numeric variables to use as analysis variables.

Alias: VARIABLES

Tip: You can use multiple VAR statements.

Example: "Example 14: Specifying Style Overrides for ODS Output" on page 2607

Syntax

VAR *analysis-variable(s)* </ *options*>;

Required Argument

analysis-variable(s);
identifies the analysis variables in the table. Analysis variables are numeric variables for which PROC TABULATE calculates statistics. The values of an analysis variable can be continuous or discrete.

If an observation contains a missing value for an analysis variable, then PROC TABULATE omits that value from calculations of all statistics except N (the number of observations with nonmissing variable values) and NMISS (the number of observations with missing variable values). For example, the missing value does not increase the SUM, and it is not counted when you are calculating statistics such as the MEAN.

Interaction If a variable name and a statistic name are the same, enclose the statistic name in single or double quotation marks.

Optional Arguments

STYLE=*style-override(s)*
specifies one or more style overrides for analysis variable name headings. For example, the following statement specifies that the background color for analysis variable name headings is tan:

```
var actual  / style=[background=tan];
```

style-override
specifies one or more style attributes or style elements to override the default style element and attributes in a specific area of a report.

You can specify a style override in three ways:

- Specify a style element. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program.

- Specify a style attribute. A style attribute is a name-value pair that describes a single behavioral or visual aspect of a piece of output. This is the most specific method of changing the appearance of your output.
- Specify the PARENT value. The PARENT value specifies that the data cell use the style element of its parent heading.

style-override has the following form:

PARENT | *style-element-name* | [*style-attribute-name-1=style-attribute-value-1*

<*style-attribute-name-2=style-attribute-value-2* ...>]

<PARENT>
specifies that the data cell use the style element of its parent heading.

The parent style element of a data cell is one of the following:

- the style element of the leaf heading above the column that contains the data cell, if the table specifies no row dimension, or if the table specifies the style element in the column dimension expression
- the style element of the leaf heading above the row that contains the cell, if the table specifies the style element in the row dimension expression
- the Beforecaption style element, if the table specifies the style element in the page dimension expression
- undefined, otherwise

Note: In this usage, the angle brackets around the word PARENT are required. Braces or square brackets cannot be substituted in the syntax.

Note: The parent of a heading (not applicable to STYLE= in the PROC TABULATE statement) is the heading under which the current heading is nested.

style-attribute-name
specifies the attribute to change.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-attribute-value
specifies a value for the attribute. Each attribute has a different set of valid values. A SAS format can also be used as an attribute value for conditional formatting.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For information about using SAS formats as style attribute values, see "Using a Format to Assign a Style Attribute" on page 2534.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

style-element-name
is the name of a style element that is part of an ODS style template.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

For a table of default style attributes and style elements for each ODS destination, see "Style Elements and Style Attributes for Table Regions" on page 2530.

Alias S=

Tips To override a style element that is specified in the VAR statement, you can specify a style element in the related TABLE statement dimension expression.

The use of STYLE= in the VAR statement differs slightly from its use in the PROC TABULATE statement. In the VAR statement, inheritance is different for rows and columns. For rows, the parent heading is located to the left of the current heading. For columns, the parent heading is located above the current heading.

See For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

Example "Example 14: Specifying Style Overrides for ODS Output" on page 2607

WEIGHT=*weight-variable*
specifies a numeric variable whose values weight the values of the variables that are specified in the VAR statement. The variable does not have to be an integer. If the value of the weight variable is

Weight Value	PROC TABULATE Response
0	Counts the observation in the total number of observations
Less than 0	Converts the value to zero and counts the observation in the total number of observations
Missing	Excludes the observation

To exclude observations that contain negative and zero weights from the analysis, use EXCLNPWGT. Note that most SAS/STAT procedures, such as PROC GLM, exclude negative and zero weights by default.

Restriction To compute weighted quantiles, use QMETHOD=OS in the PROC statement.

Note Prior to Version 7 of SAS, the procedure did not exclude the observations with missing weights from the count of observations.

Tips When you use the WEIGHT= option, consider which value of the VARDEF= option is appropriate. See the discussion of "VARDEF=*divisor* " on page 2480.

Use the WEIGHT option in multiple VAR statements to specify different weights for the analysis variables.

WEIGHT Statement

Specifies weights for analysis variables in the statistical calculations.

See: For information about calculating weighted statistics and for an example that uses the WEIGHT statement, see "Calculating Weighted Statistics" on page 83.

Syntax

WEIGHT *variable*;

Required Argument

variable
specifies a numeric variable whose values weight the values of the analysis variables. The values of the variable do not have to be integers. PROC TABULATE responds to weight values in accordance with the following table.

Weight Value	PROC TABULATE Response
0	Counts the observation in the total number of observations
Less than 0	Converts the value to zero and counts the observation in the total number of observations
Missing	Excludes the observation

To exclude observations that contain negative and zero weights from the analysis, use EXCLNPWGT. Note that most SAS/STAT procedures, such as PROC GLM, exclude negative and zero weights by default.

Note: Prior to Version 7 of SAS, the procedure did not exclude the observations with missing weights from the count of observations.

Restrictions To compute weighted quantiles, use QMETHOD=OS in the PROC statement.

PROC TABULATE will not compute MODE when a weight variable is active. Instead, try using PROC UNIVARIATE when MODE needs to be computed and a weight variable is active.

Interaction If you use the WEIGHT= option in a VAR statement to specify a weight variable, then PROC TABULATE uses this variable instead to weight those VAR statement variables.

Tip When you use the WEIGHT statement, consider which value of the VARDEF= option is appropriate. See the discussion of "VARDEF=*divisor* " on page 2480 and the calculation of weighted statistics in the "Keywords and Formulas" on page 2700 section of this document.

Usage: TABULATE Procedure

Statistics That Are Available in PROC TABULATE

Use the following keywords to request statistics in the TABLE statement or to specify statistic keywords in the KEYWORD or KEYLABEL statement.

Note: If a variable name (class or analysis) and a statistic name are the same, then enclose the statistic name in single quotation marks (for example, `'MAX'`).

Descriptive statistic keywords	
COLPCTN	PCTSUM
COLPCTSUM	RANGE

CSS	REPPCTN
CV	REPPCTSUM
KURTOSIS | KURT	ROWPCTN
LCLM	ROWPCTSUM
MAX	SKEWNESS | SKEW
MEAN	STDDEV | STD
MIN	STDERR
MODE	SUM
N	SUMWGT
NMISS	UCLM
PAGEPCTN	USS
PAGEPCTSUM	VAR
PCTN	
Quantile statistic keywords	
MEDIAN | P50	Q3 | P75
P1	P70
P5	P80
P10	P90
P20	P95
P30	P99
P40	
P60	
Q1|P25	QRANGE
Hypothesis testing keywords	

PROBT | PRT	T

These statistics, the formulas that are used to calculate them, and their data requirements are discussed in the "Keywords and Formulas" on page 2700 section of this document.

To compute standard error of the mean (STDERR) or Student's *t*-test, you must use the default value of the VARDEF= option, which is DF. The VARDEF= option is specified in the PROC TABULATE statement.

To compute weighted quantiles, you must use QMETHOD=OS in the PROC TABULATE statement.

Use both LCLM and UCLM to compute a two-sided confidence limit for the mean. Use only LCLM or UCLM to compute a one-sided confidence limit. Use the ALPHA= option in the PROC TABULATE statement to specify a confidence level.

Formatting Class Variables

Use the FORMAT statement to assign a format to a class variable for the duration of a PROC TABULATE step. When you assign a format to a class variable, PROC TABULATE uses the formatted values to create categories, and it uses the formatted values in headings. If you do not specify a format for a class variable, and the variable does not have any other format assigned to it, then the default format, BEST12., is used, unless the GROUPINTERNAL option is specified.

User-defined formats are particularly useful for grouping values into fewer categories. For example, if you have a class variable, Age, with values that range from 1 to 99, then you could create a user-defined format that groups the ages so that your tables contain a manageable number of categories. The following PROC FORMAT step creates a format that condenses all possible values of age into six groups of values.

```
proc format;
   value agefmt  0-29='Under 30'
                 30-39='30-39'
                 40-49='40-49'
                 50-59='50-59'
                 60-69='60-69'
                 other='70 or over';
run;
```

For information about creating user-defined formats, see Chapter 30, "FORMAT Procedure," on page 1075.

By default, PROC TABULATE includes in a table only those formats for which the frequency count is not zero and for which values are not missing. To include missing values for all class variables in the output, use the MISSING option in the PROC TABULATE statement, and to include missing values for selected class variables, use the MISSING option in a CLASS statement. To include formats for which the frequency count is zero, use the PRELOADFMT option in a CLASS statement and

the PRINTMISS option in the TABLE statement, or use the CLASSDATA= option in the PROC TABULATE statement.

Formatting Values in Tables

The formats for data in table cells serve two purposes. They determine how PROC TABULATE displays the values, and they determine the width of the columns. The default format for values in table cells is 12.2. You can modify the format for printing values in table cells by doing the following:

- changing the default format with the FORMAT= option in the PROC TABULATE statement
- crossing elements in the TABLE statement with the F= format modifier

Note: You cannot modify the format for printing values in table cells by using the FORMAT or the ATTRIB statement. If you use these statements, the analysis variable formats that they contain will be ignored.

PROC TABULATE determines the format to use for a particular cell from the following default order of precedence for formats:

1. If no other formats are specified, then PROC TABULATE uses the default format (12.2).
2. The FORMAT= option in the PROC TABULATE statement changes the default format. If no format modifiers affect a cell, then PROC TABULATE uses this format for the value in that cell.
3. A format modifier in the page dimension applies to the values in all the table cells on the logical page unless you specify another format modifier for a cell in the row or column dimension.
4. A format modifier in the row dimension applies to the values in all the table cells in the row unless you specify another format modifier for a cell in the column dimension.
5. A format modifier in the column dimension applies to the values in all the table cells in the column.

You can change this order of precedence by using the FORMAT_PRECEDENCE= option in the TABLE statement. For more information, see “TABLE Statement” on page 2496. For example, if you specify FORMAT_PRECEDENCE=ROW and specify a format modifier in the row dimension, then that format overrides all other specified formats for the table cells.

Calculating Percentages

Calculating the Percentage of the Value in a Single Table Cell

The following statistics print the percentage of the value in a single table cell in relation to the total of the values in a group of cells. No denominator definitions are required. However, an analysis variable can be used as a denominator definition for percentage sum statistics.

- REPPCTN and REPPCTSUM statistics—print the percentage of the value in a single table cell in relation to the total of the values in the report.
- COLPCTN and COLPCTSUM statistics—print the percentage of the value in a single table cell in relation to the total of the values in the column.
- ROWPCTN and ROWPCTSUM statistics—print the percentage of the value in a single table cell in relation to the total of the values in the row.
- PAGEPCTN and PAGEPCTSUM statistics—print the percentage of the value in a single table cell in relation to the total of the values in the page.

These statistics calculate the most commonly used percentages. See "Example 12: Calculating Various Percentage Statistics" on page 2589 for an example.

Using PCTN and PCTSUM

PCTN and PCTSUM statistics can be used to calculate these same percentages. They enable you to manually define denominators. PCTN and PCTSUM statistics print the percentage of the value in a single table cell in relation to the value (used in the denominator of the calculation of the percentage) in another table cell or to the total of the values in a group of cells. By default, PROC TABULATE summarizes the values in all N cells (for PCTN) or all SUM cells (for PCTSUM) and uses the summarized value for the denominator. You can control the value that PROC TABULATE uses for the denominator with a denominator definition.

You place a denominator definition in angle brackets (< and >) next to the PCTN or PCTSUM statistic. The denominator definition specifies which categories to sum for the denominator.

This section illustrates how to specify denominator definitions in a simple table. "Example 13: Using Denominator Definitions to Display Basic Frequency Counts and Percentages" on page 2593 illustrates how to specify denominator definitions in a table that consists of multiple subtables. For more examples of denominator definitions, see *PROC TABULATE by Example, Second Edition*.

Specifying a Denominator for the PCTN Statistic

The following PROC TABULATE step calculates the N statistic and three different versions of PCTN using the data set "ENERGY" on page 2788.

```
proc tabulate data=energy;
   class division type;
   table division*
           (n='Number of customers'
            pctn<type>='% of row' 1
            pctn<division>='% of column' 2
            pctn='% of all customers'), 3
          type/rts=50;
   title 'Number of Users in Each Division';
run;
```

The TABLE statement creates a row for each value of Division and a column for each value of Type. Within each row, the TABLE statement nests four statistics: N and three different calculations of PCTN. (See the following figure.) Each occurrence of PCTN uses a different denominator definition.

Figure 70.4 *Three Different Uses of the PCTN Statistic with Frequency Counts Highlighted*

Number of Users in Each Division

		Type	
		1	2
Division			
1	Number of customers	6.00	6.00
	% of row 1	50.00	50.00
	% of column 2	27.27	27.27
	% of all customers 3	13.64	13.64
2	Number of customers	3.00	3.00
	% of row	50.00	50.00
	% of column	13.64	13.64
	% of all customers	6.82	6.82
3	Number of customers	8.00	8.00
	% of row	50.00	50.00
	% of column	36.36	36.36
	% of all customers	18.18	18.18
4	Number of customers	5.00	5.00
	% of row	50.00	50.00
	% of column	22.73	22.73
	% of all customers	11.36	11.36

1 `<type>` sums the frequency counts for all occurrences of Type within the same value of Division. Thus, for Division=1, the denominator is 6 + 6, or 12.

2 `<division>` sums the frequency counts for all occurrences of Division within the same value of Type. Thus, for Type=1, the denominator is 6 + 3 + 8 + 5, or 22.

3 The third use of PCTN has no denominator definition. Omitting a denominator definition is the same as including all class variables in the denominator

definition. Thus, for all cells, the denominator is 6 + 3 + 8 + 5 + 6 + 3 + 8 + 5, or 44.

Specifying a Denominator for the PCTSUM Statistic

The following PROC TABULATE step sums expenditures for each combination of Type and Division and calculates three different versions of PCTSUM.

```
proc tabulate data=energy format=8.2;
   class division type;
   var expenditures;
   table division*
           (sum='Expenditures'*f=dollar10.2
            pctsum<type>='% of row' 1
            pctsum<division>='% of column' 2
            pctsum='% of all customers'), 3
         type*expenditures/rts=40;
   title 'Expenditures in Each Division';
run;
```

The TABLE statement creates a row for each value of Division and a column for each value of Type. Because Type is crossed with Expenditures, the value in each cell is the sum of the values of Expenditures for all observations that contribute to the cell. Within each row, the TABLE statement nests four statistics: SUM and three different calculations of PCTSUM. (See the following figure.) Each occurrence of PCTSUM uses a different denominator definition.

Figure 70.5 *Three Different Uses of the PCTSUM Statistic with Sums Highlighted*

Expenditures in Each Division

		Type	
		1	2
		Expenditures	Expenditures
Division			
1	Expenditures	$7,477.00	$5,129.00
	% of row 1	59.31	40.69
	% of column 2	16.15	13.66
	% of all customers 3	8.92	6.12
2	Expenditures	$19,379.00	$15,078.00
	% of row	56.24	43.76
	% of column	41.86	40.15
	% of all customers	23.11	17.98
3	Expenditures	$5,476.00	$4,729.00
	% of row	53.66	46.34
	% of column	11.83	12.59
	% of all customers	6.53	5.64
4	Expenditures	$13,959.00	$12,619.00
	% of row	52.52	47.48
	% of column	30.15	33.60
	% of all customers	16.65	15.05

1 `<type>` sums the values of Expenditures for all occurrences of Type within the same value of Division. Thus, for Division=1, the denominator is $7,477 + $5,129.

2 `<division>` sums the frequency counts for all occurrences of Division within the same value of Type. Thus, for Type=1, the denominator is $7,477 + $19,379 + $5,476 + $13,959.

3 The third use of PCTN has no denominator definition. Omitting a denominator definition is the same as including all class variables in the denominator definition. Thus, for all cells, the denominator is $7,477 + $19,379 + $5,476 + $13,959 + $5,129 + $15,078 + $4,729 + $12,619.

Using ODS Styles with PROC TABULATE

Using Styles with Base SAS Procedures

Most Base SAS procedures that support ODS use one or more table templates to produce output objects. These table templates include templates for table

elements: columns, headers, and footers. Each table element can specify the use of one or more style elements for various parts of the output. These style elements cannot be specified within the syntax of the procedure, but you can use customized styles for the ODS destinations that you use. For more information about customizing tables and styles, see "TEMPLATE Procedure: Creating a Style Template" in *SAS Output Delivery System: Procedures Guide*.

The Base SAS reporting procedures, PROC PRINT, PROC REPORT, and PROC TABULATE, enable you to quickly analyze your data and organize it into easy-to-read tables. You can use the STYLE= option with these procedure statements to modify the appearance of your report. The STYLE= option enables you to make changes in sections of output without changing the default style for all of the output. You can customize specific sections of procedure output by specifying the STYLE= option in specific statements within the procedure.

The following program uses the STYLE= option to create the colors in the PROC TABULATE output below:

```
proc sort data=sashelp.prdsale out=prdsale;
    by Country;
run;

proc tabulate data=prdsale;
   class region division prodtype / style=[background=lightgreen];
   classlev region division prodtype  / style=[background=yellow];
   var actual  / style=[background=tan];
   keyword all sum / style=[background=linen color=blue];
   keylabel all='Total';
   table (region all)*(division all),
         (prodtype all)*(actual*f=dollar10.) /
         box=[label='Region by Division and Type'
style=[backgroundcolor=orange]];

title 'Actual Product Sales';
title2 '(millions of dollars)';
run;
```

Output 70.4 *Enhanced PROC TABULATE Output*

Actual Product Sales
(millions of dollars)

Region by Division and Type		Product type		Total
		FURNITURE	OFFICE	
		Actual Sales	Actual Sales	Actual Sales
		Sum	Sum	Sum
Region	Division			
EAST	CONSUMER	$72,570	$108,686	$181,256
	EDUCATION	$73,901	$115,104	$189,005
	Total	$146,471	$223,790	$370,261
WEST	Division			
	CONSUMER	$76,209	$105,020	$181,229
	EDUCATION	$67,945	$110,902	$178,847
	Total	$144,154	$215,922	$360,076
Total	Division			
	CONSUMER	$148,779	$213,706	$362,485
	EDUCATION	$141,846	$226,006	$367,852
	Total	$290,625	$439,712	$730,337

Styles, Style Elements, and Style Attributes

Understanding Styles, Style Elements, and Style Attributes

The appearance of SAS output is controlled by ODS style templates (ODS styles). ODS styles are produced from compiled STYLE templates written in PROC TEMPLATE style syntax. An ODS style template is a collection of style elements that provides specific visual attributes for your SAS output.

- A style element is a named collection of style attributes that apply to a particular part of the output. Each area of ODS output has a style element name that is associated with it. The style element name specifies where the style attributes are applied. For example, a style element might contain instructions for the presentation of column headings or for the presentation of the data inside the cells. Style elements might also specify default colors and fonts for output that uses the style.
- A style attribute is a visual property, such as color, font properties, and line characteristics, that is defined in ODS with a reserved name and value. Style attributes are collectively referenced by a style element within a style template.

Each *style attribute* specifies a value for one aspect of the presentation. For example, the BACKGROUNDCOLOR= attribute specifies the color for the background of an HTML table or for a colored table in printed output. The FONTSTYLE= attribute specifies whether to use a Roman font or an italic font.

Note: Because styles control the presentation of the data, they have no effect on output objects that go to the LISTING, DOCUMENT, or OUTPUT destination.

Available styles are in the SASHELP.TMPLMST item store. In SAS Enterprise Guide, the list of style sheets is shown by the Style Wizard. In batch mode or SAS Studio, you can display the list of available style templates by using the LIST statement in PROC TEMPLATE:

```
proc template;
   list styles / store=sashelp.tmplmst;
run;
```

For complete information about viewing ODS styles, see "Viewing ODS Styles Supplied by SAS" in *SAS Output Delivery System: Advanced Topics*.

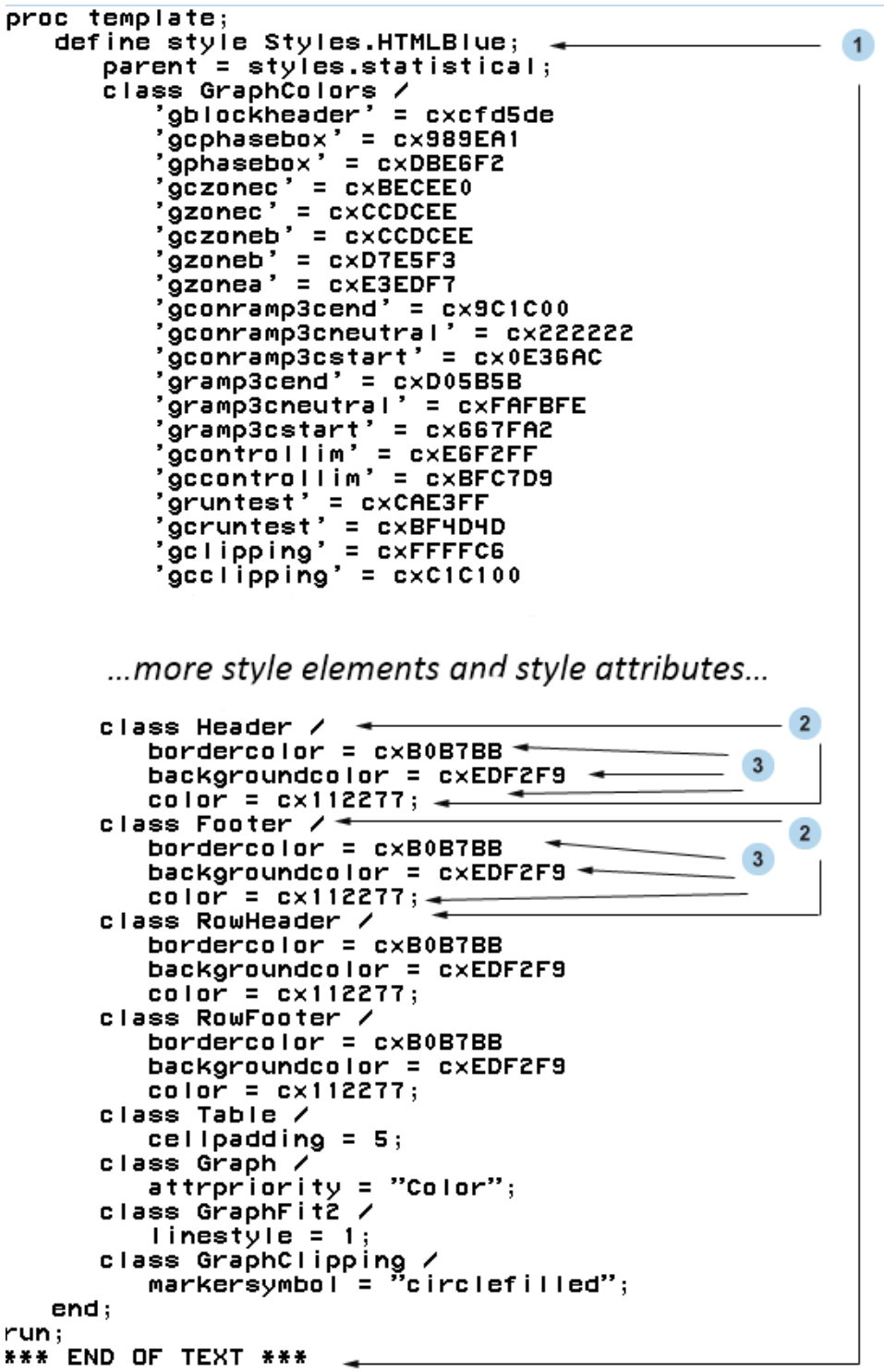
By default, HTML 4 output uses the HTMLBlue style template and HTML 5 output uses the HTMLEncore style template. To help you become familiar with styles, style elements, and style attributes, look at the relationship between them.

You can use the SOURCE statement in PROC TEMPLATE to display the structure of a style template. The following code prints the structure of the HTMLBlue style template to the SAS log:

```
proc template;
   source styles.HTMLBlue;
run;
```

The following figure illustrates the structure of a style. The figure shows the relationship between the style, the style elements, and the style attributes.

Figure 70.6 Diagram of the HtmlBlue Style



The following list corresponds to the numbered items in the preceding figure:

1 Styles.HtmlBlue is the *style*. Styles describe how to display presentation aspects (color, font, font size, and so on) of the SAS output. A style determines the overall appearance of the ODS documents that use it. The default style for HTML output is HtmlBlue. Each style consists of style elements.

You can create new styles with the "DEFINE STYLE Statement" in *SAS Output Delivery System: Procedures Guide*. New styles can be created independently or from an existing style. You can use "PARENT= Statement" in *SAS Output Delivery System: Procedures Guide* to create a new style from an existing style. For complete documentation about ODS styles, see "Style Templates" in *SAS Output Delivery System: Advanced Topics*.

2 Header and Footer are examples of *style elements*. A style element is a collection of style attributes that apply to a particular part of the output for a SAS program. For example, a style element might contain instructions for the presentation of column headings or for the presentation of the data inside table cells. Style elements might also specify default colors and fonts for output that uses the style. Style elements exist inside styles and consist of one or more style attributes. Style elements can be user-defined or supplied by SAS. User-defined style elements can be created by the "STYLE Statement" in *SAS Output Delivery System: Procedures Guide*.

Note: For a list of the default style elements used for HTML and markup languages and their inheritance, see "Style Elements" in *SAS Output Delivery System: Advanced Topics*.

3 BORDERCOLOR=, BACKGROUNDCOLOR=, and COLOR= are examples of *style attributes*. Style attributes specify a value for one aspect of the area of the output that its style element applies to. For example, the COLOR= attribute specifies the value `cx112277` for the font color. For a list of style attributes supplied by SAS, see "Style Attributes" in *SAS Output Delivery System: Advanced Topics*.

Style attributes can be referenced with style references. See "style-reference" in *SAS Output Delivery System: Advanced Topics* for more information about style references.

The following table shows commonly used style attributes that you can set with the STYLE= option in PROC PRINT, PROC TABULATE, and PROC REPORT. Most of these attributes apply to parts of the table other than cells (for example, table borders and the lines between columns and rows). Note that not all attributes are valid in all destinations. For more information about these style attributes, their valid values, and their applicable destinations, see "Style Attributes Tables" in *SAS Output Delivery System: Advanced Topics*.

Table 70.4 *Style Attributes for PROC REPORT, PROC TABULATE, and PROC PRINT*

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
ASIS=	X	X		X		X

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
BACKGROUNDCOLOR=	X	X	X	X	X	X
BACKGROUNDIMAGE=	X	X	X	X	X	X
BORDERBOTTOMCOLOR=	X	X		X		
BORDERBOTTOMSTYLE=	X	X	X	X		
BORDERBOTTOMWIDTH=	X	X	X	X		
BORDERLEFTCOLOR=	X	X		X		
BORDERLEFTSTYLE=	X	X	X	X		
BORDERLEFTWIDTH=	X	X	X	X		
BORDERCOLOR=	X	X		X	X	X
BORDERCOLORDARK=	X	X	X	X	X	X
BORDERCOLORLIGHT=	X	X	X	X	X	X
BORDERRIGHTCOLOR=	X	X		X		
BORDERRIGHTSTYLE=	X	X	X	X		
BORDERRIGHTWIDTH=	X	X	X	X		
BORDERTOPCOLOR=	X	X		X		

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
BORDERTOPSTYLE=	X	X	X	X		
BORDERTOPWIDTH=	X	X	X	X		
BORDERWIDTH=	X	X	X	X	X	X
CELLPADDING=	X		X		X	
CELLSPACING=	X		X		X	
CELLWIDTH=	X	X	X	X		X
CLASS=	X	X	X	X	X	X
COLOR=	X	X	X			
FLYOVER=	X	X		X		X
FONT=	X	X	X	X	X	X
FONTFAMILY=	X	X	X	X	X	X
FONTSIZE=	X	X	X	X	X	X
FONTSTYLE=	X	X	X	X	X	X
FONTWEIGHT=	X	X	X	X	X	X
FONTWIDTH=	X	X	X	X		X
FRAME=	X		X		X	
HEIGHT=	X	X		X	X	X
HREFTARGET=		X		X		X
HTMLSTYLE=	X	X	X	X	X	
NOBREAKSPACE=[2]	X	X		X		X
OUTPUTWIDTH=	X	X	X	X	X	
POSTHTML=[1]	X	X	X	X	X	X

Attribute	PROC REPORT STATEMENT REPORT Area	PROC REPORT Areas: CALLDEF, COLUMN, HEADER, LINES, SUMMARY	PROC TABULATE STATEMENT TABLE	PROC TABULATE STATEMENTS VAR, CLASS, BOX, CLASSLEV, KEYWORD	PROC PRINT TABLE location	PROC PRINT: all locations other than TABLE
POSTIMAGE=	X	X	X	X	X	X
POSTTEXT=[1]	X	X	X	X	X	X
PREHTML=[1]	X	X	X	X	X	X
PREIMAGE=	X	X	X	X	X	X
PRETEXT=[1]	X	X	X	X	X	X
PROTECTSPECIALCHARS=		X		X	X	X
RULES=	X		X		X	
TAGATTR=	X	X	X	X	X	X
TEXTALIGN=	X	X	X	X	X	X
URL=		X		X		X
VERTICALALIGN=		X		X		X
WIDTH=	X	X	X	X	X	

1 When you use these attributes in this location, they affect only the text that is specified with the PRETEXT=, POSTTEXT=, PREHTML=, and POSTHTML= attributes. To alter the foreground color or the font for the text that appears in the table, you must set the corresponding attribute in a location that affects the cells rather than the table. For complete documentation about style attributes and their values, see "Style Attributes" in *SAS Output Delivery System: Advanced Topics*.

2 To help prevent unexpected wrapping of long text strings when using PROC REPORT with the ODS RTF destination, set NOBREAKSPACE=OFF in a location that affects the LINE statement. The NOBREAKSPACE=OFF attribute must be set in the PROC REPORT code either on the LINE statement or on the PROC REPORT statement where style(lines) is specified.

Style Elements and Style Attributes for Table Regions

The following table lists the default style elements and style attributes for various regions of a PROC TABULATE table. The table lists defaults for the most commonly used ODS destinations: HTML, PDF, and RTF. Each destination has a default style template that is applied to all output that is written to the destination.

- The default style for HTML output is HTMLBlue.

- The default style for PRINTER output is Pearl.
- The default style for RTF output is RTF.

For complete documentation about the ODS destinations and their default styles, see "Style Templates" in *SAS Output Delivery System: Advanced Topics*.

Table 70.5 *Default Style Elements and Style Attributes for Table Regions*

Region	Style Element	HTML Style Attributes	PDF Style Attributes	RTF Style Attributes
Column headings and Box	Header	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = bold FONTSTYLE = roman COLOR = cx112277 BACKGROUNDCOLOR = cxedf2f9	FONTFAMILY = "Arial, 'Albany AMT'" FONTSIZE = 8pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxffffff BORDERWIDTH = NaN	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 11pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxbbbbbb
Page dimension text	Beforecaption	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = bold FONTSTYLE = roman COLOR = cx112277 BACKGROUNDCOLOR = cxfafbfe	FONTFAMILY = "Arial, 'Albany AMT'" FONTSIZE = 8pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxffffff	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 11pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000
Row headings	Rowheader	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = bold FONTSTYLE = roman COLOR = cx112277 BACKGROUNDCOLOR = cxedf2f9	FONTFAMILY = "Arial, 'Albany AMT'" FONTSIZE = 8pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxffffff BORDERWIDTH = NaN	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 11pt FONTWEIGHT = bold FONTSTYLE = roman COLOR =cx000000 BACKGROUNDCOLOR = cxbbbbbb

Region	Style Element	HTML Style Attributes	PDF Style Attributes	RTF Style Attributes
Data cells	Data	FONTFAMILY = "Arial, 'Albany AMT', Helvetica, Helv" FONTSIZE = 2 FONTWEIGHT = medium FONTSTYLE = roman BACKGROUNDCOLOR = cxffffff	FONTFAMILY ="'Albany AMT', Albany" FONTSIZE = 8pt FONTWEIGHT = medium FONTSTYLE = roman COLOR = cx000000 BORDERWIDTH = NaN COLOR = cx000000	FONTFAMILY ="'Times New Roman', 'Times Roman'" FONTSIZE = 10pt FONTWEIGHT = medium FONTSTYLE = roman COLOR = cx000000

Using the STYLE= Option with PROC TABULATE Statements

PROC TABULATE style overrides are applied to a table based on the statements that create the table. With the STYLE= option, you can make changes to either the style element or style attributes that control the appearance of an area of the output by specifying the STYLE= option in the statement that controls the area that you want to modify. The following table shows the areas of a table that can be modified and their corresponding statements.

Specifications in the TABLE statement override the same specification in the PROC TABULATE, CLASS, CLASSLEV, VAR, and KEYWORD statements. This enables you to have different style behavior with multiple TABLE statements. However, any style attributes that you specify in the PROC TABULATE statement and that you do not override in the TABLE statement are inherited. For example, if you specify a blue background and a white foreground for all data cells in the PROC TABULATE statement, and you specify a gray background for the data cells of a particular crossing in the TABLE statement, then the background for those data cells is gray, and the foreground is white (as specified in the PROC TABULATE statement).

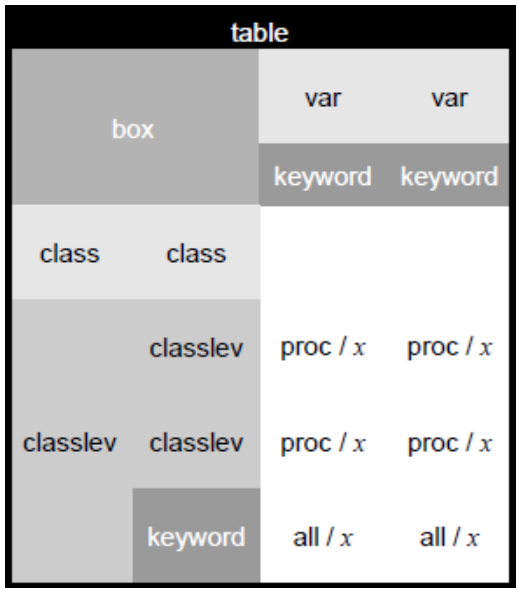
Detailed information about the STYLE= option is provided in the documentation for individual statements.

Table 70.6 *Using the STYLE= Option in PROC TABULATE*

Area To Be Modified	STYLE Option To Use
Data cells	PROC TABULATE statement or dimension expression(s) (p. 2469)

Area To Be Modified	STYLE Option To Use
Page dimension text and class variable name headings	"CLASS Statement" (p. 2482)
Class level value headings	"CLASSLEV Statement" (p. 2490)
Keyword headings	"KEYWORD Statement" (p. 2493)
Table borders, rules, and other parts that are not specified elsewhere	"TABLE Statement" (p. 2496)
Box text	BOX= option of the TABLE statement (p. 2496)
Missing values	MISSTEXT= option of the TABLE statement (p. 2496)
Analysis variable name headings	"VAR Statement" (p. 2511)

Figure 70.7 *PROC TABULATE Areas and Corresponding Statements*



Applying Style Attributes to Table Cells

PROC TABULATE determines the style attributes to use for a particular cell from the following default order of precedence for styles:

1 If no other style attributes are specified, then PROC TABULATE uses the default style attributes from the default style (Data).

2 The STYLE= option in the PROC TABULATE statement changes the default style attributes. If no other STYLE= option specifications affect a cell, then PROC TABULATE uses these style attributes for that cell.

3 A STYLE= option that is specified in the page dimension applies to all the table cells on the logical page unless you specify another STYLE= option for a cell in the row or column dimension.

4 A STYLE= option that is specified in the row dimension applies to all the table cells in the row unless you specify another STYLE= option for a cell in the column dimension.

5 A STYLE= option that is specified in the column dimension applies to all the table cells in the column.

You can change this order of precedence by using the STYLE_PRECEDENCE= option in the TABLE statement on page 2506. For example, if you specify STYLE_PRECEDENCE=ROW and specify a STYLE= option in the row dimension, then those style attribute values override all others that are specified for the table cells.

Using a Format to Assign a Style Attribute

You can use a format to assign a style attribute value to any cell whose content is determined by values of a class or analysis variable. For example, the following code assigns a red background to cells whose values are less than 10,000, a yellow background to cells whose values are at least 10,000 but less than 20,000, and a green background to cells whose values are at least 20,000:

```
proc format;
   value expfmt low-<10000='red'
                    10000-<20000='yellow'
                    20000-high='green';
run;

ods html body='external-HTML-file';
proc tabulate data=energy style=[backgroundcolor=expfmt.];
   class region division type;
   var expenditures;
   table (region all)*(division all),
           type*expenditures;
run;
ods html close;
```

Specifying Style Attributes and Style Elements in Dimension Expressions

You can specify one or more style elements or style attributes in a dimension expression to control the appearance of non-LISTING output. You can modify the appearance of the following areas:

- analysis variable name headings
- class variable name headings
- class variable level value headings
- data cells
- keyword headings
- page dimension text

Specifying a style attribute or style element in a dimension expression is useful when you want to override a style attribute or style element that you have specified in another statement, such as the PROC TABULATE, CLASS, CLASSLEV, KEYWORD, TABLE, or VAR statements.

The syntax for specifying style elements and style attributes in a dimension expression is

[STYLE<(CLASSLEV)>=<*style-element-name* | PARENT>

[*style-attribute-name-1=style-attribute-value-1< style-attribute-name-2=style-attribute-value-2 ...*>]]

These are some examples of style attributes in dimension expressions:

-
```
dept={label='Department'
      style=[color=red]}, N
```
- `dept*[style=MyDataStyle], N`
- `dept*[format=12.2 style=MyDataStyle], N`

Note: When used in a dimension expression, the STYLE= option must be enclosed within square brackets ([and]) or braces ({ and }).

(CLASSLEV)
assigns a style element to a class variable level value heading. For example, the following TABLE statement specifies that the level value heading for the class variable, DEPT, has a foreground color of yellow:

```
table dept=[style(classlev)=
            [color=yellow]]*sales;
```

Note: The CLASSLEV option is used only in dimension expressions.

For an example that shows how to specify style elements within dimension expressions, see "Example 14: Specifying Style Overrides for ODS Output" on page 2607. For information about using styles with PROC TABULATE, see "Using ODS Styles with PROC TABULATE" on page 2522.

SAS Cloud Analytic Services Processing for PROC TABULATE

If your input data set originates from SAS Cloud Analytic Services (CAS), some of the PROC TABULATE analysis can be performed by the CAS server. Reports that require significant summarization of data can benefit from CAS processing. Running PROC TABULATE with CAS actions has several advantages over processing within SAS. These advantages include reduced network traffic, and the potential for faster processing. Faster processing is possible because in-memory tables are manipulated locally on the server instead of being transferred across a relatively slow network connection. CAS is used because it might have more processing resources at its disposal.

When the DATA= input data set references an in-memory table or view in CAS, the TABULATE procedure can use CAS actions to perform a significant portion of its work within the server. To reference an in-memory table or view, you must specify the CAS engine LIBNAME statement and use the CAS engine libref with the input table name.

By default, PROC TABULATE uses CAS processing whenever a CAS engine libref is specified on the input table name.

In the following example, the LIBNAME statement assigns a CAS engine libref named mycas that you use to connect to the CAS session casauto.

```
option casport=5570 cashost="cloud.example.com";
cas casauto ;
libname mycas cas;
data mycas.class;
   set sashelp.class;
run;

proc tabulate data=mycas.class;
   class sex age;
   var height weight;
   table sex,age*(height weight)*(sum mean);
run;
```

The following statistics are supported for CAS processing:

CSS	RANGE
CV	STDERR
LCLM	SUM
MAX	SUMWGT
MEAN	STD
MIN	UCLM
N	USS
NMISS	VAR

When SAS format definitions reside in CAS, formatting of class variables occurs in CAS. If the SAS format definitions do not reside on the CAS server, the CAS aggregation occurs on the raw values, and the relevant formats are applied by SAS as the results set is merged into the PROC TABULATE internal structure. User-defined formats that are created in SAS must be copied into CAS for them to work as expected. It is a best practice to keep formats consistent between SAS and CAS. For complete documentation about using user-defined formats with CAS, see *SAS Cloud Analytic Services: User-Defined Formats*.

For information about how to use the CAS LIBNAME statement, see "CAS LIBNAME Statement" in *SAS Cloud Analytic Services: User's Guide*. For more information about how procedures work with CAS processing, see Chapter 5, "CAS Processing of Base Procedures," on page 93.

In-Database Processing for PROC TABULATE

In-database processing has several advantages over processing within SAS. These advantages include increased security, reduced network traffic, and the potential for faster processing. Increased security is possible because sensitive data does not have to be extracted from the database management system (DBMS). Faster processing is possible because data is manipulated locally, on the DBMS, using high-speed secondary storage devices instead of being transported across a relatively slow network connection, because the DBMS might have more processing resources at its disposal, and because the DBMS might be capable of optimizing a query for execution in a highly parallel and scalable fashion.

When the DATA= input data set is stored as a table or view in a DBMS, the PROC TABULATE procedure can use in-database processing to perform most of its work within the database. In-database processing can provide the advantages of faster processing and reduced data transfer between the database and SAS software.

PROC TABULATE performs in-database processing by using SQL implicit pass-through. The procedure generates SQL queries that are based on the classifications and the statistics that you specify in the TABLE statement. The database executes these SQL queries to construct initial summary tables, which are then transmitted to PROC TABULATE.

If class variables are specified, the procedure creates an SQL GROUP BY clause that represents the n-way type. Only the n-way class tree is generated on the DBMS. The result set that is created when the aggregation query executes in the database is read by SAS into the internal PROC TABULATE data structure.

When SAS format definitions have been deployed in the database, formatting of class variables occurs in the database. If the SAS format definitions have not been deployed in the database, the in-database aggregation occurs on the raw values, and the relevant formats are applied by SAS as the results' set is merged into the PROC TABULATE internal structures. Multi-label formatting is always done by SAS using the initially aggregated result set that is returned by the database.

The following statistics are supported for in-database processing:

CSS RANGE

CV	STDERR
LCLM	SUM
MAX	SUMWGT
MEAN	STD
MIN	UCLM
N	USS
NMISS	VAR

The SQLGENERATION system option or LIBNAME statement option controls whether and how in-database procedures are run inside the database. By default, the in-database procedures are run inside the database when possible. There are many data set options that will prevent in-database processing. For a complete listing, see “In-Database Procedures” in *SAS/ACCESS for Relational Databases: Reference*.

PROC TABULATE is supported by the following databases:

- Amazon Redshift
- Aster
- DB2
- Google BigQuery
- Greenplum
- Hadoop
- HAWQ
- IMPALA
- Microsoft SQL Server
- Netezza
- Oracle
- PostgreSQL
- SAP HANA
- Snowflake
- Teradata
- Vertica
- Yellowbrick

Substituting BY Line Values in a Text String

Starting with SAS 9.4M6, #BYLINE, #BYVAR, and #BYVAL substitutions are available in the following options:

- The CONTENTS= option in the TABLE statement and the PROC TABULATE statement.

- The CAPTION= option in the TABLE statement

To use the #BYVAR and #BYVAL substitutions, insert the item in the text string at the position where you want the substitution text to appear. Both #BYVAR and #BYVAL specifications must be followed by a delimiting character. The character can be either a space or other non-alphanumeric character, such as a quotation mark. If no delimiting character is provided, then the specification is ignored and its text remains intact and is displayed with the rest of the string. To allow a #BYVAR or #BYVAL substitution to be followed immediately by other text, with no delimiter, use a trailing dot (as with macro variables). The trailing dot is not displayed in the resolved text. If you want a period to be displayed as the last character in the resolved text, use two dots after the #BYVAR or #BYVAL substitution.

The substitution for #BYVAR or #BYVAL does not occur in the following cases:

- if you use a #BYVAR or #BYVAL specification for a variable that is not named in the BY statement. For example, you might use #BYVAL2 when there is only one BY-variable or #BYVAL(ABC) when ABC is non-existent or is not a BY-variable.
- if there is no BY statement

Results: TABULATE Procedure

Missing Values

How PROC TABULATE Treats Missing Values

How a missing value for a variable in the input data set affects your output depends on how you use the variable in the PROC TABULATE step. The following table summarizes how the procedure treats missing values.

Table 70.7 *Summary of How PROC TABULATE Treats Missing Values*

Condition	PROC TABULATE Default	To Override Default
An observation contains a missing value for an analysis variable	Excludes that observation from the calculation of statistics (except N and NMISS) for that particular variable	No alternative

Condition	PROC TABULATE Default	To Override Default
An observation contains a missing value for a class variable	Excludes that observation from the table[1]	Use MISSING in the PROC TABULATE statement, or MISSING in the CLASS statement
There are no data for a category	Does not show the category in the table	Use PRINTMISS in the TABLE statement, or use CLASSDATA= in the PROC TABULATE statement
Every observation that contributes to a table cell contains a missing value for an analysis variable	Displays a missing value for any statistics (except N and NMISS) in that cell	Use MISSTEXT= in the TABLE statement
There are no data for a formatted value	Does not display that formatted value in the table	Use PRELOADFMT in the CLASS statement with PRINTMISS in the TABLE statement, or use CLASSDATA= in the PROC TABULATE statement, or add dummy observations to the input data set so that it contains data for each formatted value
A FREQ variable value is missing or is less than 1	Does not use that observation to calculate statistics	No alternative
A WEIGHT variable value is missing or 0	Uses a value of 0	No alternative

This section presents a series of PROC TABULATE steps that illustrate how PROC TABULATE treats missing values. The following program creates the data set and formats that are used in this section and prints the data set. The data set COMPREV contains no missing values. (See the output below.)

```
proc format;
   value cntryfmt 1='United States'
                  2='Japan';
   value compfmt  1='Supercomputer'
                  2='Mainframe'
                  3='Midrange'
                  4='Workstation'
                  5='Personal Computer'
                  6='Laptop';
run;
```

1. The CLASS statement applies to all TABLE statements in a PROC TABULATE step. Therefore, if you define a variable as a class variable, PROC TABULATE omits observations that have missing values for that variable even if you do not use the variable in a TABLE statement.

```
data comprev;
   input Country Computer Rev90 Rev91 Rev92;
   datalines;
1 1 788.8 877.6 944.9
1 2 12538.1 9855.6 8527.9
1 3 9815.8 6340.3 8680.3
1 4 3147.2 3474.1 3722.4
1 5 18660.9 18428.0 23531.1
2 1 469.9 495.6 448.4
2 2 5697.6 6242.4 5382.3
2 3 5392.1 5668.3 4845.9
2 4 1511.6 1875.5 1924.5
2 5 4746.0 4600.8 4363.7
;

proc print data=comprev noobs;
   format country cntryfmt. computer compfmt.;
   title 'The Data Set COMPREV';
run;
```

Output 70.5 *The Data Set COMPREV*

The Data Set COMPREV

Country	Computer	Rev90	Rev91	Rev92
United States	Supercomputer	788.8	877.6	944.9
United States	Mainframe	12538.1	9855.6	8527.9
United States	Midrange	9815.8	6340.3	8680.3
United States	Workstation	3147.2	3474.1	3722.4
United States	Personal Computer	18660.9	18428.0	23531.1
Japan	Supercomputer	469.9	495.6	448.4
Japan	Mainframe	5697.6	6242.4	5382.3
Japan	Midrange	5392.1	5668.3	4845.9
Japan	Workstation	1511.6	1875.5	1924.5
Japan	Personal Computer	4746.0	4600.8	4363.7

No Missing Values

The following PROC TABULATE step produces the following output:

```
proc tabulate data=comprev;
   class country computer;
   var rev90 rev91 rev92;
   table computer*country,rev90 rev91 rev92 /
         rts=32;
   format country cntryfmt. computer compfmt.;
   title 'Revenues from Computer Sales';
   title2 'for 1990 to 1992';
run;
```

Because the data set contains no missing values, the table includes all observations. All headings and cells contain nonmissing values.

Output 70.6 *Computer Sales Data: No Missing Values*

Revenues from Computer Sales
for 1990 to 1992

		Rev90	Rev91	Rev92
		Sum	Sum	Sum
Computer	Country			
Supercomputer	United States	788.80	877.60	944.90
	Japan	469.90	495.60	448.40
Mainframe	United States	12538.10	9855.60	8527.90
	Japan	5697.60	6242.40	5382.30
Midrange	United States	9815.80	6340.30	8680.30
	Japan	5392.10	5668.30	4845.90
Workstation	United States	3147.20	3474.10	3722.40
	Japan	1511.60	1875.50	1924.50
Personal Computer	United States	18660.90	18428.00	23531.10
	Japan	4746.00	4600.80	4363.70

A Missing Class Variable

The next program copies COMPREV and alters the data so that the eighth observation has a missing value for Computer. Except for specifying this new data set, the program that produces the output “Computer Sales Data: Midrange, Japan, Deleted” below, is the same as the program that produces the output “Computer Sales Data: No Missing Values”, above. PROC TABULATE ignores observations with missing values for a class variable.

```
data compmiss;
   set comprev;
   if _n_=8 then computer=.;
run;

proc tabulate data=compmiss;
   class country computer;
   var rev90 rev91 rev92;
   table computer*country,rev90 rev91 rev92 /
         rts=32;
   format country cntryfmt. computer compfmt.;
   title 'Revenues from Computer Sales';
   title2 'for 1990 to 1992';
run;
```

The observation with a missing value for Computer was the category **`Midrange, Japan`**. This category no longer exists. By default, PROC TABULATE ignores

observations with missing values for a class variable, so this table contains one less row than the output “Computer Sales Data: No Missing Values”.

Output 70.7 *Computer Sales Data: Midrange, Japan, Deleted*

Revenues from Computer Sales
for 1990 to 1992

		Rev90	Rev91	Rev92
		Sum	Sum	Sum
Computer	Country			
Supercomputer	United States	788.80	877.60	944.90
	Japan	469.90	495.60	448.40
Mainframe	United States	12538.10	9855.60	8527.90
	Japan	5697.60	6242.40	5382.30
Midrange	United States	9815.80	6340.30	8680.30
Workstation	United States	3147.20	3474.10	3722.40
	Japan	1511.60	1875.50	1924.50
Personal Computer	United States	18660.90	18428.00	23531.10
	Japan	4746.00	4600.80	4363.70

Including Observations with Missing Class Variables

This program adds the MISSING option to the previous program. MISSING is available either in the PROC TABULATE statement or in the CLASS statement. If you want MISSING to apply only to selected class variables, but not to others, then specify MISSING in a separate CLASS statement with the selected variables. The MISSING option includes observations with missing values of a class variable in the report. (See the following output.)

```
proc tabulate data=compmiss missing;
   class country computer;
   var rev90 rev91 rev92;
   table computer*country,rev90 rev91 rev92 /
         rts=32;
   format country cntryfmt. computer compfmt.;
   title 'Revenues from Computer Sales';
   title2 'for 1990 to 1992';
run;
```

This table includes a category with missing values of Computer. This category makes up the first row of data in the table.

Output 70.8 *Computer Sales Data: Missing Values for Computer*

Revenues from Computer Sales for 1990 to 1992

		Rev90	Rev91	Rev92
		Sum	Sum	Sum
Computer	Country			
.	Japan	5392.10	5668.30	4845.90
Supercomputer	United States	788.80	877.60	944.90
	Japan	469.90	495.60	448.40
Mainframe	United States	12538.10	9855.60	8527.90
	Japan	5697.60	6242.40	5382.30
Midrange	United States	9815.80	6340.30	8680.30
Workstation	United States	3147.20	3474.10	3722.40
	Japan	1511.60	1875.50	1924.50
Personal Computer	United States	18660.90	18428.00	23531.10
	Japan	4746.00	4600.80	4363.70

Formatting Headings for Observations with Missing Class Variables

By default, as shown in the output "Computer Sales Data: Missing Values for Computer", PROC TABULATE displays missing values of a class variable as one of the standard SAS characters for missing values (a period, a blank, an underscore, or one of the letters A through Z). If you want to display something else instead, then you must assign a format to the class variable that has missing values, as shown in the following program. (See the following output.)

```
proc format;
   value misscomp 1='Supercomputer'
                  2='Mainframe'
                  3='Midrange'
                  4='Workstation'
                  5='Personal Computer'
                  6='Laptop'
                  .='No type given';
run;

proc tabulate data=compmiss missing;
   class country computer;
   var rev90 rev91 rev92;
   table computer*country,rev90 rev91 rev92 /
         rts=32;
   format country cntryfmt. computer misscomp.;
   title 'Revenues for Computer Sales';
   title2 'for 1990 to 1992';
```

```
run;
```

In this table, the missing value appears as the text that the MISSCOMP. format specifies.

Output 70.9 *Computer Sales Data: Text Supplied for Missing Computer Value*

Revenues for Computer Sales for 1990 to 1992

		Rev90	Rev91	Rev92
		Sum	Sum	Sum
Computer	Country			
No type given	Japan	5392.10	5668.30	4845.90
Supercomputer	United States	788.80	877.60	944.90
	Japan	469.90	495.60	448.40
Mainframe	United States	12538.10	9855.60	8527.90
	Japan	5697.60	6242.40	5382.30
Midrange	United States	9815.80	6340.30	8680.30
Workstation	United States	3147.20	3474.10	3722.40
	Japan	1511.60	1875.50	1924.50
Personal Computer	United States	18660.90	18428.00	23531.10
	Japan	4746.00	4600.80	4363.70

Providing Headings for All Categories

By default, PROC TABULATE evaluates each page that it prints and omits columns and rows for categories that do not exist. For example, “Computer Sales Data: Text Supplied for Missing Computer Value ” does not include a row for `No type given` and for `United States` or for `Midrange` and for `Japan` because there are no data in these categories. If you want the table to represent all possible categories, then use the PRINTMISS option in the TABLE statement, as shown in the following program. (See the following output.)

```
proc tabulate data=compmiss missing;
   class country computer;
   var rev90 rev91 rev92;
   table computer*country,rev90 rev91 rev92 /
         rts=32 printmiss;
   format country cntryfmt. computer misscomp.;
   title 'Revenues for Computer Sales';
   title2 'for 1990 to 1992';
run;
```

This table contains a row for the category **`No type given`**, **`United States`** and the category **`Midrange, Japan`**. Because there are no data in these categories, the values for the statistics are all missing.

Output 70.10 *Computer Sales Data: Missing Statistics Values*

Revenues for Computer Sales for 1990 to 1992

		Rev90	Rev91	Rev92
		Sum	Sum	Sum
Computer	Country			
No type given	United States	.	.	.
	Japan	5392.10	5668.30	4845.90
Supercomputer	United States	788.80	877.60	944.90
	Japan	469.90	495.60	448.40
Mainframe	United States	12538.10	9855.60	8527.90
	Japan	5697.60	6242.40	5382.30
Midrange	United States	9815.80	6340.30	8680.30
	Japan	.	.	.
Workstation	United States	3147.20	3474.10	3722.40
	Japan	1511.60	1875.50	1924.50
Personal Computer	United States	18660.90	18428.00	23531.10
	Japan	4746.00	4600.80	4363.70

Providing Text for Cells That Contain Missing Values

If some observations in a category contain missing values for analysis variables, then PROC TABULATE does not use those observations to calculate statistics (except N and NMISS). However, if each observation in a category contains a missing value, then PROC TABULATE displays a missing value for the value of the statistic. To replace missing values for analysis variables with text, use the MISSTEXT= option in the TABLE statement to specify the text to use, as shown in the following program. (See the following output.)

```
proc tabulate data=compmiss missing;
   class country computer;
   var rev90 rev91 rev92;
   table computer*country,rev90 rev91 rev92 /
         rts=32 printmiss misstext='NO DATA!';
   format country cntryfmt. computer misscomp.;
   title 'Revenues for Computer Sales';
   title2 'for 1990 to 1992';
run;
```

This table replaces the period normally used to display missing values with the text of the MISSTEXT= option.

Output 70.11 *Computer Sales Data: Text Supplied for Missing Statistics Values*

Revenues for Computer Sales for 1990 to 1992

		Rev90	Rev91	Rev92
		Sum	Sum	Sum
Computer	Country			
No type given	United States	NO DATA!	NO DATA!	NO DATA!
	Japan	5392.10	5668.30	4845.90
Supercomputer	United States	788.80	877.60	944.90
	Japan	469.90	495.60	448.40
Mainframe	United States	12538.10	9855.60	8527.90
	Japan	5697.60	6242.40	5382.30
Midrange	United States	9815.80	6340.30	8680.30
	Japan	NO DATA!	NO DATA!	NO DATA!
Workstation	United States	3147.20	3474.10	3722.40
	Japan	1511.60	1875.50	1924.50
Personal Computer	United States	18660.90	18428.00	23531.10
	Japan	4746.00	4600.80	4363.70

Providing Headings for All Values of a Format

PROC TABULATE prints headings only for values that appear in the input data set. For example, the format COMPFMT. provides for six possible values of Computer. Only five of these values occur in the data set COMPREV. The data set contains no data for laptop computers.

If you want to include headings for all possible values of Computer (perhaps to make it easier to compare the output with tables that are created later when you do have data for laptops), then you have three different ways to create such a table:

- Use the PRELOADFMT option in the CLASS statement with the PRINTMISS option in the TABLE statement. See "Example 3: Using Preloaded Formats with Class Variables" on page 2556 for another example that uses PRELOADFMT.
- Use the CLASSDATA= option in the PROC TABULATE statement. See "Example 2: Specifying Class Variable Combinations to Appear in a Table" on page 2553 for an example that uses the CLASSDATA= option.
- Add dummy values to the input data set so that each value that the format handles appears at least once in the data set.

The following program adds the PRELOADFMT option to a CLASS statement that contains the relevant variable.

The results are shown in the following output.

```
proc tabulate data=compmiss missing;
   class country;
   class computer / preloadfmt;
   var rev90 rev91 rev92;
   table computer*country,rev90 rev91 rev92 /
         rts=32 printmiss misstext='NO DATA!';
   format country cntryfmt. computer compfmt.;
   title 'Revenues for Computer Sales';
   title2 'for 1990 to 1992';
run;
```

This table contains a heading for each possible value of Computer.

Output 70.12 *Computer Sales Data: All Possible Computer Values Included*

Revenues for Computer Sales
for 1990 to 1992

		Rev90	Rev91	Rev92
		Sum	Sum	Sum
Computer	Country			
.	United States	NO DATA!	NO DATA!	NO DATA!
	Japan	5392.10	5668.30	4845.90
Supercomputer	United States	788.80	877.60	944.90
	Japan	469.90	495.60	448.40
Mainframe	United States	12538.10	9855.60	8527.90
	Japan	5697.60	6242.40	5382.30
Midrange	United States	9815.80	6340.30	8680.30
	Japan	NO DATA!	NO DATA!	NO DATA!
Workstation	United States	3147.20	3474.10	3722.40
	Japan	1511.60	1875.50	1924.50
Personal Computer	United States	18660.90	18428.00	23531.10
	Japan	4746.00	4600.80	4363.70
Laptop	United States	NO DATA!	NO DATA!	NO DATA!
	Japan	NO DATA!	NO DATA!	NO DATA!

Understanding the Order of Headings with ORDER=DATA

The ORDER= option applies to all class variables. Occasionally, you want to order the headings for different variables differently. One method for reordering the headings is to group the data as you want them to appear and to specify ORDER=DATA.

For this technique to work, the first value of the first class variable must occur in the data with all possible values of all the other class variables. If this criterion is not met, then the order of the headings might surprise you.

The following program creates a simple data set in which the observations are ordered first by the values of Animal, then by the values of Food. The ORDER= option in the PROC TABULATE statement orders the heading for the class variables by the order of their appearance in the data set. (See the following output.) Although `bones` is the first value for Food in the group of observations where Animal=`dog`, all other values for Food appear before `bones` in the data set because `bones` never appears when Animal=`cat`. Therefore, the heading for `bones` in the table in the following output is not in alphabetical order.

In other words, PROC TABULATE maintains for subsequent categories the order that was established by earlier categories. If you want to re-establish the order of Food for each value of Animal, then use BY-group processing. PROC TABULATE creates a separate table for each BY group, so that the ordering can differ from one BY group to the next.

```
data foodpref;
   input Animal $ Food $;
   datalines;
cat fish
cat meat
cat milk
dog bones
dog fish
dog meat
;

proc tabulate data=foodpref format=9.
              order=data;
   class animal food;
   table animal*food;
run;
```

Output 70.13 *Ordering the Headings of Class Variables*

Animal Food Preference

Animal					
cat			dog		
Food			Food		
fish	meat	milk	fish	meat	bones
N	N	N	N	N	N
1	1	1	1	1	1

Portability of ODS Output with PROC TABULATE

Under certain circumstances, using PROC TABULATE with the Output Delivery System produces files that are not portable. If the SAS system option FORMCHAR= in your SAS session uses nonstandard line-drawing characters, then the output might include strange characters instead of lines in operating environments in which the SAS Monospace font is not installed. To avoid this problem, specify the following OPTIONS statement before executing PROC TABULATE:

```
options formchar="|----|+|---+=|-/\<>*";
```

Examples: TABULATE Procedure

Example 1: Creating a Basic Two-Dimensional Table

Features:

CLASS statement

PROC TABULATE statement options
- DATA=
- FORMAT=

TABLE statement options
- crossing (*) operator
- RTS=

VAR statement

DATA step

FORMAT procedure

FORMAT statement

TITLE statement

Data set: ENERGY

Details

The following example program does the following:

- creates a category for each type of user (residential or business) in each division of each region

- applies the same format to all cells in the table
- applies a format to each class variable
- extends the space for row headings

Program

```
data energy;
   length State $2;
   input Region Division state $ Type Expenditures;
   datalines;
1 1 ME 1 708
1 1 ME 2 379

 ... more data lines ...

4 4 HI 1 273
4 4 HI 2 298
;
proc format;
   value regfmt 1='Northeast'
                2='South'
                3='Midwest'
                4='West';
   value divfmt 1='New England'
                2='Middle Atlantic'
                3='Mountain'
                4='Pacific';
   value usetype 1='Residential Customers'
                 2='Business Customers';
run;
proc tabulate data=energy format=dollar12.;
   class region division type;

   var expenditures;
   table region*division,
         type*expenditures
          / rts=25;
   format region regfmt. division divfmt. type usetype.;
   title 'Energy Expenditures for Each Region';
   title2 '(millions of dollars)';
run;
```

Program Description

Create the ENERGY data set. ENERGY contains data on expenditures of energy for business and residential customers in individual states in the Northeast and West regions of the United States. A DATA step on page 2788 creates the data set.

```
data energy;
   length State $2;
   input Region Division state $ Type Expenditures;
   datalines;
1 1 ME 1 708
1 1 ME 2 379

 ... more data lines ...

4 4 HI 1 273
4 4 HI 2 298
;
```

Create the REGFMT., DIVFMT., and USETYPE. formats. PROC FORMAT creates formats for Region, Division, and Type.

```
proc format;
   value regfmt 1='Northeast'
                2='South'
                3='Midwest'
                4='West';
   value divfmt 1='New England'
                2='Middle Atlantic'
                3='Mountain'
                4='Pacific';
   value usetype 1='Residential Customers'
                 2='Business Customers';
run;
```

Specify the table options. The FORMAT= option specifies DOLLAR12. as the default format for the value in each table cell.

```
proc tabulate data=energy format=dollar12.;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by values of Region, Division, and Type.

```
   class region division type;
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Expenditures variable.

```
   var expenditures;
```

Define the table rows and columns. The TABLE statement creates a row for each formatted value of Region. Nested within each row are rows for each formatted value of Division. The TABLE statement also creates a column for each formatted value of Type. Each cell that is created by these rows and columns contains the sum of the analysis variable Expenditures for all observations that contribute to that cell.

```
   table region*division,
         type*expenditures
```

Specify the row title space. RTS= provides 25 characters per line for row headings.

```
    / rts=25;
```

Format the output. The FORMAT statement assigns formats to the variables Region, Division, and Type.

```
    format region regfmt. division divfmt. type usetype.;
```

Specify the titles.

```
    title 'Energy Expenditures for Each Region';
    title2 '(millions of dollars)';
run;
```

Output

Output 70.14 *Basic Two-Dimensional Table*

Energy Expenditures for Each Region
(millions of dollars)

		Type	
		Residential Customers	Business Customers
		Expenditures	Expenditures
		Sum	Sum
Region	Division		
Northeast	New England	$7,477	$5,129
	Middle Atlantic	$19,379	$15,078
West	Mountain	$5,476	$4,729
	Pacific	$13,959	$12,619

Example 2: Specifying Class Variable Combinations to Appear in a Table

Features:

CLASS statement

PROC TABULATE Statement options
- DATA=
- CLASSDATA=
- EXCLUSIVE
- FORMAT=

TABLE statement options
- crossing (*) operator
- RTS=

VAR statement

DATA step
FORMAT statement
TITLE statement

Data set: ENERGY

Details

This example does the following:

- uses the CLASSDATA= option to specify combinations of class variables to appear in a table.
- uses the EXCLUSIVE option to restrict the output to only the combinations specified in the CLASSDATA= data set. Without the EXCLUSIVE option, the output would be the same as in "Example 1: Creating a Basic Two-Dimensional Table" on page 2550.

Program

```
data classes;
   input region division type;
   datalines;
1 1 1
1 1 2
4 4 1
4 4 2
;

proc tabulate data=energy format=dollar12.
              classdata=classes exclusive;


   class region division type;

   var expenditures;

   table region*division,
         type*expenditures

        / rts=25;

   format region regfmt. division divfmt. type usetype.;

   title 'Energy Expenditures for Each Region';
   title2 '(millions of dollars)';
run;
```

Program Description

Create the CLASSES data set. CLASSES contains the combinations of class variable values that PROC TABULATE uses to create the table.

```
data classes;
   input region division type;
   datalines;
1 1 1
1 1 2
4 4 1
4 4 2
;
```

Specify the table options. CLASSDATA= and EXCLUSIVE restrict the class level combinations to those that are specified in the CLASSES data set.

```
proc tabulate data=energy format=dollar12.
              classdata=classes exclusive;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by values of Region, Division, and Type.

```
   class region division type;
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Expenditures variable.

```
   var expenditures;
```

Define the table rows and columns. The TABLE statement creates a row for each formatted value of Region. Nested within each row are rows for each formatted value of Division. The TABLE statement also creates a column for each formatted value of Type. Each cell that is created by these rows and columns contains the sum of the analysis variable Expenditures for all observations that contribute to that cell.

```
   table region*division,
         type*expenditures
```

Specify the row title space. RTS= provides 25 characters per line for row headings.

```
        / rts=25;
```

Format the output. The FORMAT statement assigns formats to the variables Region, Division, and Type.

```
   format region regfmt. division divfmt. type usetype.;
```

Specify the titles.

```
   title 'Energy Expenditures for Each Region';
   title2 '(millions of dollars)';
run;
```

Output

Output 70.15 *Energy Expenditures for Each Region*

Energy Expenditures for Each Region
(millions of dollars)

		Type	
		Residential Customers	Business Customers
		Expenditures	Expenditures
		Sum	Sum
Region	Division		
Northeast	New England	$7,477	$5,129
West	Pacific	$13,959	$12,619

Example 3: Using Preloaded Formats with Class Variables

Features:

CLASS statement options
- EXCLUSIVE
- PRELOADFMT

PROC TABULATE statement options
- DATA=
- FORMAT=
- OUT=

TABLE statement options
- crossing (*) operator
- PRINTMISS
- RTS

VAR statement

FORMAT statement

PRINT procedure

TITLE statement

Data set: ENERGY

Details

This example does the following:

- creates a table that includes all possible combinations of formatted class variable values (PRELOADFMT with PRINTMISS), even if those combinations have a zero frequency and even if they do not make sense
- uses only the preloaded range of user-defined formats as the levels of class variables (PRELOADFMT with EXCLUSIVE)
- writes the output to an output data set, and prints that data set

Program

```
proc tabulate data=energy format=dollar12.;
   class region division type / preloadfmt;
   var expenditures;
   table region*division,
         type*expenditures / rts=25 printmiss;
   format region regfmt. division divfmt. type usetype.;
   title 'Energy Expenditures for Each Region';
   title2 '(millions of dollars)';
run;
proc tabulate data=energy format=dollar12. out=tabdata;
   class region division type / preloadfmt exclusive;
   var expenditures;
   table region*division,
         type*expenditures / rts=25;
   format region regfmt. division divfmt. type usetype.;
   title 'Energy Expenditures for Each Region';
   title2 '(millions of dollars)';
run;
proc print data=tabdata;
run;
```

Program Description

Specify the table options. The FORMAT= option specifies DOLLAR12. as the default format for the value in each table cell.

```
proc tabulate data=energy format=dollar12.;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by values of Region, Division, and Type. PRELOADFMT specifies that PROC TABULATE use the preloaded values of the user-defined formats for the class variables.

```
   class region division type / preloadfmt;
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Expenditures variable.

```
var expenditures;
```

Define the table rows and columns, and specify row and column options. PRINTMISS specifies that all possible combinations of user-defined formats be used as the levels of the class variables.

```
table region*division,
      type*expenditures / rts=25 printmiss;
```

Format the output. The FORMAT statement assigns formats to the variables Region, Division, and Type.

```
format region regfmt. division divfmt. type usetype.;
```

Specify the titles.

```
title 'Energy Expenditures for Each Region';
title2 '(millions of dollars)';
run;
```

Specify the table options and the output data set. The OUT= option specifies the name of the output data set to which PROC TABULATE writes the data.

```
proc tabulate data=energy format=dollar12. out=tabdata;
```

Specify subgroups for the analysis. The EXCLUSIVE option, when used with PRELOADFMT, uses only the preloaded range of user-defined formats as the levels of class variables.

```
class region division type / preloadfmt exclusive;
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Expenditures variable.

```
var expenditures;
```

Define the table rows and columns, and specify row and column options. The PRINTMISS option is not specified in this case. If it were, then it would override the EXCLUSIVE option in the CLASS statement.

```
table region*division,
      type*expenditures / rts=25;
```

Format the output. The FORMAT statement assigns formats to the variables Region, Division, and Type.

```
format region regfmt. division divfmt. type usetype.;
```

Specify the titles.

```
title 'Energy Expenditures for Each Region';
title2 '(millions of dollars)';
run;
```

Print the output data set WORK.TABDATA.

```
proc print data=tabdata;
run;
```

Output

This output, created with the PRELOADFMT and PRINTMISS options, contains all possible combinations of preloaded user-defined formats for the class variable values. It includes combinations with zero frequencies, and combinations that make no sense, such as **Northeast** and **Pacific**.

Output 70.16 *Energy Expenditures for Each Region*

Energy Expenditures for Each Region
(millions of dollars)

		Type	
		Residential Customers	Business Customers
		Expenditures	Expenditures
		Sum	Sum
Region	Division		
Northeast	New England	$7,477	$5,129
	Middle Atlantic	$19,379	$15,078
	Mountain	.	.
	Pacific	.	.
South	New England	.	.
	Middle Atlantic	.	.
	Mountain	.	.
	Pacific	.	.
Midwest	New England	.	.
	Middle Atlantic	.	.
	Mountain	.	.
	Pacific	.	.
West	New England	.	.
	Middle Atlantic	.	.
	Mountain	$5,476	$4,729
	Pacific	$13,959	$12,619

This output, created with the PRELOADFMT and EXCLUSIVE options, contains only those combinations of preloaded user-defined formats for the class variable values that appear in the input data set. This output is identical to the output from "Example 1: Creating a Basic Two-Dimensional Table" on page 2550.

Output 70.17 *Energy Expenditures for Each Region*

Energy Expenditures for Each Region
(millions of dollars)

		Type	
		Residential Customers	Business Customers
		Expenditures	Expenditures
		Sum	Sum
Region	Division		
Northeast	New England	$7,477	$5,129
	Middle Atlantic	$19,379	$15,078
West	Mountain	$5,476	$4,729
	Pacific	$13,959	$12,619

This output shows the output data set TABDATA, which was created by the OUT= option in the PROC TABULATE statement. TABDATA contains the data that is created by having the PRELOADFMT and EXCLUSIVE options specified.

Output 70.18 *Energy Expenditures for Each Region*

Energy Expenditures for Each Region
(millions of dollars)

Obs	Region	Division	Type	_TYPE_	_PAGE_	_TABLE_	Expenditures_Sum
1	Northeast	New England	Residential Customers	111	1	1	7477
2	Northeast	New England	Business Customers	111	1	1	5129
3	Northeast	Middle Atlantic	Residential Customers	111	1	1	19379
4	Northeast	Middle Atlantic	Business Customers	111	1	1	15078
5	West	Mountain	Residential Customers	111	1	1	5476
6	West	Mountain	Business Customers	111	1	1	4729
7	West	Pacific	Residential Customers	111	1	1	13959
8	West	Pacific	Business Customers	111	1	1	12619

Example 4: Using Multilabel Formats

Features:

CLASS statement options
- MLF

PROC TABULATE statement options
- DATA=
- FORMAT=

TABLE statement

ALL class variable
concatenation (blank) operator
crossing (*) operator
grouping elements (parentheses) operator
label
variable list

VAR statement

DATA step

FORMAT procedure

FORMAT statement

TITLE statement

Data set: CARSURVEY

Details

This example does the following:

- shows how to specify a multilabel format in the VALUE statement of PROC FORMAT
- shows how to activate multilabel format processing using the MLF option with the CLASS statement
- demonstrates the behavior of the N statistic when multilabel format processing is activated

Program

```
data carsurvey;
   input Rater Age Progressa Remark Jupiter Dynamo;
   datalines;
1   38  94  98  84  80
2   49  96  84  80  77
3   16  64  78  76  73
4   27  89  73  90  92

 ... more data lines ...

77   61  92  88  77  85
78   24  87  88  88  91
79   18  54  50  62  74
80   62  90  91  90  86
;

proc format;
   value agefmt (multilabel notsorted)
         15 - 29 = 'Below 30 years'
         30 - 50 = 'Between 30 and 50'
```

```
        51 - high = 'Over 50 years'
          15 - 19 = '15 to 19'
          20 - 25 = '20 to 25'
          25 - 39 = '25 to 39'
          40 - 55 = '40 to 55'
        56 - high = '56 and above';
run;

proc tabulate data=carsurvey format=10.;

   class age / mlf;

   var progressa remark jupiter dynamo;

   table age all, n all='Potential Car Names'*(progressa remark
      jupiter dynamo)*mean;


   title1 "Rating Four Potential Car Names";
   title2 "Rating Scale 0-100 (100 is the highest rating)";

   format age agefmt.;
run;
```

Program Description

Create the CARSURVEY data set. CARSURVEY contains data from a survey that was distributed by a car manufacturer to a focus group of potential customers who were brought together to evaluate new car names. Each observation in the data set contains an identification number, the participant's age, and the participant's ratings of four car names. A DATA step creates the data set.

```
data carsurvey;
   input Rater Age Progressa Remark Jupiter Dynamo;
   datalines;
1   38  94  98  84  80
2   49  96  84  80  77
3   16  64  78  76  73
4   27  89  73  90  92

 ... more data lines ...

77   61  92  88  77  85
78   24  87  88  88  91
79   18  54  50  62  74
80   62  90  91  90  86
;
```

Create the AGEFMT. format. The FORMAT procedure creates a multilabel format for ages by using the "MULTILABEL" on page 1124. A multilabel format is one in which multiple labels can be assigned to the same value, in this case because of overlapping ranges. Each value is represented in the table for each range in which it occurs. The NOTSORTED option stores the ranges in the order in which they are defined.

```
proc format;
   value agefmt (multilabel notsorted)
```

```
          15 - 29 = 'Below 30 years'
          30 - 50 = 'Between 30 and 50'
        51 - high = 'Over 50 years'
          15 - 19 = '15 to 19'
          20 - 25 = '20 to 25'
          25 - 39 = '25 to 39'
          40 - 55 = '40 to 55'
        56 - high = '56 and above';
run;
```

Specify the table options. The FORMAT= option specifies up to 10 digits as the default format for the value in each table cell.

```
proc tabulate data=carsurvey format=10.;
```

Specify subgroups for the analysis. The CLASS statement identifies Age as the class variable and uses the MLF option to activate multilabel format processing.

```
   class age / mlf;
```

Specify the analysis variables. The VAR statement specifies that PROC TABULATE calculate statistics on the Progressa, Remark, Jupiter, and Dynamo variables.

```
   var progressa remark jupiter dynamo;
```

Define the table rows and columns. The row dimension of the TABLE statement creates a row for each formatted value of Age. Multilabel formatting allows an observation to be included in multiple rows or age categories. The row dimension uses the ALL class variable to summarize information for all rows. The column dimension uses the N statistic to calculate the number of observations for each age group. Notice that the result of the N statistic crossed with the ALL class variable in the row dimension is the total number of observations instead of the sum of the N statistics for the rows. The column dimension uses the ALL class variable at the beginning of a crossing to assign a label, `Potential Car Names`. The four nested columns calculate the mean ratings of the car names for each age group.

```
   table age all, n all='Potential Car Names'*(progressa remark
      jupiter dynamo)*mean;
```

Specify the titles.

```
   title1 "Rating Four Potential Car Names";
   title2 "Rating Scale 0-100 (100 is the highest rating)";
```

Format the output. The FORMAT statement assigns the user-defined format AGEFMT. to Age for this analysis.

```
   format age agefmt.;
run;
```

Output

Output 70.19 *Rating Four Potential Car Names*

Rating Four Potential Car Names
Rating Scale 0-100 (100 is the highest rating)

	N	Potential Car Names			
		Progressa	Remark	Jupiter	Dynamo
		Mean	Mean	Mean	Mean
Age					
15 to 19	14	75	78	81	73
20 to 25	11	89	88	84	89
25 to 39	26	84	90	82	72
40 to 55	14	85	87	80	68
56 and above	15	84	82	81	75
Below 30 years	36	82	84	82	75
Between 30 and 50	25	86	89	81	73
Over 50 years	19	82	84	80	76
All	80	83	86	81	74

Example 5: Customizing Row and Column Headings

Features:
CLASS statement
PROC TABULATE statement options
- DATA=
- FORMAT=

TABLE statement options
- crossing (*) operator
- labels
- RTS=

VAR statement
FORMAT statement
TITLE statement

Data set: ENERGY
Format: REGFMT.
Format: DIVFMT.
Format: USETYPE.

Details

This example shows how to customize row and column headings. A label specifies text for a heading. A blank label creates a blank heading. PROC TABULATE removes the space for blank column headings from the table.

Program

```
proc tabulate data=energy format=dollar12.;
   class region division type;
   var expenditures;
   table region*division,
        type='Customer Base'*expenditures=' '*sum=' '
         / rts=25;
   format region regfmt. division divfmt. type usetype.;
   title 'Energy Expenditures for Each Region';
   title2 '(millions of dollars)';
run;
```

Program Description

Specify the table options. The FORMAT= option specifies DOLLAR12. as the default format for the value in each table cell.

```
proc tabulate data=energy format=dollar12.;
```

Specify subgroups for the analysis. The CLASS statement identifies Region, Division, and Type as class variables.

```
   class region division type;
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Expenditures variable.

```
   var expenditures;
```

Define the table rows and columns. The TABLE statement creates a row for each formatted value of Region. Nested within each row are rows for each formatted value of Division. The TABLE statement also creates a column for each formatted value of Type. Each cell that is created by these rows and columns contains the sum of the analysis variable Expenditures for all observations that contribute to that cell. Text in quotation marks specifies headings for the corresponding variable or statistic. Although Sum is the default statistic, it is specified here so that you can specify a blank for its heading.

```
   table region*division,
```

```
          type='Customer Base'*expenditures=' '*sum=' '
```

Specify the row title space. RTS= provides 25 characters per line for row headings.

```
           / rts=25;
```

Format the output. The FORMAT statement assigns formats to Region, Division, and Type.

```
     format region regfmt. division divfmt. type usetype.;
```

Specify the titles.

```
     title 'Energy Expenditures for Each Region';
     title2 '(millions of dollars)';
run;
```

Output

The heading for Type contains text that is specified in the TABLE statement. The TABLE statement eliminated the headings for Expenditures and Sum.

Output 70.20 *Energy Expenditures for Each Region*

Energy Expenditures for Each Region
(millions of dollars)

		Customer Base	
		Residential Customers	Business Customers
Region	Division		
Northeast	New England	$7,477	$5,129
	Middle Atlantic	$19,379	$15,078
West	Mountain	$5,476	$4,729
	Pacific	$13,959	$12,619

Example 6: Summarizing Information with the Universal Class Variable ALL

Features:

CLASS statement

PROC TABULATE statement options
- DATA=
- FORMAT=

TABLE statement
- ALL class variable
- concatenation (blank operator)
- format modifiers

grouping elements (parentheses operator)
RTS=

VAR statement

FORMAT statement

TITLE statement

Data set:	ENERGY
Format:	REGFMT.
Format:	DIVFMT.
Format:	USETYPE.

Details

This example shows how to use the universal class variable ALL to summarize information from multiple categories.

Program

```
proc tabulate data=energy format=comma12.;
   class region division type;
   var expenditures;
   table region*(division all='Subtotal')
      all='Total for All Regions'*f=dollar12.,
      type='Customer Base'*expenditures=' '*sum=' '
         all='All Customers'*expenditures=' '*sum=' '
      / rts=25;
   format region regfmt. division divfmt. type usetype.;
   title 'Energy Expenditures for Each Region';
   title2 '(millions of dollars)';
run;
```

Program Description

Specify the table options. The FORMAT= option specifies COMMA12. as the default format for the value in each table cell.

```
proc tabulate data=energy format=comma12.;
```

Specify subgroups for the analysis. The CLASS statement identifies Region, Division, and Type as class variables.

```
   class region division type;
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Expenditures variable.

```
var expenditures;

table region*(division all='Subtotal')
   all='Total for All Regions'*f=dollar12.,

   type='Customer Base'*expenditures=' '*sum=' '
      all='All Customers'*expenditures=' '*sum=' '
```

Specify the row title space. RTS= provides 25 characters per line for row headings.

```
   / rts=25;
```

Format the output. The FORMAT statement assigns formats to the variables Region, Division, and Type.

```
format region regfmt. division divfmt. type usetype.;
```

Specify the titles.

```
   title 'Energy Expenditures for Each Region';
   title2 '(millions of dollars)';
run;
```

Output

The universal class variable ALL provides subtotals and totals in this table.

Output 70.21 *Energy Expenditures for Each Region*

Energy Expenditures for Each Region
(millions of dollars)

		Customer Base		All Customers
		Residential Customers	Business Customers	
Region	Division			
Northeast	New England	7,477	5,129	12,606
	Middle Atlantic	19,379	15,078	34,457
	Subtotal	26,856	20,207	47,063
West	Division			
	Mountain	5,476	4,729	10,205
	Pacific	13,959	12,619	26,578
	Subtotal	19,435	17,348	36,783
Total for All Regions		$46,291	$37,555	$83,846

Example 7: Eliminating Row Headings

Features:
CLASS statement
PROC TABULATE statement options
DATA=
FORMAT=
TABLE statement options
crossing (*) operator
labels
ROW=FLOAT
RTS=
VAR statement
FORMAT statement
TITLE statement

Data set: ENERGY

Format: REGFMT.

Format: DIVFMT.

Format: USETYPE.

Details

This example shows how to eliminate blank row headings from a table. To do so, you must both provide blank labels for the row headings and specify ROW=FLOAT in the TABLE statement.

Program

```
proc tabulate data=energy format=dollar12.;
   class region division type;
   var expenditures;
   table region*division*expenditures=' '*sum=' ',
         type='Customer Base'
         / rts=25 row=float;
   format region regfmt. division divfmt. type usetype.;
   title 'Energy Expenditures for Each Region';
   title2 '(millions of dollars)';
run;
```

Program Description

Specify the table options. The FORMAT= option specifies DOLLAR12. as the default format for the value in each table cell.

```
proc tabulate data=energy format=dollar12.;
```

Specify subgroups for the analysis. The CLASS statement identifies Region, Division, and Type as class variables.

```
    class region division type;
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Expenditures variable.

```
    var expenditures;
```

Define the table rows. The row dimension of the TABLE statement creates a row for each formatted value of Region. Nested within these rows is a row for each formatted value of Division. The analysis variable Expenditures and the Sum statistic are also included in the row dimension, so PROC TABULATE creates row headings for them as well. The text in quotation marks specifies the headings for the corresponding variable or statistic. Although Sum is the default statistic, it is specified here so that you can specify a blank for its heading.

```
    table region*division*expenditures=' '*sum=' ',
```

Define the table columns. The column dimension of the TABLE statement creates a column for each formatted value of Type.

```
          type='Customer Base'
```

Specify the row title space and eliminate blank row headings. RTS= provides 25 characters per line for row headings. ROW=FLOAT eliminates blank row headings.

```
          / rts=25 row=float;
```

Format the output. The FORMAT statement assigns formats to the variables Region, Division, and Type.

```
    format region regfmt. division divfmt. type usetype.;
```

Specify the titles.

```
    title 'Energy Expenditures for Each Region';
    title2 '(millions of dollars)';
run;
```

Output

Compare this table with the output in "Example 5: Customizing Row and Column Headings" on page 2564. The two tables are identical, but the program that creates this table uses Expenditures and Sum in the row dimension. PROC TABULATE automatically eliminates blank headings from the column dimension, whereas you must specify ROW=FLOAT to eliminate blank headings from the row dimension.

Output 70.22 *Energy Expenditures for Each Region*

Energy Expenditures for Each Region
(millions of dollars)

		Customer Base	
		Residential Customers	Business Customers
Region	Division		
Northeast	New England	$7,477	$5,129
	Middle Atlantic	$19,379	$15,078
West	Mountain	$5,476	$4,729
	Pacific	$13,959	$12,619

Example 8: Indenting Row Headings and Eliminating Horizontal Separators

Features:

CLASS statement

PROC TABULATE statement options
- DATA=
- FORMAT=
- NOSEPS

TABLE statement options
- crossing (*) operator
- labels
- INDENT=
- RTS=

VAR statement

FORMAT statement

ODS LISTING statement

ODS LISTING CLOSE statement

OPTIONS statement

TITLE statement

Data set: ENERGY

Format: REGFMT.

Format: DIVFMT.

Format: USETYPE.

Details

This example shows how to condense the structure of a table by doing the following:

- removing row headings for class variables
- indenting nested rows underneath parent rows instead of placing them next to each other
- eliminating horizontal separator lines from the row titles and the body of the table

Program

```
options nodate nonumber;
ods listing;

proc tabulate data=energy format=dollar12. noseps;

   class region division type;

   var expenditures;

    table region*division,
          type='Customer Base'*expenditures=' '*sum=' '

         / rts=25 indent=4;

   format region regfmt. division divfmt. type usetype.;

   title 'Energy Expenditures for Each Region';
   title2 '(millions of dollars)';
run;

ods listing close;
```

Program Description

Open the LISTING destination. The INDENT argument does not indent nested row headings for HTML output. The output will be captured as a listing with page numbering and date turned off.

```
options nodate nonumber;
ods listing;
```

Specify the table options. The FORMAT= option specifies DOLLAR12. as the default format for the value in each table cell. NOSEPS eliminates horizontal separator lines from row titles and from the body of the table.

```
proc tabulate data=energy format=dollar12. noseps;
```

Specify subgroups for the analysis. The CLASS statement identifies Region, Division, and Type as class variables.

```
class region division type;
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Expenditures variable.

```
var expenditures;
```

Define the table rows and columns. The TABLE statement creates a row for each formatted value of Region. Nested within each row are rows for each formatted value of Division. The TABLE statement also creates a column for each formatted value of Type. Each cell that is created by these rows and columns contains the sum of the analysis variable Expenditures for all observations that contribute to that cell. Text in quotation marks in all dimensions specifies headings for the corresponding variable or statistic. Although Sum is the default statistic, it is specified here so that you can specify a blank for its heading.

```
 table region*division,
       type='Customer Base'*expenditures=' '*sum=' '
```

Specify the row title space and indention value. RTS= provides 25 characters per line for row headings. INDENT= removes row headings for class variables, places values for Division beneath values for Region rather than beside them, and indents values for Division four spaces.

```
      / rts=25 indent=4;
```

Format the output. The FORMAT statement assigns formats to the variables Region, Division, and Type.

```
format region regfmt. division divfmt. type usetype.;
```

Specify the titles.

```
    title 'Energy Expenditures for Each Region';
    title2 '(millions of dollars)';
run;
```

Close the LISTING destination.

```
ods listing close;
```

Output

NOSEPS removes the separator lines from the row titles and the body of the table. INDENT= eliminates the row headings for Region and Division and indents values for Division underneath values for Region.

Output 70.23 *Energy Expenditures for Each Region*

Energy Expenditures for Each Region
(millions of dollars)

	Customer Base	
	Residential Customers	Business Customers
Northeast		
New England	$7,477	$5,129
Middle Atlantic	$19,379	$15,078
West		
Mountain	$5,476	$4,729
Pacific	$13,959	$12,619

Example 9: Creating Multipage Tables

Features:
- CLASS statement
- PROC TABULATE statement options
  - DATA=
  - FORMAT=
- TABLE statement options
  - ALL class variable
  - BOX=
  - CONDENSE
  - INDENT=
  - page expression
  - RTS=
- VAR statement
- FORMAT statement
- TITLE statement

Data set: ENERGY

Format: REGFMT.

Format: DIVFMT.

Format: USETYPE.

Details

This example creates a separate table for each region and one table for all regions. By default, PROC TABULATE creates each table on a separate page, but the CONDENSE option places them all on the same page.

Program

```
proc tabulate data=energy format=dollar12.;
   class region division type;
   var expenditures;
   table region='Region: ' all='All Regions',
   division all='All Divisions',
         type='Customer Base'*expenditures=' '*sum=' '
         / rts=25 box=_page_ condense indent=1;
   format region regfmt. division divfmt. type usetype.;
   title 'Energy Expenditures for Each Region and All Regions';
   title2 '(millions of dollars)';
run;
```

Program Description

Specify the table options. The FORMAT= option specifies DOLLAR12. as the default format for the value in each table cell.

```
proc tabulate data=energy format=dollar12.;
```

Specify subgroups for the analysis. The CLASS statement identifies Region, Division, and Type as class variables.

```
   class region division type;
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Expenditures variable.

```
   var expenditures;
```

Define the table pages. The page dimension of the TABLE statement creates one table for each formatted value of Region and one table for all regions. Text in quotation marks provides the heading for each page.

```
   table region='Region: ' all='All Regions',
```

Define the table rows. The row dimension creates a row for each formatted value of Division and a row for all divisions. Text in quotation marks provides the row headings.

```
   division all='All Divisions',
```

Define the table columns. The column dimension of the TABLE statement creates a column for each formatted value of Type. Each cell that is created by these pages, rows, and columns contains the sum of the analysis variable Expenditures for all observations that contribute to that cell. Text in quotation marks specifies headings for the corresponding variable or statistic. Although Sum is the default statistic, it is specified here so that you can specify a blank for its heading.

```
         type='Customer Base'*expenditures=' '*sum=' '
```

Specify additional table options. RTS= provides 25 characters per line for row headings. BOX= places the page heading inside the box above the row headings. CONDENSE places as many tables as possible on one physical page. INDENT= eliminates the row heading for Division. (Because there is no nesting in the row dimension, there is nothing to indent.)

```
/ rts=25 box=_page_ condense indent=1;
```

Format the output. The FORMAT statement assigns formats to the variables Region, Division, and Type.

```
format region regfmt. division divfmt. type usetype.;
```

Specify the titles.

```
title 'Energy Expenditures for Each Region and All Regions';
title2 '(millions of dollars)';
run;
```

Output

Output 70.24 *Energy Expenditures for Each Region and All Regions*

Energy Expenditures for Each Region and All Regions
(millions of dollars)

Region: Northeast	Customer Base	
	Residential Customers	Business Customers
New England	$7,477	$5,129
Middle Atlantic	$19,379	$15,078
All Divisions	$26,856	$20,207

Region: West	Customer Base	
	Residential Customers	Business Customers
Mountain	$5,476	$4,729
Pacific	$13,959	$12,619
All Divisions	$19,435	$17,348

All Regions	Customer Base	
	Residential Customers	Business Customers
New England	$7,477	$5,129
Middle Atlantic	$19,379	$15,078
Mountain	$5,476	$4,729
Pacific	$13,959	$12,619
All Divisions	$46,291	$37,555

Example 10: Reporting on Multiple-Response Survey Data

Features:

PROC TABULATE statement options
- DATA=

TABLE statement
- denominator definition (angle bracket operators)
- N statistic
- PCTN statistic
- variable list

VAR statement

DATA step
FORMAT procedure
FOOTNOTE statement
OPTIONS statement options
    FORMDLIM=
    NONUMBER
SYMPUT routine
TITLE statement

Data set: CUSTOMER_RESPONSE

Details

The two tables in this example show the following:

- which factors most influenced customers' decisions to buy products
- where customers heard of the company

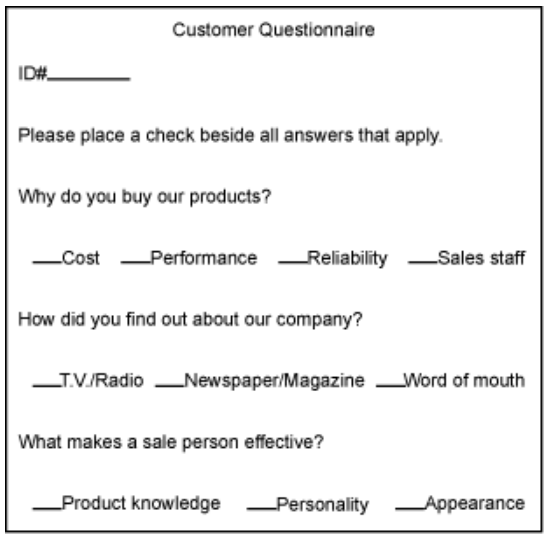
The reports appear on one physical page with only one page number. By default, they would appear on separate pages.

In addition to showing how to create these tables, this example shows how to do the following:

- use a DATA step to count the number of observations in a data set
- store that value in a macro variable
- access that value later in the SAS session

The following figure shows the survey form that is used to collect data.

Figure 70.8 *Completed Survey Form*


Customer Questionnaire

ID#_____

Please place a check beside all answers that apply.

Why do you buy our products?

___Cost ___Performance ___Reliability ___Sales staff

How did you find out about our company?

___T.V./Radio ___Newspaper/Magazine ___Word of mouth

What makes a sale person effective?

___Product knowledge ___Personality ___Appearance

Program

```
data customer_response;
   input Customer Factor1-Factor4 Source1-Source3
         Quality1-Quality3;
   datalines;
1 . . 1 1 1 1 . 1 . .
2 1 1 . 1 1 1 . 1 1 .
3 . . 1 1 1 1 . . . .

. . . more data lines . . .

119 . . . 1 . . . 1 . .
120 1 1 . 1 . . . . 1 .
;

data _null_;
   if 0 then set customer_response nobs=count;
   call symput('num',left(put(count,4.)));
   stop;
run;

proc format;
   picture pctfmt low-high='009.9 %';
run;

proc tabulate data=customer_response;

   var factor1-factor4 customer;

   table factor1='Cost'
         factor2='Performance'
         factor3='Reliability'
         factor4='Sales Staff',
         (n='Count'*f=7. pctn<customer>='Percent'*f=pctfmt9.) ;

   title 'Customer Survey Results: Spring 1996';
   title3 'Factors Influencing the Decision to Buy';
run;

proc tabulate
data=customer_response;

   var source1-source3 customer;

   table source1='TV/Radio'
         source2='Newspaper'
         source3='Word of Mouth',
         (n='Count'*f=7. pctn<customer>='Percent'*f=pctfmt9.) ;

   title 'Source of Company Name';
   footnote "Number of Respondents: &num";
run;

options formdlim='' number;
```

Program Description

Create the CUSTOMER_RESPONSE data set. CUSTOMER_RESPONSE contains data from a customer survey. Each observation in the data set contains information about factors that influence one respondent's decisions to buy products. A DATA step on page 2782 creates the data set. Using missing values rather than 0s is crucial for calculating frequency counts in PROC TABULATE.

```
data customer_response;
   input Customer Factor1-Factor4 Source1-Source3
         Quality1-Quality3;
   datalines;
1 . . 1 1 1 1 . 1 . .
2 1 1 . 1 1 1 . 1 1 .
3 . . 1 1 1 1 . . . .

. . . more data lines . . .

119 . . . 1 . . . 1 . .
120 1 1 . 1 . . . . 1 .
;
```

Store the number of observations in a macro variable. The SET statement reads the descriptor portion of CUSTOMER_RESPONSE at compile time and stores the number of observations (the number of respondents) in COUNT. The SYMPUT routine stores the value of COUNT in the macro variable NUM. This variable is available for use by other procedures and DATA steps for the remainder of the SAS session. The IF 0 condition, which is always false, ensures that the SET statement, which reads the observations, never executes. (Reading observations is unnecessary.) The STOP statement ensures that the DATA step executes only once.

```
data _null_;
   if 0 then set customer_response nobs=count;
   call symput('num',left(put(count,4.)));
   stop;
run;
```

Create the PCTFMT. format. The FORMAT procedure creates a format for percentages. The PCTFMT. format writes all values with at least one digit to the left of the decimal point and with one digit to the right of the decimal point. A blank and a percent sign follow the digits.

```
proc format;
   picture pctfmt low-high='009.9 %';
run;
```

Create the report and use the default table options.

```
proc tabulate data=customer_response;
```

Specify the analysis variables. The VAR statement specifies that PROC TABULATE calculate statistics on the Factor1, Factor2, Factor3, Factor4, and Customer variables. The variable Customer must be listed because it is used to calculate the Percent column that is defined in the TABLE statement.

```
   var factor1-factor4 customer;
```

Define the table rows and columns. The TABLE statement creates a row for each factor, a column for frequency counts, and a column for the percentages. Text in quotation marks supplies headings for the corresponding row or column. The

format modifiers F=7. and F=PCTFMT9. provide formats for values in the associated cells and extend the column widths to accommodate the column headings.

```
      table factor1='Cost'
            factor2='Performance'
            factor3='Reliability'
            factor4='Sales Staff',
            (n='Count'*f=7. pctn<customer>='Percent'*f=pctfmt9.) ;
```

Specify the titles.

```
      title 'Customer Survey Results: Spring 1996';
      title3 'Factors Influencing the Decision to Buy';
   run;
```

Create the report and use the default table options.

```
   proc tabulate
   data=customer_response;
```

Specify the analysis variables. The VAR statement specifies that PROC TABULATE calculate statistics on the Source1, Source2, Source3, and Customer variables. The variable Customer must be in the variable list because it appears in the denominator definition.

```
      var source1-source3 customer;
```

Define the table rows and columns. The TABLE statement creates a row for each source of the company name, a column for frequency counts, and a column for the percentages. Text in quotation marks supplies a heading for the corresponding row or column.

```
      table source1='TV/Radio'
            source2='Newspaper'
            source3='Word of Mouth',
            (n='Count'*f=7. pctn<customer>='Percent'*f=pctfmt9.) ;
```

Specify the title and footnote. The macro variable NUM resolves to the number of respondents. The FOOTNOTE statement uses double rather than single quotation marks so that the macro variable will resolve.

```
      title 'Source of Company Name';
      footnote "Number of Respondents: &num";
   run;
```

Reset the SAS system options. The FORMDLIM= option resets the page delimiter to a page eject. The NUMBER option resumes the display of page numbers on subsequent pages.

```
   options formdlim='' number;
```

Output

Output 70.25 *Customer Survey Results: Spring 1996*

Customer Survey Results: Spring 1996

Factors Influencing the Decision to Buy

	Count	Percent
Cost	87	72.5 %
Performance	62	51.6 %
Reliability	30	25.0 %
Sales Staff	120	100.0 %

Source of Company Name

	Count	Percent
TV/Radio	92	76.6 %
Newspaper	69	57.5 %
Word of Mouth	26	21.6 %

Number of Respondents: 120

Example 11: Reporting on Multiple-Choice Survey Data

Features:

CLASS statement

PROC TABULATE statement options
- DATA=
- FORMAT=

TABLE statement
- N statistic

DATA step

FORMAT procedure

FORMAT statement

TRANSPOSE procedure

Data set options
- RENAME=

TITLE statement

Data set: RADIO

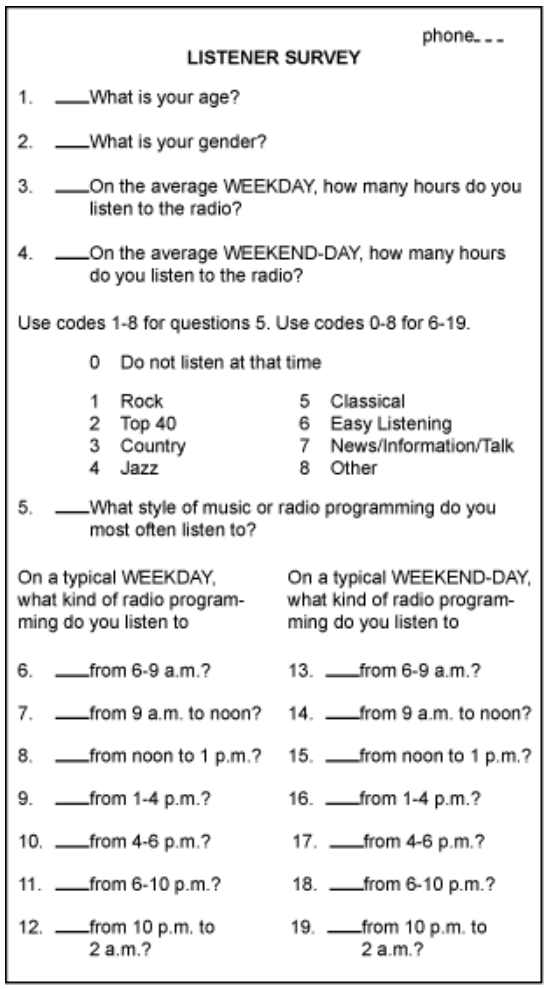
Details

This report of listener preferences shows how many listeners select each type of programming during each of seven time periods on a typical weekday. The data was collected by a survey, and the results were stored in a SAS data set. Although this data set contains all the information needed for this report, the information is not arranged in a way that PROC TABULATE can use.

To make this crosstabulation of time of day and choice of radio programming, you must have a data set that contains a variable for time of day and a variable for programming preference. PROC TRANSPOSE reshapes the data into a new data set that contains these variables. Once the data are in the appropriate form, PROC TABULATE creates the report.

The following figure shows the survey form that is used to collect data.

Figure 70.9 *Completed Survey Form*



phone_ _ _

LISTENER SURVEY

1. ____What is your age?

2. ____What is your gender?

3. ____On the average WEEKDAY, how many hours do you listen to the radio?

4. ____On the average WEEKEND-DAY, how many hours do you listen to the radio?

Use codes 1-8 for questions 5. Use codes 0-8 for 6-19.

0 Do not listen at that time

1	Rock	5	Classical
2	Top 40	6	Easy Listening
3	Country	7	News/Information/Talk
4	Jazz	8	Other

5. ____What style of music or radio programming do you most often listen to?

On a typical WEEKDAY, what kind of radio programming do you listen to	On a typical WEEKEND-DAY, what kind of radio programming do you listen to
6. ____from 6-9 a.m.?	13. ____from 6-9 a.m.?
7. ____from 9 a.m. to noon?	14. ____from 9 a.m. to noon?
8. ____from noon to 1 p.m.?	15. ____from noon to 1 p.m.?
9. ____from 1-4 p.m.?	16. ____from 1-4 p.m.?
10. ____from 4-6 p.m.?	17. ____from 4-6 p.m.?
11. ____from 6-10 p.m.?	18. ____from 6-10 p.m.?
12. ____from 10 p.m. to 2 a.m.?	19. ____from 10 p.m. to 2 a.m.?

An external file on page 2811 contains the raw data for the survey. Several lines from that file appear here.

```
967 32 f 5 3 5
7 5 5 5 7 0 0 0 8 7 0 0 8 0
781 30 f 2 3 5
5 0 0 0 5 0 0 0 4 7 5 0 0 0
859 39 f 1 0 5
1 0 0 0 1 0 0 0 0 0 0 0 0 0

 ... more data lines ...

859 32 m .25 .25 1
1 0 0 0 0 0 0 0 1 0 0 0 0 0
```

Program

```
data radio;
   infile 'input-file' missover;

   input /(Time1-Time7) ($1. +1);
   listener=_n_;
run;

proc format;
   value $timefmt 'Time1'='6-9 a.m.'
                  'Time2'='9 a.m. to noon'
                  'Time3'='noon to 1 p.m.'
                  'Time4'='1-4 p.m.'
                  'Time5'='4-6 p.m.'
                  'Time6'='6-10 p.m.'
                  'Time7'='10 p.m. to 2 a.m.'
                    other='*** Data Entry Error ***';
   value $pgmfmt      '0'="Don't Listen"
                  '1','2'='Rock and Top 40'
                      '3'='Country'
              '4','5','6'='Jazz, Classical, and Easy Listening'
                      '7'='News/ Information /Talk'
                      '8'='Other'
                    other='*** Data Entry Error ***';
run;

proc transpose data=radio
               out=radio_transposed(rename=(col1=Choice))
               name=Timespan;
   by listener;
   var time1-time7;
run;

proc tabulate data=radio_transposed format=12.;

format timespan $timefmt. choice $pgmfmt.;

   class timespan choice;

   table timespan='Time of Day',
         choice='Choice of Radio Program'*n='Number of Listeners';
```

```
   title 'Listening Preferences on Weekdays';
run;
```

Program Description

Create the RADIO data set and specify the input file. RADIO contains data from a survey of 336 listeners. The data set contains information about listeners and their preferences in radio programming. The INFILE statement specifies the external file that contains the data. MISSOVER prevents the input pointer from going to the next record if it fails to find values in the current line for all variables that are listed in the INPUT statement.

```
data radio;
   infile 'input-file' missover;

   input /(Time1-Time7) ($1. +1);
   listener=_n_;
run;
```

Create the $TIMEFMT. and $PGMFMT. formats. PROC FORMAT creates formats for the time of day and the choice of programming.

```
proc format;
   value $timefmt 'Time1'='6-9 a.m.'
                  'Time2'='9 a.m. to noon'
                  'Time3'='noon to 1 p.m.'
                  'Time4'='1-4 p.m.'
                  'Time5'='4-6 p.m.'
                  'Time6'='6-10 p.m.'
                  'Time7'='10 p.m. to 2 a.m.'
                    other='*** Data Entry Error ***';
   value $pgmfmt      '0'="Don't Listen"
                  '1','2'='Rock and Top 40'
                     '3'='Country'
              '4','5','6'='Jazz, Classical, and Easy Listening'
                     '7'='News/ Information /Talk'
                     '8'='Other'
                    other='*** Data Entry Error ***';
run;
```

Reshape the data by transposing the RADIO data set. PROC TRANSPOSE creates RADIO_TRANSPOSED. This data set contains the variable Listener from the original data set. It also contains two transposed variables: Timespan and Choice. Timespan contains the names of the variables (Time1-Time7) from the input data set that are transposed to form observations in the output data set. Choice contains the values of these variables. (See "Details" on page 2587 for a complete explanation of the PROC TRANSPOSE step.)

```
proc transpose data=radio
               out=radio_transposed(rename=(col1=Choice))
               name=Timespan;
   by listener;
   var time1-time7;
run;
```

Create the report and specify the table options. The FORMAT= option specifies the default format for the values in each table cell.

```
proc tabulate data=radio_transposed format=12.;
```

Format the transposed variables. The FORMAT statement permanently associates these formats with the variables in the output data set.

```
format timespan $timefmt. choice $pgmfmt.;
```

Specify subgroups for the analysis. The CLASS statement identifies Timespan and Choice as class variables.

```
class timespan choice;
```

Define the table rows and columns. The TABLE statement creates a row for each formatted value of Timespan and a column for each formatted value of Choice. In each column are values for the N statistic. Text in quotation marks supplies headings for the corresponding rows or columns.

```
table timespan='Time of Day',
      choice='Choice of Radio Program'*n='Number of Listeners';
```

Specify the title.

```
title 'Listening Preferences on Weekdays';
run;
```

Output

Output 70.26 *Listening Preferences on Weekdays*

Listening Preferences on Weekdays

	Choice of Radio Program					
	Don't Listen	Rock and Top 40	Country	Jazz, Classical, and Easy Listening	News/ Information /Talk	Other
	Number of Listeners	Number of Listeners	Number of Listeners	Number of Listeners	Number of Listeners	Number of Listeners
Time of Day						
6-9 a.m.	34	143	7	39	96	17
9 a.m. to noon	214	59	5	51	3	4
noon to 1 p.m.	238	55	3	27	9	4
1-4 p.m.	216	60	5	50	2	3
4-6 p.m.	56	130	6	57	69	18
6-10 p.m.	202	54	9	44	20	7
10 p.m. to 2 a.m.	264	29	3	36	2	2

Details

Reshape the Data

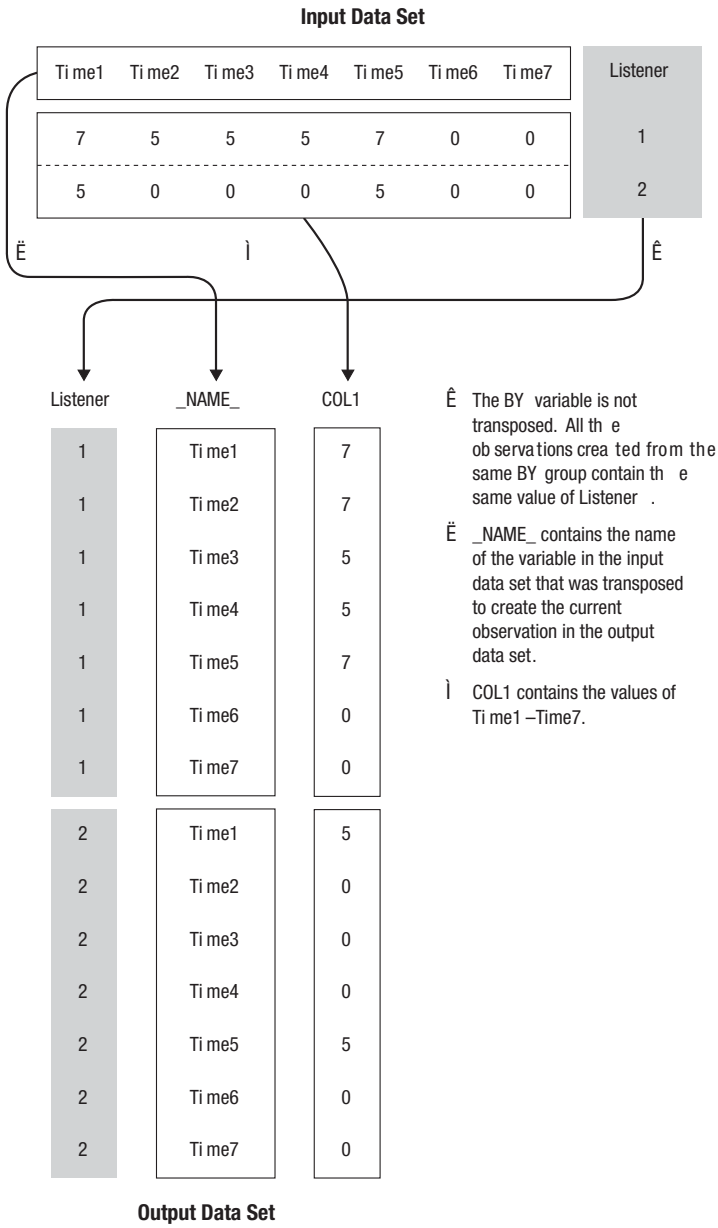
The original input data set has all the information that you need to make the crosstabular report, but PROC TABULATE cannot use the information in that form. PROC TRANSPOSE rearranges the data so that each observation in the new data set contains the variable Listener, a variable for time of day, and a variable for programming preference. The following figure illustrates the transposition. PROC TABULATE uses this new data set to create the crosstabular report.

PROC TRANSPOSE restructures data so that values that were stored in one observation are written to one variable. You can specify which variables you want to transpose.

When you transpose with BY processing, as this example does, you create from each BY group one observation for each variable that you transpose. In this example, Listener is the BY variable. Each observation in the input data set is a BY group because the value of Listener is unique for each observation.

This example transposes seven variables, Time1 through Time7. Therefore, the output data set has seven observations from each BY group (each observation) in the input data set.

Figure 70.10 Transposing Two Observations



Understanding the PROC TRANSPOSE Step

Here is a detailed explanation of the PROC TRANSPOSE step that reshapes the data:

```
proc transpose data=radio    1
               out=radio_transposed(rename=(col1=Choice))    2

               name=Timespan;    3
   by listener;    4
   var time1-time7;    5
   format timespan $timefmt. choice $pgmfmt.;    6
```

```
run;
```

1 The DATA= option specifies the input data set.

2 The OUT= option specifies the output data set. The RENAME= data set option renames the transposed variable from COL1 (the default name) to Choice.

3 The NAME= option specifies the name for the variable in the output data set that contains the name of the variable that is being transposed to create the current observation. By default, the name of this variable is _NAME_.

4 The BY statement identifies Listener as the BY variable.

5 The VAR statement identifies Time1 through Time7 as the variables to transpose.

6 The FORMAT statement assigns formats to Timespan and Choice. The PROC TABULATE step that creates the report does not need to format Timespan and Choice because the formats are stored with these variables.

Example 12: Calculating Various Percentage Statistics

Features:

CLASS statement

PROC TABULATE statement options
- FORMAT=

TABLE statement options
- ALL class variable
- COLPCTSUM statistic
- concatenation (blank) operator
- crossing (*) operator
- format modifiers
- grouping elements (parentheses) operator
- labels
- REPPCTSUM statistic
- ROWPCTSUM statistic
- variable list
- ROW=FLOAT
- RTS=

VAR statement

DATA step

FORMAT procedure

TITLE statement

Details

This example shows how to use three percentage sum statistics: COLPCTSUM, REPPCTSUM, and ROWPCTSUM.

Program

```
data fundrais;
   length name $ 8 classrm $ 1;
   input @1 team $ @8 classrm $ @10 name $
         @19 pencils @23 tablets;
   sales=pencils + tablets;
   datalines;
BLUE   A ANN       4   8
RED    A MARY      5  10
GREEN  A JOHN      6   4
RED    A BOB       2   3
BLUE   B FRED      6   8
GREEN  B LOUISE   12   2
BLUE   B ANNETTE   .   9
RED    B HENRY     8  10
GREEN  A ANDREW    3   5
RED    A SAMUEL   12  10
BLUE   A LINDA     7  12
GREEN  A SARA      4   .
BLUE   B MARTIN    9  13
RED    B MATTHEW   7   6
GREEN  B BETH     15  10
RED    B LAURA     4   3
;

proc format;
   picture pctfmt low-high='009 %';
run;

title "Fundraiser Sales";

proc tabulate format=7.;

   class team classrm;

   var sales;

   table (team all),

         classrm='Classroom'*sales=' '*(sum
         colpctsum*f=pctfmt9.
         rowpctsum*f=pctfmt9.
         reppctsum*f=pctfmt9.)
         all*sales*sum=' '

         /rts=20;
run;
```

Program Description

Create the FUNDRAIS data set. FUNDRAIS contains data on student sales during a school fund-raiser. A DATA step creates the data set.

```
data fundrais;
   length name $ 8 classrm $ 1;
   input @1 team $ @8 classrm $ @10 name $
         @19 pencils @23 tablets;
   sales=pencils + tablets;
   datalines;
BLUE    A ANN       4   8
RED     A MARY      5  10
GREEN   A JOHN      6   4
RED     A BOB       2   3
BLUE    B FRED      6   8
GREEN   B LOUISE   12   2
BLUE    B ANNETTE   .   9
RED     B HENRY     8  10
GREEN   A ANDREW    3   5
RED     A SAMUEL   12  10
BLUE    A LINDA     7  12
GREEN   A SARA      4   .
BLUE    B MARTIN    9  13
RED     B MATTHEW   7   6
GREEN   B BETH     15  10
RED     B LAURA     4   3
;
```

Create the PCTFMT. format. The FORMAT procedure creates a format for percentages. The PCTFMT. format writes all values with at least one digit, a blank, and a percent sign.

```
proc format;
   picture pctfmt low-high='009 %';
run;
```

Specify the title.

```
title "Fundraiser Sales";
```

Create the report and specify the table options. The FORMAT= option specifies up to seven digits as the default format for the value in each table cell.

```
proc tabulate format=7.;
```

Specify subgroups for the analysis. The CLASS statement identifies Team and Classrm as class variables.

```
   class team classrm;
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Sales variable.

```
   var sales;
```

Define the table rows. The row dimension of the TABLE statement creates a row for each formatted value of Team. The last row of the report summarizes sales for all teams.

```
      table (team all),
```

Define the table columns. The column dimension of the TABLE statement creates a column for each formatted value of Classrm. Crossed within each value of Classrm is the analysis variable (`sales`) with a blank label. Nested within each column are columns that summarize sales for the class. The first nested column, labeled `sum`, is the sum of sales for the row for the classroom. The second nested column, labeled `ColPctSum`, is the percentage of the sum of sales for the row for the classroom in relation to the sum of sales for all teams in the classroom. The third nested column, labeled `RowPctSum`, is the percentage of the sum of sales for the row for the classroom in relation to the sum of sales for the row for all classrooms. The fourth nested column, labeled `RepPctSum`, is the percentage of the sum of sales for the row for the classroom in relation to the sum of sales for all teams for all classrooms. The last column of the report summarizes sales for the row for all classrooms.

```
            classrm='Classroom'*sales=' '*(sum
            colpctsum*f=pctfmt9.
            rowpctsum*f=pctfmt9.
            reppctsum*f=pctfmt9.)
            all*sales*sum=' '
```

Specify the row title space and eliminate blank row headings. RTS= provides 20 characters per line for row headings.

```
            /rts=20;
run;
```

Output

Output 70.27 *Fundraiser Sales*

Fundraiser Sales

	Classroom								All
	A				B				
	Sum	ColPctSum	RowPctSum	RepPctSum	Sum	ColPctSum	RowPctSum	RepPctSum	sales
team									
BLUE	31	34 %	46 %	15 %	36	31 %	53 %	17 %	67
GREEN	18	19 %	31 %	8 %	39	34 %	68 %	19 %	57
RED	42	46 %	52 %	20 %	38	33 %	47 %	18 %	80
All	91	100 %	44 %	44 %	113	100 %	55 %	55 %	204

Details

Here are the percentage sum statistic calculations used to produce the output for the Blue Team in Classroom A:

- COLPCTSUM=31/91*100=34%
- ROWPCTSUM=31/67*100=46%
- REPPCTSUM=31/204*100=15%

Similar calculations were used to produce the output for the remaining teams and classrooms.

Example 13: Using Denominator Definitions to Display Basic Frequency Counts and Percentages

Features:

CLASS statement

PROC TABULATE statement options
- DATA=
- FORMAT=

TABLE statement options
- ALL class variable
- denominator definitions (angle bracket operators)
- N statistic
- PCTN statistic
- RTS=

DATA step

FORMAT procedure

FORMAT statement

TITLE statement

Details

Crosstabulation tables (also called contingency tables or stub-and-banner reports) show combined frequency distributions for two or more variables. This table shows frequency counts for females and males within each of four job classes. The table also shows the percentage that each frequency count represents the following:

- the total women and men in that job class (row percentage)
- the total for that gender in all job classes (column percentage)
- the total for all employees

Program

```
data jobclass;
   input Gender Occupation @@;
```

```
   datalines;
1 1  1 1  1 1  1 1  1 1  1 1  1 1
1 2  1 2  1 2  1 2  1 2  1 2  1 2
1 3  1 3  1 3  1 3  1 3  1 3  1 3
1 1  1 1  1 1  1 2  1 2  1 2  1 2
1 2  1 2  1 3  1 3  1 4  1 4  1 4
1 4  1 4  1 4  1 1  1 1  1 1  1 1
1 1  1 2  1 2  1 2  1 2  1 2  1 2
1 2  1 3  1 3  1 3  1 3  1 4  1 4
1 4  1 4  1 4  1 1  1 3  2 1  2 1
2 1  2 1  2 1  2 1  2 1  2 2  2 2
2 2  2 2  2 2  2 3  2 3  2 3  2 4
2 4  2 4  2 4  2 4  2 4  2 1  2 3
2 3  2 3  2 3  2 3  2 4  2 4  2 4
2 4  2 4  2 1  2 1  2 1  2 1  2 1
2 2  2 2  2 2  2 2  2 2  2 2  2 2
2 3  2 3  2 4  2 4  2 4  2 1  2 1
2 1  2 1  2 1  2 2  2 2  2 2  2 3
2 3  2 3  2 3  2 4
;

proc format;
   value gendfmt 1='Female'
                 2='Male'
              other='*** Data Entry Error ***';
   value occupfmt 1='Technical'
                  2='Manager/Supervisor'
                  3='Clerical'
                  4='Administrative'
               other='*** Data Entry Error ***';
run;

proc tabulate data=jobclass format=8.2;

   class gender occupation;

    table (occupation='Job Class' all='All Jobs')
              *(n='Number of employees'*f=9.
              pctn<gender all>='Percent of row total'
              pctn<occupation all>='Percent of column total'
              pctn='Percent of total'),

    gender='Gender' all='All Employees'/ rts=50;

   format gender gendfmt. occupation occupfmt.;

   title 'Gender Distribution';
   title2 'within Job Classes';
run;
```

Program Description

Create the JOBCLASS data set. JOBCLASS contains encoded information about the gender and job class of employees at a fictitious company.

```
data jobclass;
   input Gender Occupation @@;
   datalines;
```

```
1 1  1 1  1 1  1 1  1 1  1 1  1 1
1 2  1 2  1 2  1 2  1 2  1 2  1 2
1 3  1 3  1 3  1 3  1 3  1 3  1 3
1 1  1 1  1 1  1 2  1 2  1 2  1 2
1 2  1 2  1 3  1 3  1 4  1 4  1 4
1 4  1 4  1 4  1 1  1 1  1 1  1 1
1 1  1 2  1 2  1 2  1 2  1 2  1 2
1 2  1 3  1 3  1 3  1 3  1 4  1 4
1 4  1 4  1 4  1 1  1 3  2 1  2 1
2 1  2 1  2 1  2 1  2 1  2 2  2 2
2 2  2 2  2 2  2 3  2 3  2 3  2 4
2 4  2 4  2 4  2 4  2 4  2 1  2 3
2 3  2 3  2 3  2 3  2 4  2 4  2 4
2 4  2 4  2 1  2 1  2 1  2 1  2 1
2 2  2 2  2 2  2 2  2 2  2 2  2 2
2 3  2 3  2 4  2 4  2 4  2 1  2 1
2 1  2 1  2 1  2 2  2 2  2 2  2 3
2 3  2 3  2 3  2 4
;
```

Create the GENDFMT. and OCCUPFMT. formats. PROC FORMAT creates formats for the variables Gender and Occupation.

```
proc format;
   value gendfmt 1='Female'
                 2='Male'
              other='*** Data Entry Error ***';
   value occupfmt 1='Technical'
                  2='Manager/Supervisor'
                  3='Clerical'
                  4='Administrative'
               other='*** Data Entry Error ***';
run;
```

Create the report and specify the table options. The FORMAT= option specifies the 8.2 format as the default format for the value in each table cell.

```
proc tabulate data=jobclass format=8.2;
```

Specify subgroups for the analysis. The CLASS statement identifies Gender and Occupation as class variables.

```
   class gender occupation;

    table (occupation='Job Class' all='All Jobs')
              *(n='Number of employees'*f=9.
              pctn<gender all>='Percent of row total'
              pctn<occupation all>='Percent of column total'
              pctn='Percent of total'),
```

Define the table columns and specify the amount of space for row headings. The column dimension creates a column for each formatted value of Gender and for all employees. Text in quotation marks supplies the heading for the corresponding column. The RTS= option provides 50 characters per line for row headings.

```
    gender='Gender' all='All Employees'/ rts=50;
```

Format the output. The FORMAT statement assigns formats to the variables Gender and Occupation.

```
   format gender gendfmt. occupation occupfmt.;
```

Specify the titles.

```
   title 'Gender Distribution';
   title2 'within Job Classes';
run;
```

Output

Output 70.28 *Gender Distribution within Job Classes*

Gender Distribution within Job Classes

		Gender		All Employees
		Female	Male	
Job Class				
Technical	Number of employees	16	18	34
	Percent of row total	47.06	52.94	100.00
	Percent of column total	26.23	29.03	27.64
	Percent of total	13.01	14.63	27.64
Manager/Supervisor	Number of employees	20	15	35
	Percent of row total	57.14	42.86	100.00
	Percent of column total	32.79	24.19	28.46
	Percent of total	16.26	12.20	28.46
Clerical	Number of employees	14	14	28
	Percent of row total	50.00	50.00	100.00
	Percent of column total	22.95	22.58	22.76
	Percent of total	11.38	11.38	22.76
Administrative	Number of employees	11	15	26
	Percent of row total	42.31	57.69	100.00
	Percent of column total	18.03	24.19	21.14
	Percent of total	8.94	12.20	21.14
All Jobs	Number of employees	61	62	123
	Percent of row total	49.59	50.41	100.00
	Percent of column total	100.00	100.00	100.00
	Percent of total	49.59	50.41	100.00

Details

Overview

The part of the TABLE statement that defines the rows of the table uses the PCTN statistic to calculate three different percentages.

In all calculations of PCTN, the numerator is N, the frequency count for one cell of the table. The denominator for each occurrence of PCTN is determined by the denominator definition. The denominator definition appears in angle brackets after the keyword PCTN. It is a list of one or more expressions. The list tells PROC TABULATE which frequency counts to sum for the denominator.

Analyzing the Structure of the Table

Taking a close look at the structure of the table helps you understand how PROC TABULATE uses the denominator definitions. The following simplified version of the TABLE statement clarifies the basic structure of the table:

```
table occupation='Job Class' all='All Jobs',
      gender='Gender' all='All Employees';
```

The table is a concatenation of four subtables. In this report, each subtable is a crossing of one class variable in the row dimension and one class variable in the column dimension. Each crossing establishes one or more categories. A category is a combination of unique values of class variables, such as `female, technical` or `all, clerical`

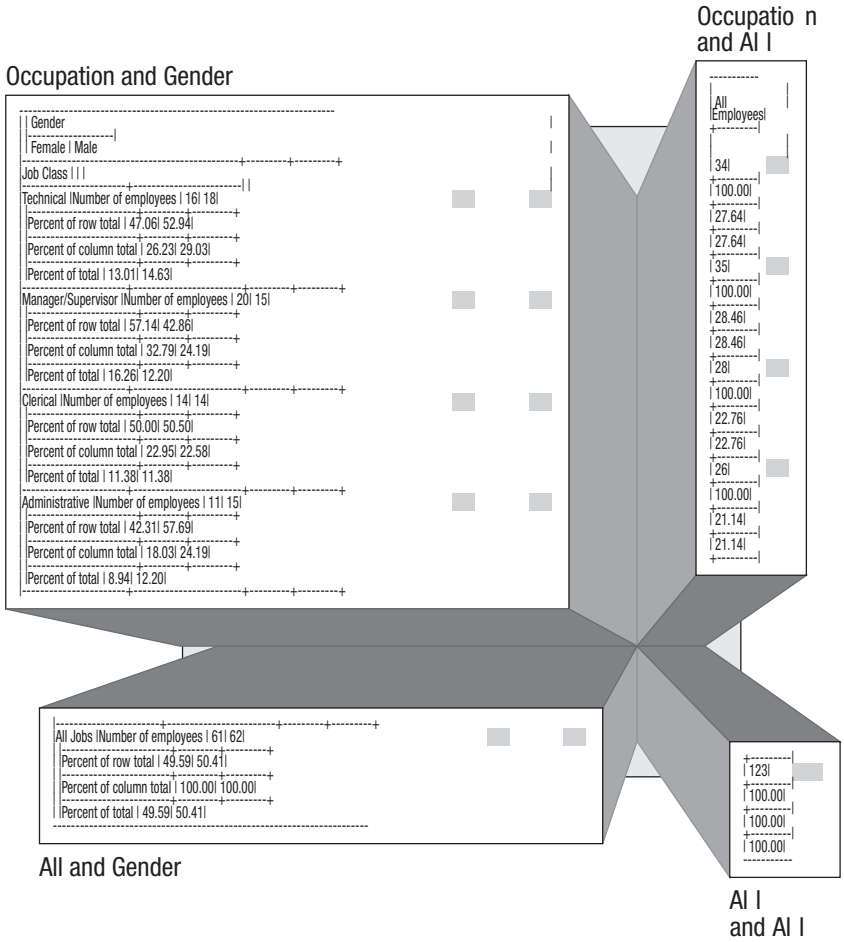
The following table describes each subtable:

Table 70.8 *Contents of Subtables*

Class Variables Contributing to the Subtable	Description of Frequency Counts	Number of Categories
Occupation and Gender	Number of females in each job or number of males in each job	8
All and Gender	Number of females or number of males	2
Occupation and All	Number of people in each job	4
All and All	Number of people in all jobs	1

The following figure highlights these subtables and the frequency counts for each category.

Figure 70.11 *Illustration of the Four Subtables*



Interpreting Denominator Definitions

The following fragment of the TABLE statement defines the denominator definitions for this report. The PCTN keyword and the denominator definitions are highlighted.

```
table (occupation='Job Class' all='All Jobs')
            *(n='Number of employees'*f=5.
              pctn<gender all>='Row percent'
              pctn<occupation all>='Column percent'
              pctn='Percent of total'),
```

Each use of PCTN nests a row of statistics within each value of Occupation and All. Each denominator definition tells PROC TABULATE which frequency counts to sum for the denominators in that row. This section explains how PROC TABULATE interprets these denominator definitions.

Row Percentages

The part of the TABLE statement that calculates the row percentages and that labels the row is

```
pctn<gender all>='Row percent'
```

Consider how PROC TABULATE interprets this denominator definition for each subtable.

Output 70.29 *Subtable 1: Occupation and Gender*

Gender Distribution within Job Classes

		Gender		All Employees
		Female	Male	
Job Class				
Technical	Number of employees	16	18	34
	Percent of row total	47.06	52.94	100.00
	Percent of column total	26.23	29.03	27.64
	Percent of total	13.01	14.63	27.64
Manager/Supervisor	Number of employees	20	15	35
	Percent of row total	57.14	42.86	100.00
	Percent of column total	32.79	24.19	28.46
	Percent of total	16.26	12.20	28.46
Clerical	Number of employees	14	14	28
	Percent of row total	50.00	50.00	100.00
	Percent of column total	22.95	22.58	22.76
	Percent of total	11.38	11.38	22.76
Administrative	Number of employees	11	15	26
	Percent of row total	42.31	57.69	100.00
	Percent of column total	18.03	24.19	21.14
	Percent of total	8.94	12.20	21.14
All Jobs	Number of employees	61	62	123
	Percent of row total	49.59	50.41	100.00
	Percent of column total	100.00	100.00	100.00
	Percent of total	49.59	50.41	100.00

PROC TABULATE looks at the first element in the denominator definition, Gender, and asks whether Gender contributes to the subtable. Because Gender does contribute to the subtable, PROC TABULATE uses it as the denominator definition. This denominator definition tells PROC TABULATE to sum the frequency counts for all occurrences of Gender within the same value of Occupation.

For example, the denominator for the category `female, technical` is the sum of all frequency counts for all categories in this subtable for which the value of Occupation is `technical`. There are two such categories: `female, technical` and `male, technical`. The corresponding frequency counts are 16 and 18. Therefore, the denominator for this category is 16+18, or 34.

Output 70.30 *Subtable 2: All and Gender*

Gender Distribution
within Job Classes

		Gender		All Employees
		Female	Male	
Job Class				
Technical	Number of employees	16	18	34
	Percent of row total	47.06	52.94	100.00
	Percent of column total	26.23	29.03	27.64
	Percent of total	13.01	14.63	27.64
Manager/Supervisor	Number of employees	20	15	35
	Percent of row total	57.14	42.86	100.00
	Percent of column total	32.79	24.19	28.46
	Percent of total	16.26	12.20	28.46
Clerical	Number of employees	14	14	28
	Percent of row total	50.00	50.00	100.00
	Percent of column total	22.95	22.58	22.76
	Percent of total	11.38	11.38	22.76
Administrative	Number of employees	11	15	26
	Percent of row total	42.31	57.69	100.00
	Percent of column total	18.03	24.19	21.14
	Percent of total	8.94	12.20	21.14
All Jobs	Number of employees	61	62	123
	Percent of row total	49.59	50.41	100.00
	Percent of column total	100.00	100.00	100.00
	Percent of total	49.59	50.41	100.00

PROC TABULATE looks at the first element in the denominator definition, Gender, and asks whether Gender contributes to the subtable. Because Gender does contribute to the subtable, PROC TABULATE uses it as the denominator definition. This denominator definition tells PROC TABULATE to sum the frequency counts for all occurrences of Gender in the subtable.

For example, the denominator for the category `all, female` is the sum of the frequency counts for `all, female` and `all, male`. The corresponding frequency counts are 61 and 62. Therefore, the denominator for cells in this subtable is 61+62, or 123.

Output 70.31 *Subtable 3: Occupation and All*

Gender Distribution within Job Classes

		Gender		All Employees
		Female	Male	
Job Class				
Technical	Number of employees	16	18	34
	Percent of row total	47.06	52.94	100.00
	Percent of column total	26.23	29.03	27.64
	Percent of total	13.01	14.63	27.64
Manager/Supervisor	Number of employees	20	15	35
	Percent of row total	57.14	42.86	100.00
	Percent of column total	32.79	24.19	28.46
	Percent of total	16.26	12.20	28.46
Clerical	Number of employees	14	14	28
	Percent of row total	50.00	50.00	100.00
	Percent of column total	22.95	22.58	22.76
	Percent of total	11.38	11.38	22.76
Administrative	Number of employees	11	15	26
	Percent of row total	42.31	57.69	100.00
	Percent of column total	18.03	24.19	21.14
	Percent of total	8.94	12.20	21.14
All Jobs	Number of employees	61	62	123
	Percent of row total	49.59	50.41	100.00
	Percent of column total	100.00	100.00	100.00
	Percent of total	49.59	50.41	100.00

PROC TABULATE looks at the first element in the denominator definition, Gender, and asks whether Gender contributes to the subtable. Because Gender does not contribute to the subtable, PROC TABULATE looks at the next element in the denominator definition, which is All. The variable All does contribute to this subtable, so PROC TABULATE uses it as the denominator definition. All is a reserved class variable with only one category. Therefore, this denominator definition tells PROC TABULATE to use the frequency count of All as the denominator.

For example, the denominator for the category `clerical, all` is the frequency count for that category, 28.

Note: In these table cells, because the numerator and the denominator are the same, the row percentages in this subtable are all 100.

Output 70.32 *Subtable 4: All and All*

Gender Distribution
within Job Classes

		Gender		All Employees
		Female	Male	
Job Class				
Technical	Number of employees	16	18	34
	Percent of row total	47.06	52.94	100.00
	Percent of column total	26.23	29.03	27.64
	Percent of total	13.01	14.63	27.64
Manager/Supervisor	Number of employees	20	15	35
	Percent of row total	57.14	42.86	100.00
	Percent of column total	32.79	24.19	28.46
	Percent of total	16.26	12.20	28.46
Clerical	Number of employees	14	14	28
	Percent of row total	50.00	50.00	100.00
	Percent of column total	22.95	22.58	22.76
	Percent of total	11.38	11.38	22.76
Administrative	Number of employees	11	15	26
	Percent of row total	42.31	57.69	100.00
	Percent of column total	18.03	24.19	21.14
	Percent of total	8.94	12.20	21.14
All Jobs	Number of employees	61	62	123
	Percent of row total	49.59	50.41	100.00
	Percent of column total	100.00	100.00	100.00
	Percent of total	49.59	50.41	100.00

PROC TABULATE looks at the first element in the denominator definition, Gender, and asks whether Gender contributes to the subtable. Because Gender does not contribute to the subtable, PROC TABULATE looks at the next element in the denominator definition, which is All. The variable All does contribute to this subtable, so PROC TABULATE uses it as the denominator definition. All is a reserved class variable with only one category. Therefore, this denominator definition tells PROC TABULATE to use the frequency count of All as the denominator.

There is only one category in this subtable: `all, all`. The denominator for this category is 123.

Note: In this table cell, because the numerator and denominator are the same, the row percentage in this subtable is 100.

Column Percentages

The part of the TABLE statement that calculates the column percentages and labels the row is

```
pctn<occupation all>='Column percent'
```

Consider how PROC TABULATE interprets this denominator definition for each subtable.

Output 70.33 *Subtable 1: Occupation and Gender*

Gender Distribution within Job Classes

		Gender		All Employees
		Female	Male	
Job Class				
Technical	Number of employees	16	18	34
	Percent of row total	47.06	52.94	100.00
	Percent of column total	26.23	29.03	27.64
	Percent of total	13.01	14.63	27.64
Manager/Supervisor	Number of employees	20	15	35
	Percent of row total	57.14	42.86	100.00
	Percent of column total	32.79	24.19	28.46
	Percent of total	16.26	12.20	28.46
Clerical	Number of employees	14	14	28
	Percent of row total	50.00	50.00	100.00
	Percent of column total	22.95	22.58	22.76
	Percent of total	11.38	11.38	22.76
Administrative	Number of employees	11	15	26
	Percent of row total	42.31	57.69	100.00
	Percent of column total	18.03	24.19	21.14
	Percent of total	8.94	12.20	21.14
All Jobs	Number of employees	61	62	123
	Percent of row total	49.59	50.41	100.00
	Percent of column total	100.00	100.00	100.00
	Percent of total	49.59	50.41	100.00

PROC TABULATE looks at the first element in the denominator definition, Occupation, and asks whether Occupation contributes to the subtable. Because Occupation does contribute to the subtable, PROC TABULATE uses it as the denominator definition. This denominator definition tells PROC TABULATE to sum the frequency counts for all occurrences of Occupation within the same value of Gender.

For example, the denominator for the category `manager/supervisor, male` is the sum of all frequency counts for all categories in this subtable for which the value of Gender is `male`. There are four such categories: `technical, male`; `manager/supervisor, male`; `clerical, male`; and `administrative, male`. The corresponding frequency counts are 18, 15, 14, and 15. Therefore, the denominator for this category is 18+15+14+15, or 62.

Output 70.34 *Subtable 2: All and Gender*

Gender Distribution within Job Classes

		Gender		All Employees
		Female	Male	
Job Class				
Technical	Number of employees	16	18	34
	Percent of row total	47.06	52.94	100.00
	Percent of column total	26.23	29.03	27.64
	Percent of total	13.01	14.63	27.64
Manager/Supervisor	Number of employees	20	15	35
	Percent of row total	57.14	42.86	100.00
	Percent of column total	32.79	24.19	28.46
	Percent of total	16.26	12.20	28.46
Clerical	Number of employees	14	14	28
	Percent of row total	50.00	50.00	100.00
	Percent of column total	22.95	22.58	22.76
	Percent of total	11.38	11.38	22.76
Administrative	Number of employees	11	15	26
	Percent of row total	42.31	57.69	100.00
	Percent of column total	18.03	24.19	21.14
	Percent of total	8.94	12.20	21.14
All Jobs	Number of employees	61	62	123
	Percent of row total	49.59	50.41	100.00
	Percent of column total	100.00	100.00	100.00
	Percent of total	49.59	50.41	100.00

PROC TABULATE looks at the first element in the denominator definition, Occupation, and asks whether Occupation contributes to the subtable. Because Occupation does not contribute to the subtable, PROC TABULATE looks at the next element in the denominator definition, which is All. Because the variable All does contribute to this subtable, PROC TABULATE uses it as the denominator definition. All is a reserved class variable with only one category. Therefore, this denominator definition tells PROC TABULATE to use the frequency count for All as the denominator.

For example, the denominator for the category `all, female` is the frequency count for that category, 61.

Note: In these table cells, because the numerator and denominator are the same, the column percentages in this subtable are all 100.

Output 70.35 *Subtable 3: Occupation and All*

Gender Distribution within Job Classes

		Gender		All Employees
		Female	Male	
Job Class				
Technical	Number of employees	16	18	34
	Percent of row total	47.06	52.94	100.00
	Percent of column total	26.23	29.03	27.64
	Percent of total	13.01	14.63	27.64
Manager/Supervisor	Number of employees	20	15	35
	Percent of row total	57.14	42.86	100.00
	Percent of column total	32.79	24.19	28.46
	Percent of total	16.26	12.20	28.46
Clerical	Number of employees	14	14	28
	Percent of row total	50.00	50.00	100.00
	Percent of column total	22.95	22.58	22.76
	Percent of total	11.38	11.38	22.76
Administrative	Number of employees	11	15	26
	Percent of row total	42.31	57.69	100.00
	Percent of column total	18.03	24.19	21.14
	Percent of total	8.94	12.20	21.14
All Jobs	Number of employees	61	62	123
	Percent of row total	49.59	50.41	100.00
	Percent of column total	100.00	100.00	100.00
	Percent of total	49.59	50.41	100.00

PROC TABULATE looks at the first element in the denominator definition, Occupation, and asks whether Occupation contributes to the subtable. Because Occupation does contribute to the subtable, PROC TABULATE uses it as the denominator definition. This denominator definition tells PROC TABULATE to sum the frequency counts for all occurrences of Occupation in the subtable.

For example, the denominator for the category `technical, all` is the sum of the frequency counts for `technical, all`; `manager/supervisor, all`; `clerical, all`; and `administrative, all`. The corresponding frequency counts are 34, 35, 28, and 26. Therefore, the denominator for this category is 34+35+28+26, or 123.

Output 70.36 *Subtable 4: All and All*

Gender Distribution
within Job Classes

		Gender		All Employees
		Female	Male	
Job Class				
Technical	Number of employees	16	18	34
	Percent of row total	47.06	52.94	100.00
	Percent of column total	26.23	29.03	27.64
	Percent of total	13.01	14.63	27.64
Manager/Supervisor	Number of employees	20	15	35
	Percent of row total	57.14	42.86	100.00
	Percent of column total	32.79	24.19	28.46
	Percent of total	16.26	12.20	28.46
Clerical	Number of employees	14	14	28
	Percent of row total	50.00	50.00	100.00
	Percent of column total	22.95	22.58	22.76
	Percent of total	11.38	11.38	22.76
Administrative	Number of employees	11	15	26
	Percent of row total	42.31	57.69	100.00
	Percent of column total	18.03	24.19	21.14
	Percent of total	8.94	12.20	21.14
All Jobs	Number of employees	61	62	123
	Percent of row total	49.59	50.41	100.00
	Percent of column total	100.00	100.00	100.00
	Percent of total	49.59	50.41	100.00

PROC TABULATE looks at the first element in the denominator definition, Occupation, and asks whether Occupation contributes to the subtable. Because Occupation does not contribute to the subtable, PROC TABULATE looks at the next element in the denominator definition, which is All. Because the variable All does contribute to this subtable, PROC TABULATE uses it as the denominator definition. All is a reserved class variable with only one category. Therefore, this denominator definition tells PROC TABULATE to use the frequency count of All as the denominator.

There is only one category in this subtable: `all, all`. The frequency count for this category is 123.

Note: In this calculation, because the numerator and denominator are the same, the column percentage in this subtable is 100.

Total Percentages

The part of the TABLE statement that calculates the total percentages and labels the row is:

```
pctn='Total percent'
```

If you do not specify a denominator definition, then PROC TABULATE obtains the denominator for a cell by totaling all the frequency counts in the subtable. The following table summarizes the process for all subtables in this example.

Table 70.9 *Denominators for Total Percentages*

Class Variables Contributing to the Subtable	Frequency Counts	Total
Occupant and Gender	16, 18, 20, 15 14, 14, 11, 15	123
Occupant and All	34, 35, 28, 26	123
Gender and All	61, 62	123
All and All	123	123

Consequently, the denominator for total percentages is always 123.

Example 14: Specifying Style Overrides for ODS Output

Features:

CLASS statement option
    STYLE=

CLASSLEV statement option
    STYLE=

KEYLABEL statement

KEYWORD statement option
    STYLE=

PROC TABULATE statement options
    DATA=
    STYLE=

TABLE statement options
    STYLE=
    MISSTEXT=
    BOX=

ODS HTML statement
ODS HTML CLOSE statement
ODS PDF statement
ODS PDF CLOSE statement
ODS RTF statement
ODS RTF CLOSE statement
OPTIONS statement
TITLE statement

Data set: ENERGY
Format: REGFMT.
Format: DIVFMT.
Format: USETYPE.

Details

This example creates HTML, RTF, and PDF files and specifies style overrides for various table regions.

Program

```
options nodate pageno=1;

proc sort data=energy;
   by region;
run;

ods html5 path='path' body='filename.htm';
ods pdf file='filename.pdf' contents=yes;
ods rtf file='filename.rtf' contents=yes;

proc tabulate data=energy style=[fontweight=bold];

by region;

   class region division type / style=[textalign=center];

   classlev region division type / style=[textalign=left];

   var expenditures / style=[fontsize=3];

   keyword all sum / style=[fontwidth=wide];
   keylabel all="Total";

   table (region all)*(division all*[style=[backgroundcolor=yellow]]),
         (type all)*(expenditures*f=dollar10.) /
         style=[bordercolor=blue]

         misstext=[label="Missing" style=[fontweight=light]]

         box=[label="Region by Division by Type"
```

```
            style=[fontstyle=italic]];
   format region regfmt. division divfmt. type usetype.;
   title 'Energy Expenditures';
   title2 '(millions of dollars)';
run;
ods _all_ close;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number.

```
options nodate pageno=1;
```

Sort the data set.

```
proc sort data=energy;
   by region;
run;
```

Specify the ODS output filenames. By opening multiple ODS destinations, you can produce multiple output files in a single execution. The ODS HTML5 statement produces output that is written in HTML 5.0. The ODS PDF statement produces output in Portable Document Format (PDF). The ODS RTF statement produces output in Rich Text Format (RTF). The output from PROC TABULATE goes to each of these files.

In the ODS PDF and ODS RTF statements, the CONTENTS= option creates a table of contents.

```
ods html5 path='path' body='filename.htm';
ods pdf file='filename.pdf' contents=yes;
ods rtf file='filename.rtf' contents=yes;
```

Customize the data cells. The STYLE= option in the PROC TABULATE statement specifies the style override for the data cells of the table.

```
proc tabulate data=energy style=[fontweight=bold];
```

Specify the BY-group. When BY statements are specified, labels for the BY group tables are displayed in the table of contents. The labels are based on the values of the BY variable.

```
by region;
```

Customize the class variable name headings. The STYLE= option in the CLASS statement specifies the style override for the class variable name headings.

```
   class region division type / style=[textalign=center];
```

Customize the class variable value headings. The STYLE= option in the CLASSLEV statement specifies the style override for the class variable level value headings.

```
   classlev region division type / style=[textalign=left];
```

Customize the analysis variable name headings. The STYLE= option in the VAR statement specifies a style element for the variable name headings.

```
      var expenditures / style=[fontsize=3];
```

Specify the style attributes for keywords, and label the "all" keyword. The STYLE= option in the KEYWORD statement specifies a style element for keywords. The KEYLABEL statement assigns a label to the keyword.

```
      keyword all sum / style=[fontwidth=wide];
      keylabel all="Total";
```

Define and customize the table rows and columns. The STYLE= option in the dimension expression overrides any other STYLE= specifications in PROC TABULATE that specify overrides for table cells. The STYLE= option after the slash (/) specifies style overrides for parts of the table other than table cells.

```
      table (region all)*(division all*[style=[backgroundcolor=yellow]]),
            (type all)*(expenditures*f=dollar10.) /
            style=[bordercolor=blue]
```

Customize missing values. The STYLE= option in the MISSTEXT option of the TABLE statement specifies a style element to use for the text in table cells that contain missing values.

```
            misstext=[label="Missing" style=[fontweight=light]]
```

Customize the box above the row titles. The STYLE= option in the BOX option of the TABLE statement specifies a style override for text in the box above the row titles.

```
            box=[label="Region by Division by Type"
               style=[fontstyle=italic]];
```

Format the class variable values.

```
      format region regfmt. division divfmt. type usetype.;
```

Specify the titles.

```
      title 'Energy Expenditures';
      title2 '(millions of dollars)';
   run;
```

Close all of the ODS destinations.

```
   ods _all_ close;
```

Output

Output 70.37 *HTML Output*

Energy Expenditures
(millions of dollars)

Region=Northeast

Region by Division by Type		Type		Total
		Residential Customers	Business Customers	
		Expenditures	Expenditures	Expenditures
		Sum	Sum	Sum
Region	Division			
Northeast	New England	$7,477	$5,129	$12,606
	Middle Atlantic	$19,379	$15,078	$34,457
	Total	$26,856	$20,207	$47,063
Total	Division			
	New England	$7,477	$5,129	$12,606
	Middle Atlantic	$19,379	$15,078	$34,457
	Total	$26,856	$20,207	$47,063

Output 70.38 *PDF Output*

Energy Expenditures
(millions of dollars)

Region=Northeast

Region by Division by Type		Type		Total
		Residential Customers	Business Customers	
		Expenditures	Expenditures	Expenditures
		Sum	Sum	Sum
Region	Division			
Northeast	New England	$7,477	$5,129	$12,606
	Middle Atlantic	$19,379	$15,078	$34,457
	Total	$26,856	$20,207	$47,063
Total	Division			
	New England	$7,477	$5,129	$12,606
	Middle Atlantic	$19,379	$15,078	$34,457
	Total	$26,856	$20,207	$47,063

Output 70.39 *RTF Output*

Energy Expenditures
(millions of dollars)

Region=Northeast

Region by Division by Type		Type		Total
		Residential Customers	Business Customers	
		Expenditures	Expenditures	Expenditures
		Sum	Sum	Sum
Region	Division			
Northeast	New England	$7,477	$5,129	$12,606
	Middle Atlantic	$19,379	$15,078	$34,457
	Total	$26,856	$20,207	$47,063
Total	Division			
	New England	$7,477	$5,129	$12,606
	Middle Atlantic	$19,379	$15,078	$34,457
	Total	$26,856	$20,207	$47,063

Example 15: Style Precedence

Features:

CLASS statement0

CLASSLEV statement option
- STYLE=

KEYLABEL statement

LABEL statement

PROC TABULATE statement options
- DATA=
- FORMAT=

TABLE statement
- crossing (*) operator
- STYLE=
- STYLE_PRECEDENCE= option

VAR statement

ODS HTML statement

FORMAT procedure

FORMAT statement

TITLE statement

Data set: SALES

Details

This example does the following:

- creates a category for each sales type, retail or wholesale, in each region
- applies the dollar format to all cells in the table
- applies an italic font style for each region and sales type
- applies a style (background = red, yellow, or orange) color based on the STYLE_PRECEDENCE = option
- generates ODS HTML output

Program

```
proc format;
      value $saletypefmt 'R'='Retail'
                         'W'='WholeSale';
run;

ods html file="stylePrecedence.html";

title "Style Precedence";
title2 "First Table: no precedence, Orange";
title3 "Second Table: style_precedence=page, Yello";

proc tabulate data=sales format=dollar10.;

class product region saletype;


classlev region saletype / style={font_style=italic};


var netsales;

label netsales="Net Sales";


keylabel all="Total";


table product *{style={background=#edf8b1}},
region*{style={background=yellow}},
saletype*{style={background=orange}};

table product *{style={background=#edf8b1}},
region*{style={background=yellow}},
saletype*{style={background=orange}} / style_precedence=page;

format saletype $saletypefmt.;


run;
```

Program Description

Create the SALETYPEFMT. formats. PROC FORMAT creates formats for SALETYPE.

```
proc format;
      value $saletypefmt 'R'='Retail'
                         'W'='WholeSale';
run;
```

Specify the ODS output filename. The ODS HTML statement produces output that is written in HTML.

```
ods html file="stylePrecedence.html";
```

Specify the titles of the tables to be produced. Two tables will be generated. The First Table will show no style precedence whereas the Second Table will show that the color that takes precedence is based on what is specified by the STYLE_PRECEDENCE option.

```
title "Style Precedence";
title2 "First Table: no precedence, Orange";
title3 "Second Table: style_precedence=page, Yello";
```

Specify the table options. The FORMAT= option specifies DOLLAR10. as the default format for the value in each table cell.

```
proc tabulate data=sales format=dollar10.;
```

Specify subgroups for the analysis. The CLASS statement separates the analysis by values of Product, Region, and SaleType.

```
class product region saletype;
```

Specify styles for the subgroups. The CLASSLEV statement specifies a style for the Region and Saletype elements.

```
classlev region saletype / style={font_style=italic};
```

Specify the analysis variable. The VAR statement specifies that PROC TABULATE calculate statistics on the Netsales variable.

```
var netsales;
```

Specify labels. The LABEL statement renames the Netsales variable to Net Sales.

```
label netsales="Net Sales";
```

Specify Keylabel. The KEYLABEL statement labels the universal class variable ALL to Total.

```
keylabel all="Total";
```

Define the table rows and columns. The TABLE statement creates a table per product per page. In this example, there is one product, A100. The TABLE statement also creates a row for each formatted value of Region and creates a column for each formatted value of SaleType. Each cell that is created by these rows and columns contains the sum of the analysis variable Net Sales for all

observations that contribute to that cell. The STYLE= option in the dimension expression overrides any other STYLE= specifications in PROC TABULATE that specify attributes for the table cells. In this first table, the column expression is the default and the style associated with column takes precedence. Therefore, orange will be the default color of the background.

```
table product *{style={background=#edf8b1}},
region*{style={background=yellow}},
saletype*{style={background=orange}};
```

Define the table rows and columns using the STYLE_PRECEDENCE option. The TABLE statement creates a table per product per page, A100. The TABLE statement also creates a row for each formatted value of Region and creates a column for each formatted value of SaleType. Each cell that is created by these rows and columns contains the sum of the analysis variable Net Sales for all observations that contribute to that cell. The STYLE= option in the dimension expression overrides any other STYLE= specifications in PROC TABULATE that specify attributes for the table cells. In this second table, the STYLE_PRECEDENCE option is specified on the page expression. Therefore, the style that applies to the background is red.

```
table product *{style={background=#edf8b1}},
region*{style={background=yellow}},
saletype*{style={background=orange}} / style_precedence=page;
```

Format the output. The FORMAT statement assigns formats to the SaleType variable.

```
format saletype $saletypefmt.;
```

Run the program.

```
run;
```

Output

Output 70.40 *Table with No Style Precedence*

Style Precedence
First Table: no precedence, orange
Second Table: style_precedence=page, Yellow

Product A100

	SaleType	
	Retail	*WholeSale*
	N	N
Region		
NC	$3	$3
TX	.	$2

Output 70.41 *Table Style Precedence*

Style Precedence
First Table: no precedence, orange
Second Table: style_precedence=page, Yellow

Product A100

	SaleType	
	Retail	*WholeSale*
	N	N
Region		
NC	$3	$3
TX	.	$2

Example 16: Using the NOCELLMERGE Option

Features:

CLASS statement

PROC TABULATE statement options
- DATA=
- STYLE=

CLASS statement

TABLE statement
- crossing (*) operator
- STYLE= option
- NOCELLMERGE= option

ODS HTML statement

ODS HTML CLOSE statement

TITLE statement

Details

This example does the following:

- creates a table with merged cells style behavior
- creates a second table without merged cells
- shows how cells styles are affected when empty data cells and the formatted data cells use different styles

Program

```
ods html file="tabstyle.html";
proc tabulate data=sashelp.class style={background=#edf8b1};
class sex age;

table sex*{style={background=#7fcdbb}} all, age;
title 'Data Cell Styles in Merged Cells';
run;

proc tabulate data=sashelp.class style={background=#edf8b1};
class sex age;

table sex*{style={background=#7fcdbb}} all, age/nocellmerge;
title1 'Data Cell Styles with NOCELLMERGE Option';
run;

ODS html close;
ods html;
```

Program Description

Specify the ODS output filename. The ODS HTML statement produces output that is written in HTML.

```
ods html file="tabstyle.html";
```

Specify the PROC TABULATE options. The STYLE= option sets the background color for the cells in the table to red.

```
proc tabulate data=sashelp.class style={background=#edf8b1};
```

Specify subgroups. The CLASS statement separates the data by sex and age.

```
class sex age;
```

Define the table rows and columns. The TABLE statement creates a table. The STYLE= option in the dimension expression overrides the STYLE= setting from the PROC TABULATE statement for table cells attributes.

```
table sex*{style={background=#7fcdbb}} all, age;
```

Specify the title of the table to be produced. This table shows how changing the style color affects the merged cells.

```
title 'Data Cell Styles in Merged Cells';
```

Run the program.

```
run;
```

Specify the PROC TABULATE options. The STYLE= option sets the background color for the cells in the table to red.

```
proc tabulate data=sashelp.class style={background=#edf8b1};
```

Specify subgroups. The CLASS statement separates the data by sex and age.

```
class sex age;
```

Define the table rows and columns. The TABLE statement creates a table. The STYLE= option in the dimension expression overrides the STYLE= setting from the PROC TABULATE statement, but only for the formatted data cells.

```
table sex*{style={background=#7fcdbb}} all, age/nocellmerge;
```

Specify the title of the table to be produced. This table shows how changing the style color affects the formatted cells that are not merged.

```
title1 'Data Cell Styles with NOCELLMERGE Option';
```

Run the program.

```
run;
```

Close the ODS HTML output destination.

```
ODS html close;
ods html;
```

Output

Output 70.42 *Data Cell Styles in Merged Cells*

Data Cell Styles in Merged Cells

	Age					
	11	12	13	14	15	16
	N	N	N	N	N	N
Sex						
F	1	2	2	2	2	.
M	1	3	1	2	2	1
All	2	5	3	4	4	1

Output 70.43 *Data Cell Styles in Unmerged Cells*

Data Cell Styles with NOCELLMERGE Option

	Age					
	11	12	13	14	15	16
	N	N	N	N	N	N
Sex						
F	1	2	2	2	2	.
M	1	3	1	2	2	1
All	2	5	3	4	4	1

References

Jain, Raj and Imrich Chlamtac. 1985. "The P^2 Algorithm for Dynamic Calculation of Quantiles and Histograms without Storing Observations." *Communications of the Association of Computing Machinery* 28 (10): 1076–1085.

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TIMEPLOT Procedure

Overview: TIMEPLOT Procedure

What Does the TIMEPLOT Procedure Do?

The TIMEPLOT procedure plots one or more variables over time intervals. A listing of variable values accompanies the plot. Although the plot and the listing are

similar to the ones produced by the PLOT and PRINT procedures, PROC TIMEPLOT output has these distinctive features:

- The vertical axis always represents the sequence of observations in the data set. Thus, if the observations are in order of date or time, then the vertical axis represents the passage of time.
- The horizontal axis represents the values of the variable that you are examining. Like PROC PLOT, PROC TIMEPLOT can overlay multiple plots on one set of axes so that each line of the plot can contain values for more than one variable.
- A plot produced by PROC TIMEPLOT can occupy more than one page.
- Each observation appears sequentially on a separate line of the plot; PROC TIMEPLOT does not hide observations as PROC PLOT sometimes does.
- The listing of the plotted values can include variables that do not appear in the plot.

The following output illustrates a simple report that you can produce with PROC TIMEPLOT. This report shows sales of refrigerators for two sales representatives during the first six weeks of the year. The statements that produce the output follow. A DATA step in "Example 1: Plotting a Single Variable" on page 2637 creates the data set Sales.

```
title 'The SAS System';
options source;

options linesize=64 pagesize=60 nodate
        pageno=1;

proc timeplot data=sales;
   plot icebox;
   id month week;
   title 'Weekly Sales of Refrigerators';
   title2 'for the';
   title3 'First Six Weeks of the Year';
run;
```

Output 71.1 Simple Report Created with PROC TIMEPLOT

```
                Weekly Sales of Refrigerators
                          for the
                First Six Weeks of the Year

Month     Week     Icebox    min                           max
                             2520.04                   3550.43
                             *-------------------------------*
    1        1    3450.94    |                            I  |
    1        1    2520.04    |I                              |
    1        2    3240.67    |                      I        |
    1        2    2675.42    |     I                         |
    1        3    3160.45    |                   I           |
    1        3    2805.35    |         I                     |
    1        4    3400.24    |                          I    |
    1        4    2870.61    |           I                   |
    2        1    3550.43    |                              I|
    2        1    2730.09    |      I                        |
    2        2    3385.74    |                          I    |
    2        2    2670.93    |     I                         |
                             *-------------------------------*
```

The following output is a more complicated report of the same data set that is used to create Output 71.389 on page 2623. The statements that create this report do the following:

- create one plot for the sale of refrigerators and one for the sale of stoves
- plot sales for both sales representatives on the same line
- identify points on the plots by the first letter of the sales representative's last name
- control the size of the horizontal axis
- control formats and labels

For an explanation of the program that produces this report, see "Example 5: Showing Multiple Observations on One Line of a Plot" on page 2648.

Output 71.2 *More Complex Report Created with PROC TIMEPLOT*

Weekly Appliance Sales for the First Quarter

Month	Week	Kreitz Icebox	LeGrange Icebox	min $2,520.04 — max $3,550.43
January	1	$3,450.94	$2,520.04	|L K |
January	2	$3,240.67	$2,675.42	| L K |
January	3	$3,160.45	$2,805.35	| L K |
January	4	$3,400.24	$2,870.61	| L K |
February	1	$3,550.43	$2,730.09	| L K|
February	2	$3,385.74	$2,670.93	| L K |

Weekly Appliance Sales for the First Quarter

Month	Week	Seller :Kreitz Stove	Seller :LeGrange Stove	min $184.24 — max $2,910.37
January	1	$1,312.61	$728.13	| L K |
January	2	$222.35	$184.24	|! |
January	3	$2,263.33	$267.35	| L K |
January	4	$1,787.45	$274.51	| L K |
February	1	$2,910.37	$397.98	| L K|
February	2	$819.69	$2,242.24	| K L |

Syntax: TIMEPLOT Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Requirement: At least one PLOT statement is required.

Tip: You can use the ATTRIB, FORMAT, LABEL, and WHERE statements with PROC TIMEPLOT.

PROC TIMEPLOT <*options*>;

BY <DESCENDING> *variable-1* <<DESCENDING> *variable-2* ...> <NOTSORTED>;

CLASS *variable(s)*;

ID *variable(s)*;

PLOT *plot-request(s)* </*options*>;

Statement	Task	Example
PROC TIMEPLOT	Request that the plots be produced	Ex. 4
BY	Produce a separate plot for each BY group	
CLASS	Group data according to the values of the class variables	Ex. 5
ID	Print in the listing the values of the variables that you identify	Ex. 1, Ex. 2, Ex. 3
PLOT	Specify the plots to produce	Ex. 1, Ex. 2, Ex. 3, Ex. 4, Ex. 5

PROC TIMEPLOT Statement

Requests that the plots be produced.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Example: "Example 4: Superimposing Two Plots" on page 2646

Syntax

PROC TIMEPLOT <*options*>;

Optional Arguments

DATA=*SAS-data-set*
identifies the input data set.

ENCRYPTKEY=*key-value*
specifies the key value needed for plotting an AES-encrypted data set. If the input data set was created with ENCRYPT=AES, then you must specify the ENCRYPTKEY= value to plot its data. For example, if a data set named secretPlot is created using the DATA statement.

```
data secretPlot(encrypt=AES encryptkey=Ib007)
```

Then, you must specify the following PROC statement to plot the data in secretPlot:

```
proc timeplot data=secretPlot(encryptkey=Ib007);
```

See "ENCRYPTKEY= Data Set Option" in *SAS Data Set Options: Reference* for more information about the ENCRYPTKEY= data set option.

MAXDEC=*number*
specifies the maximum number of decimal places to be printed in the listing.

Default 2

Range 0-12

Interaction A decimal specification in a format overrides a MAXDEC= specification.

Example "Example 4: Superimposing Two Plots" on page 2646

SPLIT='*split-character*'
specifies a split character, which controls line breaks in column headings. It also specifies that labels be used as column headings. PROC TIMEPLOT breaks a column heading when it reaches the split character and continues the heading on the next line. Unless the split character is a blank, it is not part of the column heading. Each occurrence of the split character counts toward the 256-character maximum for a label.

Alias S=

Default blank (' ')

Note Column headings can occupy up to three lines. If the column label can be split into more lines than this fixed number, then the split character is used only as a recommendation on how to split the label.

UNIFORM
uniformly scales the horizontal axis across all BY groups. By default, PROC TIMEPLOT separately determines the scale of the axis for each BY group.

Interaction UNIFORM also affects the calculation of means for reference lines. For more information, see "REF=*reference-value(s)* " on page 2634.

BY Statement

Produces a separate plot for each BY group.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

See: "BY" on page 74

Syntax

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2* ...>
<NOTSORTED>;

Required Argument

variable
specifies the variable that the procedure uses to form BY groups. You can specify more than one variable. Unless you use the NOTSORTED option in the BY statement, the data must either be sorted by variables or indexed. These variables are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the data set is sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The data is grouped in another way, such as chronological order.

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. In fact, the procedure does not use an index if you specify NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations that have the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

CLASS Statement

Groups data according to the values of the class variables.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Tip: PROC TIMEPLOT uses the formatted values of the CLASS variables to form classes. Thus, if a format groups the values, then the procedure uses those groups.

Example: "Example 5: Showing Multiple Observations on One Line of a Plot" on page 2648

Syntax

CLASS *variable(s)*;

Required Argument

variable(s)
specifies one or more variables that the procedure uses to group the data. Variables in a CLASS statement are called *class variables*. Class variables can be numeric or character. Class variables can have continuous values, but they

typically have a few discrete values that define the classifications of the variable. You do not have to sort the data by class variables.

The values of the class variables appear in the listing. PROC TIMEPLOT prints and plots one line each time the combination of values of the class variables changes. Therefore, the output typically is more meaningful if you sort or group the data according to values of the class variables.

Details

Using Multiple CLASS Statements

You can use any number of CLASS statements. If you use more than one CLASS statement, then PROC TIMEPLOT simply concatenates all variables from all of the CLASS statements. The following form of the CLASS statement includes three variables:

CLASS *variable-1 variable-2 variable-3*;

It has the same effect as this form:

CLASS *variable-1*;

CLASS *variable-2*;

CLASS *variable-3*;

Using a Symbol Variable

Normally, you use the CLASS statement with a symbol variable. In this case, the listing of the plot variable contains a column for each value of the symbol variable. Each row of the plot contains a point for each value of the symbol variable. The plotting symbol is the first character of the formatted value of the symbol variable. But, if more than one observation within a class has the same symbol value, then PROC TIMEPLOT plots and prints only the first occurrence of that symbol. SAS prints a warning in the log describing this behavior.

For more information about plotting symbols and the CLASS statement, see plot requests on page 2630.

ID Statement

Prints in the listing the values of the variables that you identify.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Examples: “Example 1: Plotting a Single Variable” on page 2637

“Example 2: Customizing an Axis and a Plotting Symbol” on page 2640

“Example 3: Using a Variable for a Plotting Symbol” on page 2643

Syntax

ID *variable(s)*;

Required Argument

variable(s)
identifies one or more *ID variables* to be printed in the listing.

PLOT Statement

Specifies the plots to produce.

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

Tip: Each PLOT statement produces a separate plot.

Examples:
"Example 1: Plotting a Single Variable" on page 2637
"Example 2: Customizing an Axis and a Plotting Symbol" on page 2640
"Example 3: Using a Variable for a Plotting Symbol" on page 2643
"Example 4: Superimposing Two Plots" on page 2646
"Example 5: Showing Multiple Observations on One Line of a Plot" on page 2648

Syntax

PLOT *plot-request(s)* </*options*>;

Summary of Optional Arguments

Control the appearance of the plot

HILOC
connects the leftmost plotting symbol to the rightmost plotting symbol with a line of hyphens (-).

JOINREF
connects the leftmost and rightmost symbols on each line of the plot with a line of hyphens (-) regardless of whether the symbols are reference symbols or plotting symbols.

NOSYMNAME
suppresses the name of the symbol variable in column headings when you use a CLASS statement.

NPP
suppresses the listing of the values of the variables that appear in the PLOT statement.

POS=*print-positions-for-plot*
specifies the number of print positions to use for the horizontal axis.

Create and customize a reference line

REF=*reference-value(s)*
draws lines on the plot that are perpendicular to the specified values on the horizontal axis.

REFCHAR=*'character'*
specifies the character for drawing reference lines.

Customize the axis

AXIS=*axis-specification*
specifies the range of values to plot on the horizontal axis, as well as the interval represented by each print position on the horizontal axis.

REVERSE
orders the values on the horizontal axis with the largest value in the leftmost position.

Display multiple plots on the same set of axes

OVERLAY
plots all requests in one PLOT statement on one set of axes.

OVPCHAR=*'character'*
specifies the character to be printed if multiple plotting symbols coincide.

Required Argument

plot-request(s)
specifies the variable or variables to plot. (Optional) Also specifies the plotting symbol to use. By default, each plot request produces a separate plot.

You can mix different forms of requests in one PLOT statement. For an example of mixing forms, see "Example 4: Superimposing Two Plots" on page 2646.

variable(s)
identifies one or more numeric variables to plot. PROC TIMEPLOT uses the first character of the variable name as the plotting symbol.

Example "Example 1: Plotting a Single Variable" on page 2637

(variable(s))='plotting-symbol'
identifies one or more numeric variables to plot and specifies the plotting symbol to use for all variables in the list. You can omit the parentheses if you use only one variable.

Example "Example 2: Customizing an Axis and a Plotting Symbol" on page 2640

(variable(s))=symbol-variable
identifies one or more numeric variables to plot and specifies a *symbol variable*. PROC TIMEPLOT uses the first nonblank character of the formatted value of the symbol variable as the plotting symbol for all variables in the list. The plotting symbol changes from one observation to the next if the

value of the symbol variable changes. You can omit the parentheses if you use only one variable.

Example "Example 3: Using a Variable for a Plotting Symbol" on page 2643

Optional Arguments

AXIS=*axis-specification*

specifies the range of values to plot on the horizontal axis, as well as the interval represented by each print position on the axis. PROC TIMEPLOT labels the first and last ends of the axis, if space permits.

For numeric values, *axis-specification* can be one of the following or a combination of both:

n< ...*n*>

n **TO** *n* <BY *increment*>

The values must be in either ascending or descending order. Use a negative value for *increment* to specify descending order. The specified values are spaced evenly along the horizontal axis even if the values are not uniformly distributed. Numeric values can be specified in the following ways:

Table 71.1 *Specifying AXIS= Values*

Specification	Comments
`axis=1 2 10`	Values are 1, 2, and 10.
`axis=10 to 100 by 5`	Values appear in increments of 5, starting at 10 and ending at 100.
`axis=12 10 to 100 by 5`	A combination of the two previous forms of specification.

For axis variables that contain datetime values, *axis-specification* is either an explicit list of values or a starting value and an ending value with an increment specified:

'*date-time-value*'*i* < ...'*date-time-value*'*i*>

'*date-time-value*'*i* **TO** '*date-time-value*'*i*
<BY *increment*>

'date-time-value'i

any SAS date, time, or datetime value described for the SAS functions INTCK and INTNX. The suffix *i* is one of the following:

D date

T time

DT datetime

increment
one of the valid arguments for the INTCK or INTNX functions. For dates, *increment* can be one of the following:

- DAY
- WEEK
- MONTH
- QTR
- YEAR

For datetimes, *increment* can be one of the following:

- DTDAY
- DTWEEK
- DTMONTH
- DTQTR
- DTYEAR

For times, *increment* can be one of the following:

- HOUR
- MINUTE
- SECOND

The following statement is an example of using the day increment:

```
axis='01JAN95'd to '01JAN96'd by month
axis='01JAN95'd to '01JAN96'd by qtr
```

For descriptions of individual intervals, see *SAS Language Reference: Concepts*.

Note: You must use a FORMAT statement to print the tick-mark values in an understandable form.

Interaction The value of POS= (see "POS=*print-positions-for-plot*" on page 2633) overrides an interval set with AXIS=.

Tip It is possible for your data to be out of range and fall outside the axis area of the plot. When this happens, PROC TIMEPLOT places angle brackets, (<) or (>), on the sides of the plot to indicate that there is data not being represented.

Example "Example 2: Customizing an Axis and a Plotting Symbol" on page 2640

HILOC
connects the leftmost plotting symbol to the rightmost plotting symbol with a line of hyphens (-).

Interaction If you specify JOINREF, then PROC TIMEPLOT ignores HILOC.

JOINREF
connects the leftmost and rightmost symbols on each line of the plot with a line of hyphens (-), regardless of whether the symbols are reference symbols or plotting symbols. However, if a line contains only reference symbols, then PROC TIMEPLOT does not connect the symbols.

Example "Example 3: Using a Variable for a Plotting Symbol" on page 2643

NOSYMNAME
suppresses the name of the symbol variable in column headings when you use a CLASS statement. If you use NOSYMNAME, then only the value of the symbol variable appears in the column heading.

Example "Example 5: Showing Multiple Observations on One Line of a Plot" on page 2648

NPP
suppresses the listing of the values of the variables that appear in the PLOT statement.

Example "Example 3: Using a Variable for a Plotting Symbol" on page 2643

OVERLAY
plots all requests in one PLOT statement on one set of axes. Otherwise, PROC TIMEPLOT produces a separate plot for each plot request.

Example "Example 4: Superimposing Two Plots" on page 2646

OVPCHAR='*character*'
specifies the character to be printed if multiple plotting symbols coincide. If a plotting symbol and a character in a reference line coincide, then PROC TIMEPLOT prints the plotting symbol.

Default at sign (@)

Example "Example 5: Showing Multiple Observations on One Line of a Plot" on page 2648

POS=*print-positions-for-plot*
specifies the number of print positions to use for the horizontal axis.

Default If you omit both POS= and AXIS=, then PROC TIMEPLOT initially assumes that POS=20. However, if space permits, then this value increases so that the plot fills the available space.

Interaction If you specify POS=0 and AXIS=, then the plot fills the available space. POS= overrides an interval set with AXIS= . See the discussion of "AXIS=*axis-specification*" on page 2631.

See "Page Layout" on page 2635

Example "Example 1: Plotting a Single Variable" on page 2637

REF=*reference-value(s)*
draws lines on the plot that are perpendicular to the specified values on the horizontal axis. The values for *reference-value(s)* can be constants, or you can use the form

MEAN(*variable(s)*)

If you use this form of REF=, then PROC TIMEPLOT evaluates the mean for each variable that you list and draws a reference line for each mean.

Interactions If you use the UNIFORM option in the PROC TIMEPLOT statement, then the procedure calculates the mean values for the variables over all observations for all BY groups. If you do not use UNIFORM, then the procedure calculates the mean for each variable for each BY group.

If a plotting symbol and a reference character coincide, then PROC TIMEPLOT prints the plotting symbol.

Examples "Example 3: Using a Variable for a Plotting Symbol" on page 2643

"Example 4: Superimposing Two Plots" on page 2646

REFCHAR=*'character'*
specifies the character for drawing reference lines.

Default vertical bar (|)

Interaction If you are using the JOINREF or HILOC option, then do not specify a value for REFCHAR= that is the same as a plotting symbol. If you do this, then PROC TIMEPLOT will interpret the plotting symbols as reference characters and will not connect the symbols as you expect.

Example "Example 3: Using a Variable for a Plotting Symbol" on page 2643

REVERSE
orders the values on the horizontal axis with the largest value in the leftmost position.

Example "Example 4: Superimposing Two Plots" on page 2646

Results: TIMEPLOT Procedure

Data Considerations

The input data set usually contains a date variable to use as either a class or ID variable. Although PROC TIMEPLOT does not require an input data set sorted by date, the output is usually more meaningful if the observations are in chronological order. In addition, if you use a CLASS statement, then the output is more meaningful if the input data set groups observations according to combinations of class variable values. For more information, see "CLASS Statement" on page 2627.

Procedure Output

Page Layout

For each plot request, PROC TIMEPLOT prints a listing and a plot. PROC TIMEPLOT determines the arrangement of the page as follows:

- If you use POS=, then the procedure does the following:
  - determines the size of the plot from the POS= value
  - determines the space for the listing from the width of the columns of printed values, equally spaced and with a maximum of five positions between columns
  - centers the output on the page
- If you omit POS=, then the procedure does the following:
  - determines the width of the plot from the value of the AXIS= option
  - expands the listing to fill the rest of the page

If there is not enough space to print the listing and the plot, then PROC TIMEPLOT produces no output and writes the following error message to the SAS log:

```
ERROR:  Too many variables/symbol values
        to print.
```

The error does not affect other plot requests.

Contents of the Listing

The listing in the output contains different information depending on whether you use a CLASS statement. If you do not use a CLASS statement, then PROC TIMEPLOT prints (and plots) each observation on a separate line. For an example of the output without the CLASS statement, see "Example 1: Plotting a Single Variable" on page 2637.

If you do use a CLASS statement, then the form of the output varies depending on whether you specify a symbol variable. For more information about using a symbol variable with the CLASS statement, see "Using a Symbol Variable" on page 2628.

ODS Table Names

The TIMEPLOT procedure assigns a name to each table that it creates. You can use these names to reference the table when using the Output Delivery System (ODS) to select tables and create output data sets. For more information, see *SAS Output Delivery System: User's Guide*.

Table 71.2 *ODS Tables Produced by the TIMEPLOT Procedure*

Table Name	Description	Conditions When Table Is Generated
Plot	A single plot	If you do not specify the OVERLAY option
OverlaidPlot	Two or more plots on a single set of axes	If you specify the OVERLAY option

Missing Values

Four types of variables can appear in the listing from PROC TIMEPLOT:

- plot variables
- ID variables
- class variables
- symbol variables (as part of some column headings)

Plot variables and symbol variables can also appear in the plot.

Observations with missing values of a class variable form a class of observations.

In the listing, missing values appear as a period (.), a blank, or a special missing value (the letters A through Z and the underscore (_) character).

In the plot, PROC TIMEPLOT handles different variables in different ways:

- An observation or class of observations with a missing value does not appear in the plot.
- If you use a symbol variable, then PROC TIMEPLOT uses a period (.) as the symbol variable on the plot for all observations that have a missing value for the symbol variable. For more information about using symbol variables, see plot requests on page 2630.

Examples: TIMEPLOT Procedure

Example 1: Plotting a Single Variable

Features:

PROC TIMEPLOT statement options
DATA=

ID statement

PLOT statement

PLOT statement option
POS=

DATA step

Details

This example demonstrates the following tasks:

- uses a DATA step to create the data set Sales
- uses a single PLOT statement to plot sales of refrigerators
- specifies the number of print positions to use for the horizontal axis of the plot
- provides context for the points in the plot by printing in the listing the values of two variables that are not in the plot

Program

```
options formchar="|----|+|---+=|-/\<>*";

data sales;
   input Month Week Seller $ Icebox Stove;
   datalines;
1 1 Kreitz   3450.94 1312.61
1 1 LeGrange 2520.04  728.13
1 2 Kreitz   3240.67  222.35
1 2 LeGrange 2675.42  184.24
1 3 Kreitz   3160.45 2263.33
1 3 LeGrange 2805.35  267.35
1 4 Kreitz   3400.24 1787.45
1 4 LeGrange 2870.61  274.51
2 1 Kreitz   3550.43 2910.37
2 1 LeGrange 2730.09  397.98
2 2 Kreitz   3385.74  819.69
2 2 LeGrange 2670.93 2242.24
;

proc timeplot data=sales;
   plot icebox / pos=50;

   id month week;

   title 'Weekly Sales of Iceboxes';
   title2 'for the';
   title3 'First Six Weeks of the Year';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create the Sales data set. Sales contains weekly information about the sales of refrigerators and stoves by two sales representatives.

```
data sales;
   input Month Week Seller $ Icebox Stove;
   datalines;
1 1 Kreitz   3450.94 1312.61
1 1 LeGrange 2520.04  728.13
1 2 Kreitz   3240.67  222.35
1 2 LeGrange 2675.42  184.24
1 3 Kreitz   3160.45 2263.33
1 3 LeGrange 2805.35  267.35
1 4 Kreitz   3400.24 1787.45
1 4 LeGrange 2870.61  274.51
2 1 Kreitz   3550.43 2910.37
2 1 LeGrange 2730.09  397.98
2 2 Kreitz   3385.74  819.69
```

```
2 2 LeGrange 2670.93 2242.24
;
```

Plot sales of refrigerators. The plot variable, Icebox, appears in both the listing and the output. POS= provides 50 print positions for the horizontal axis.

```
proc timeplot data=sales;
   plot icebox / pos=50;
```

Label the rows in the plot listing. The values of the ID variables, Month and Week, are used to uniquely identify each row of the listing section of the plot.

```
   id month week;
```

Specify the titles.

```
   title 'Weekly Sales of Iceboxes';
   title2 'for the';
   title3 'First Six Weeks of the Year';
run;
```

Output

The column headings in the listing are the variables' names. The plot uses the default plotting symbol, which is the first character of the plot variable's name.

Output 71.3 *Plot for a Single Variable*

Weekly Sales of Refrigerators
for the
First Six Weeks of the Year

Month	Week	Icebox	min 2520.04 … max 3550.43
1	1	3450.94	I
1	1	2520.04	I
1	2	3240.67	I
1	2	2675.42	I
1	3	3160.45	I
1	3	2805.35	I
1	4	3400.24	I
1	4	2870.61	I
2	1	3550.43	I
2	1	2730.09	I
2	2	3385.74	I
2	2	2670.93	I

Example 2: Customizing an Axis and a Plotting Symbol

Features:
- PROC PLOT statement option AXIS=
- ID statement
- PLOT statement
- LABEL statement
- PROC FORMAT
- LIBNAME statement
- FMTSEARCH= system option

Data set: Sales

Details

This example demonstrates the following tasks:

- specifies the character to use as the plotting symbol
- specifies the minimum and maximum values for the horizontal axis as well as the interval represented by each print position
- provides context for the points in the plot by printing in the listing the values of two variables that are not in the plot
- uses a variable's label as a column heading in the listing
- creates and uses a permanent format

Program

```
libname proclib  'SAS-library';

options formchar="|----|+|---+=|-/\<>*";

proc format library=proclib;
   value monthfmt 1='January'
                  2='February';
run;

proc timeplot data=sales;
   plot icebox='R' / axis=2500 to 3600 by 25;

   id month week;

   label icebox='Refrigerator';

   format month monthfmt.;

title 'Weekly Refrigerator Sales';
title2 'for the First Six Weeks of the Year';
run;
```

Program Description

Declare the PROCLIB SAS library.

```
libname proclib  'SAS-library';
```

Set the SAS system options. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Create a format for the Month variable. PROC FORMAT creates a permanent format for Month. The LIBRARY= option specifies a permanent storage location so

that the formats are available in subsequent SAS sessions. This format is used for examples throughout this chapter.

```
proc format library=proclib;
   value monthfmt 1='January'
                  2='February';
run;
```

Plot sales of refrigerators. The plot variable, Icebox, appears in both the listing and the output. The plotting symbol is 'R'. AXIS= sets the minimum value of the axis to 2500 and the maximum value to 3600. BY 25 specifies that each print position on the axis represents 25 units (in this case, dollars).

```
proc timeplot data=sales;
   plot icebox='R' / axis=2500 to 3600 by 25;
```

Label the rows in the listing. The values of the ID variables, Month and Week, are used to uniquely identify each row of the listing.

```
   id month week;
```

Apply a label to the sales column in the listing. The LABEL statement associates a label with the variable Icebox for the duration of the PROC TIMEPLOT step. PROC TIMEPLOT uses the label as the column heading in the listing.

```
   label icebox='Refrigerator';
```

Apply the MONTHFMT. format to the Month variable. The FORMAT statement assigns a format to use for Month in the report.

```
   format month monthfmt.;
```

Specify the titles.

```
title 'Weekly Refrigerator Sales';
title2 'for the First Six Weeks of the Year';
run;
```

Output

There are three column headings in the listing: the variables Month and Week, which have no labels, and the label Refrigerator, which is the label for the variable Icebox. The plotting symbol is `R`, which represents the variable label Refrigerator).

Output 71.4 *Plot with Customized Axis and Plotting Symbol*

Refrigerator Sales
for the First Six Weeks of the Year

Month	Week	Refrigerator	min 2500 ... max 3600
January	1	3450.94	R
January	1	2520.04	R
January	2	3240.67	R
January	2	2675.42	R
January	3	3160.45	R
January	3	2805.35	R
January	4	3400.24	R
January	4	2870.61	R
February	1	3550.43	R
February	1	2730.09	R
February	2	3385.74	R
February	2	2670.93	R

Example 3: Using a Variable for a Plotting Symbol

Features: ID statement
PLOT statement
PLOT statement options
JOINREF
NPP
REF=
REFCHAR=

Data set: Sales

Format: MONTHFMT.

Details

This example demonstrates the following:

- specifies a variable to use as the plotting symbol to distinguish between points for each of two sales representatives
- suppresses the printing of the values of the plot variable in the listing
- draws a reference line to a specified value on the axis and specifies the character to use to draw the line
- connects the leftmost and rightmost symbols on each line of the plot

Program

```
libname proclib
'SAS-library';

options formchar="|----|+|---+=|-/\<>*" fmtsearch=(proclib);

proc timeplot data=sales;
   plot stove=seller /

                      npp

                      ref=1500 refchar=':'

                      joinref

                      axis=100 to 3000 by 50;

   id month week;

   format month monthfmt.;

   title 'Weekly Sales of Stoves';
   title2 'Compared to Target Sales of $1500';
   title3 'K for Kreitz; L for LeGrange';
run;
```

Program Description

Declare the PROCLIB SAS library.

```
libname proclib
'SAS-library';
```

Set the SAS system options. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available. FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options formchar="|----|+|---+=|-/\<>*" fmtsearch=(proclib);
```

Plot sales of stoves. The PLOT statement specifies both the plotting variable, Stove, and a symbol variable, Seller. The plotting symbol is the first letter of the formatted value of the Seller (in this case, **L** or **K**).

```
proc timeplot data=sales;
   plot stove=seller /
```

Suppress the appearance of the plotting variable in the listing. The values of the Stove variable will not appear in the listing.

```
                      npp
```

Create a reference line on the plot. REF= and REFCHAR= draw a line of colons at the sales target of $1500.

```
                      ref=1500 refchar=':'
```

Draw a line between the symbols on each line of the plot. In this plot, JOINREF connects each plotting symbol to the reference line.

```
joinref
```

Customize the horizontal axis. AXIS= sets the minimum value of the horizontal axis to 100 and the maximum value to 3000. BY 50 specifies that each print position on the axis represents 50 units (in this case, dollars).

```
axis=100 to 3000 by 50;
```

Label the rows in the listing. The values of the ID variables, Month and Week, are used to identify each row of the listing.

```
id month week;
```

Apply the MONTHFMT. format to the Month variable. The FORMAT statement assigns a format to use for Month in the report.

```
format month monthfmt.;
```

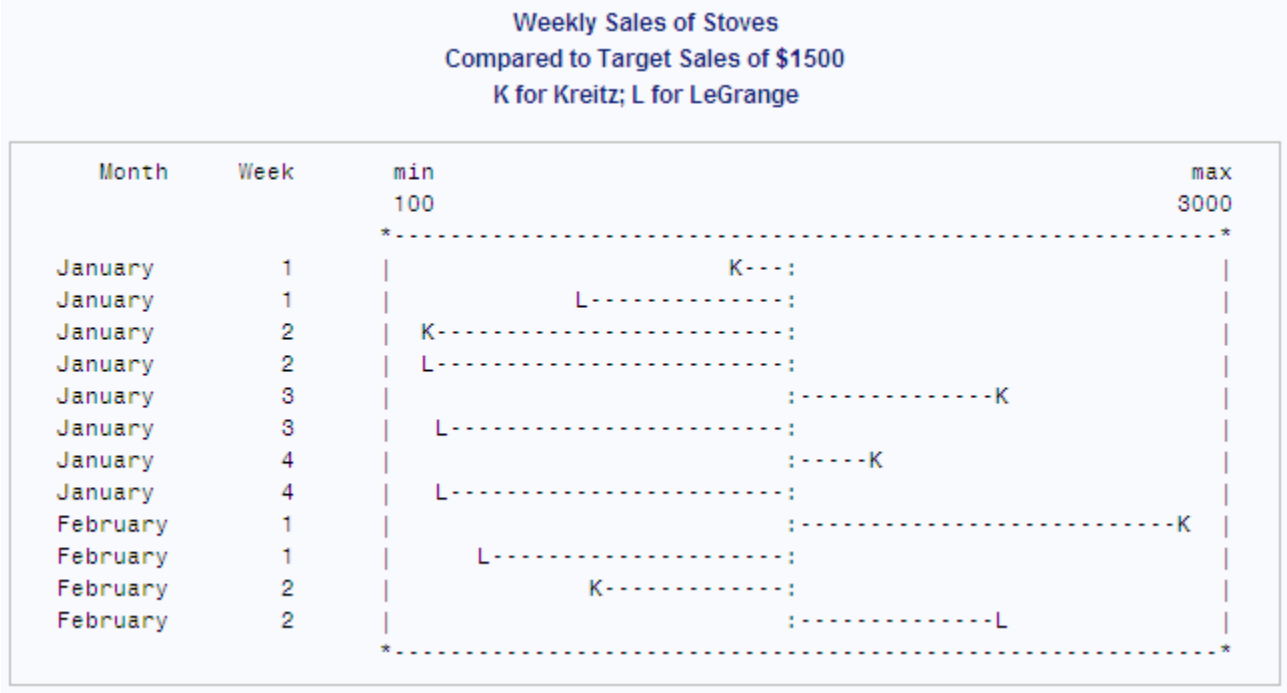
Specify the titles.

```
title 'Weekly Sales of Stoves';
title2 'Compared to Target Sales of $1500';
title3 'K for Kreitz; L for LeGrange';
run;
```

Output

The plot uses the first letter of the value of Seller as the plotting symbol.

Output 71.5 *Plot with Variable for Plotting Symbol*



Example 4: Superimposing Two Plots

Features:
PROC TIMEPLOT statement option
MAXDEC=
PLOT statement
PLOT statement options
OVERLAY
REF=MEAN(*variable(s)*)
REVERSE

Data set: Sales

Details

This example demonstrates the following:

- superimposes two plots on one set of axes
- specifies a variable to use as the plotting symbol for one plot and a character to use as the plotting symbol for the other plot
- draws a reference line to the mean value of each of the two variables plotted
- reverses the labeling of the axis so that the largest value is at the far left of the plot

Program

```
options formchar="|----|+|---+=|-/\<>*";
proc timeplot data=sales maxdec=0;
   plot stove=seller icebox='R' /
          overlay
            ref=mean(stove icebox)

reverse;
   label icebox='Refrigerators';
   title 'Weekly Sales of Stoves and Refrigerators';
   title2 'for the';
   title3 'First Six Weeks of the Year';
run;
```

Program Description

Set the FORMCHAR option. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available.

```
options formchar="|----|+|---+=|-/\<>*";
```

Specify the number of decimal places to display. MAXDEC= specifies the number of decimal places to display in the listing.

```
proc timeplot data=sales maxdec=0;
```

Plot sales of both stoves and refrigerators. The PLOT statement requests two plots. One plot uses the first letter of the formatted value of Seller to plot the values of Stove. The other uses the letter **R** (to match the label Refrigerators) to plot the value of Icebox.

```
    plot stove=seller icebox='R' /
```

Print both plots on the same set of axes.

```
          overlay
```

Create two reference lines on the plot. REF= draws two reference lines: one perpendicular to the mean of Stove, the other perpendicular to the mean of Icebox.

```
            ref=mean(stove icebox)
```

Order the values on the horizontal axis from largest to smallest.

```
reverse;
```

Apply a label to the sales column in the listing. The LABEL statement associates a label with the variable Icebox for the duration of the PROC TIMEPLOT step. PROC TIMEPLOT uses the label as the column heading in the listing.

```
    label icebox='Refrigerators';
```

Specify the titles.

```
    title 'Weekly Sales of Stoves and Refrigerators';
    title2 'for the';
    title3 'First Six Weeks of the Year';
run;
```

Output

The column heading for the variable Icebox in the listing is the variable's label (Refrigerators). One plot uses the first letter of the value of Seller as the plotting symbol. The other plot uses the letter `R`.

Output 71.6 Two Plots Superimposed Using Different Plotting Symbols

Weekly Sales of Stoves and Refrigerators
for the
First Six Weeks of the Year

```
Stove     Refrigerators      max                                           min
                             3550.43                                    184.24
                            *-------------------------------------------------*
 1313              3451     |R     |                        K   |             |
  728              2520     |      |       R                    |    L        |
  222              3241     |   R  |                            |           K |
  184              2675     |      |    R                       |            L|
 2263              3160     |     R|          K                 |             |
  267              2805     |      |   R                        |           L |
 1787              3400     | R    |                  K         |             |
  275              2871     |      |  R                         |           L |
 2910              3550     |R     | K                          |             |
  398              2730     |      |    R                       |         L   |
  820              3386     | R    |                            |   K         |
 2242              2671     |      |     R     L                |             |
                            *-------------------------------------------------*
```

Example 5: Showing Multiple Observations on One Line of a Plot

Features: CLASS statement
PLOT statement
PLOT statement options
NOSYMNAME
OVPCHAR=
POS=

Data set: Sales

Format: MONTHFMT.

Details

This example demonstrates the following tasks:

- groups observations for the same month and week so that sales for the two sales representatives appear on the same line of the plot
- specifies a variable to use as the plotting symbol

- suppresses the name of the plotting variable in one plot
- specifies a size for the plots so that they both occupy the same amount of space

Program

```
libname proclib
'SAS-library';

options formchar="|----|+|---+=|-/\<>*" fmtsearch=(proclib);

proc timeplot data=sales;
   class month week;

   plot stove=seller  / pos=25 ovpchar='!';
   plot icebox=seller / pos=25 ovpchar='!' nosymname;

   format stove icebox dollar10.2 month monthfmt.;

   title 'Weekly Appliance Sales for the First Quarter';
run;
```

Program Description

Declare the PROCLIB SAS library.

```
libname proclib
'SAS-library';
```

Set the SAS system options. Setting FORMCHAR to this exact string renders better HTML output when it is viewed outside of the SAS environment where SAS Monospace fonts are not available. FMTSEARCH= adds the SAS library PROCLIB to the search path that is used to locate formats.

```
options formchar="|----|+|---+=|-/\<>*" fmtsearch=(proclib);
```

Specify subgroups for the analysis. The CLASS statement groups all observations with the same values of Month and Week into one line in the output. Using the CLASS statement with a symbol variable produces in the listing one column of the plot variable for each value of the symbol variable.

```
proc timeplot data=sales;
   class month week;
```

Plot sales of stoves and refrigerators. Each PLOT statement produces a separate plot. The plotting symbol is the first character of the formatted value of the symbol variable: `K` for Kreitz; `L` for LeGrange. POS= specifies that each plot uses 25 print positions for the horizontal axis. OVPCHAR= designates the exclamation point as the plotting symbol when the plotting symbols coincide. NOSYMNAME suppresses the name of the symbol variable Seller from the second listing.

```
   plot stove=seller  / pos=25 ovpchar='!';
   plot icebox=seller / pos=25 ovpchar='!' nosymname;
```

Apply formats to values in the listing. The FORMAT statement assigns formats to use for Stove, Icebox, and Month in the report. The TITLE statement specifies a title.

```
format stove icebox dollar10.2 month monthfmt.;
```

Specify the title.

```
title 'Weekly Appliance Sales for the First Quarter';
run;
```

Output

Output 71.7 *Weekly Icebox Sales by Seller*

Weekly Appliance Sales for the First Quarter

Month	Week	Kreitz Icebox	LeGrange Icebox	min $2,520.04 … max $3,550.43
January	1	$3,450.94	$2,520.04	L … K
January	2	$3,240.67	$2,675.42	L … K
January	3	$3,160.45	$2,805.35	L … K
January	4	$3,400.24	$2,870.61	L … K
February	1	$3,550.43	$2,730.09	L … K
February	2	$3,385.74	$2,670.93	L … K

Output 71.8 *Weekly Stove Sales by Seller*

Weekly Appliance Sales for the First Quarter

Month	Week	Seller :Kreitz Stove	Seller :LeGrange Stove	min $184.24 … max $2,910.37
January	1	$1,312.61	$728.13	L K
January	2	$222.35	$184.24	!
January	3	$2,263.33	$267.35	L … K
January	4	$1,787.45	$274.51	L … K
February	1	$2,910.37	$397.98	L … K
February	2	$819.69	$2,242.24	K … L

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TRANSPOSE Procedure

Overview: TRANSPOSE Procedure

What Does the TRANSPOSE Procedure Do?

The TRANSPOSE procedure creates an output data set by restructuring the values in a SAS data set, transposing selected variables into observations. The TRANSPOSE procedure can often eliminate the need to write a lengthy DATA step to achieve the same result. Further, the output data set can be used in subsequent DATA or PROC steps for analysis, reporting, or further data manipulation.

PROC TRANSPOSE does not produce printed output. To print the output data set from the PROC TRANSPOSE step, use PROC PRINT, PROC REPORT, or another SAS reporting tool.

To create a transposed variable, the procedure transposes the values of an observation in the input data set into values of a variable in the output data set.

What Types of Transpositions Can PROC TRANSPOSE Perform?

Simple Transposition

The following example illustrates a simple transposition. In the input data set, each variable represents the scores from one tester. In the output data set, each observation now represents the scores from one tester. Each value of _NAME_ is the name of a variable in the input data set that the procedure transposed. Thus, the value of _NAME_ identifies the source of each observation in the output data set. For example, the values in the first observation in the output data set come from the values of the variable Tester1 in the input data set. The statements that produce the output follow.

```
proc print data=proclib.product noobs;
   title 'The Input Data Set';
run;

proc transpose data=proclib.product
               out=proclib.product_transposed;
```

```
run;

proc print data=proclib.product_transposed noobs;
   title 'The Output Data Set';
run;
```

Output 72.1 *A Simple Transposition*

The Input Data Set 1

Tester1	Tester2	Tester3	Tester4
22	25	21	21
15	19	18	17
17	19	19	19
20	19	16	19
14	15	13	13
15	17	18	19
10	11	9	10
22	24	23	21

The Output Data Set 2

NAME	COL1	COL2	COL3	COL4	COL5	COL6	COL7	COL8
Tester1	22	15	17	20	14	15	10	22
Tester2	25	19	19	19	15	17	11	24
Tester3	21	18	19	16	13	18	9	23
Tester4	21	17	19	19	13	19	10	21

Complex Transposition Using BY Groups

The next example, which uses BY groups, is more complex. The input data set represents measurements of the weight and length of fish at two lakes. The statements that create the output data set do the following:

- transpose only the variables that contain the length measurements
- create six BY groups, one for each lake and date
- use a data set option to name the transposed variable

Output 72.2 *A Transposition with BY Groups*

Input Data Set 1

Location	Date	Length1	Width1	Length2	Width2	Length3	Width3	Length4	Width4
Cole Pond	02JUN95	31	0.25	32	0.30	32	0.25	33	0.30
Cole Pond	03JUL95	33	0.32	34	0.41	37	0.48	32	0.28
Cole Pond	04AUG95	29	0.23	30	0.25	34	0.47	32	0.30
Eagle Lake	02JUN95	32	0.35	32	0.25	33	0.30	.	.
Eagle Lake	03JUL95	30	0.20	36	0.45	.	.	.	.
Eagle Lake	04AUG95	33	0.30	33	0.28	34	0.42	.	

.

Fish Length Data for Each Location and Date 2

Location	Date	_NAME_	Measurement
Cole Pond	02JUN95	Length1	31
Cole Pond	02JUN95	Length2	32
Cole Pond	02JUN95	Length3	32
Cole Pond	02JUN95	Length4	33
Cole Pond	03JUL95	Length1	33
Cole Pond	03JUL95	Length2	34
Cole Pond	03JUL95	Length3	37
Cole Pond	03JUL95	Length4	32
Cole Pond	04AUG95	Length1	29
Cole Pond	04AUG95	Length2	30
Cole Pond	04AUG95	Length3	34
Cole Pond	04AUG95	Length4	32
Eagle Lake	02JUN95	Length1	32
Eagle Lake	02JUN95	Length2	32
Eagle Lake	02JUN95	Length3	33
Eagle Lake	02JUN95	Length4	.
Eagle Lake	03JUL95	Length1	30
Eagle Lake	03JUL95	Length2	36
Eagle Lake	03JUL95	Length3	.
Eagle Lake	03JUL95	Length4	.
Eagle Lake	04AUG95	Length1	33
Eagle Lake	04AUG95	Length2	33
Eagle Lake	04AUG95	Length3	34
Eagle Lake	04AUG95	Length4	.

For a complete explanation of the SAS program that produces these results, see "Example 4: Transposing BY Groups" on page 2673.

In-Database Processing for PROC TRANSPOSE

In-database processing has several advantages over processing within SAS. These advantages include increased security, reduced network traffic, and the potential for faster processing. Increased security is possible because sensitive data does not have to be extracted from the data source. Faster processing is possible because data is manipulated locally, on the data source, using high-speed secondary storage devices instead of being transported across a relatively slow network connection. The data source is used because it might have more processing resources at its disposal, and it might be capable of optimizing a query for execution in a highly parallel and scalable fashion.

Note: In-database processing of PROC TRANSPOSE is not supported in SAS Viya.

When the DATA= input table is stored as a table or view in a database, PROC TRANSPOSE can use in-database processing to perform most of its work within the database. In-database processing can provide the advantages of faster processing and reduced data transfer between the database and SAS software.

In-database processing for PROC TRANSPOSE supports the following data providers:

- Hadoop
- Teradata

Note: A valid license for SAS Code Accelerator for Hadoop or SAS Code Accelerator for Teradata is required.

The TRANSPOSE procedure performs a dynamic transformation of the data in which the characteristics of the output table, specifically the number and names of the variables, as well as their types, are determined from the variable values, as well as the characteristics of the input table. This dynamic behavior is achieved by a two-pass process in which rows of the input table are examined to determine the characteristics of the output table, during the first pass, and in which the work of transposing the data is performed during the second pass. Parallel operation within the massively parallel processing (MPP) database speeds up both the first and second pass. The MPP performs a set of coordinated computations in parallel with the use of a large number of processors or separate computers. In the first pass, rows are examined in parallel and in place, according to the manner in which they are already partitioned across the nodes of a cluster. In the second pass, rows are repartitioned to form BY groups that are then processed independently and in parallel.

Both the first and second passes of the in-database processing are performed by executing a DS2 program within the SAS Embedded Process that resides within the nodes of the cluster. The DBMS provides the SAS Embedded Process with the ability to read data from and write data to tables. The SAS Embedded Process provides an execution context for the DS2 program. Because the two passes of

work are expressed in the DS2 language, columns of the tables are cast to variables that have DS2 data types. Data type support within DS2 is more extensive than that provided by the traditional SAS system so, when executing inside the database, the ability of the TRANSPOSE procedure to preserve data types and value of input data within the transposed output data is enhanced.

The SQLGENERATION system option or LIBNAME statement option controls whether and how in-database procedures are run inside the database. PROC TRANSPOSE runs inside the database when you specify INDB=YES. There are many programming considerations that can prevent in-database processing. For a complete listing, see "Procedure Considerations and Limitations" in *SAS In-Database Products: User's Guide*.

CAS Processing for PROC TRANSPOSE

If your input originates from SAS Cloud Analytic Services (CAS) and your output is directed back to the CAS server, then the transposition might be performed entirely on the server. Running PROC TRANSPOSE with CAS actions has several advantages over processing within SAS. These advantages include reduced network traffic, and the potential for faster processing. Faster processing is possible because in-memory tables are manipulated locally on the server instead of being transferred across a relatively slow network connection. CAS is used because it might have more processing resources at its disposal.

See the "Transpose Action Set" in *SAS Viya: System Programming Guide* for information about the Transpose action that runs in CAS.

When the DATA= input data set references an in-memory table or view in CAS, the TRANSPOSE procedure can use CAS actions to perform all of its work within the server.

The CAS LIBNAME statement option controls whether and how CAS procedures are run inside CAS. By default, the CAS procedures are run inside CAS when possible. There are many data set options that prevent CAS processing.

CAS is the analytic server and associated cloud services in SAS Viya. The CAS LIBNAME engine can connect a SAS 9.4 session to an existing SAS Cloud Analytic Services session through the CAS session name or the CAS session UUID. The libref then becomes your handle to communicate from SAS with the specific session. See The Future of Transpose for more information about PROC TRANSPOSE and examples.

For conceptual information about procedures that run in CAS, see Chapter 5, "CAS Processing of Base Procedures," on page 93.

Syntax: TRANSPOSE Procedure

Restriction: If the DATA= and OUT= options point to CAS, the transpose is performed within CAS by invoking the CAS TRANSPOSE action.

Tips: Does not support the Output Delivery System

For in-database processing to occur, your data must reside within a supported version of a DBMS that has been properly configured for SAS in-database processing. For more information, see "In-Database Processing for PROC TRANSPOSE " on page 2655.

You can use the ATTRIB, FORMAT, LABEL, and WHERE statements. For more information, see "Statements with the Same Function in Multiple Procedures" on page 73. You can also use any global statement. For a list, see "Dictionary of SAS Global Statements" in *SAS Global Statements: Reference*.

PROC TRANSPOSE <DATA=*input-data-set*> <DELIMITER=*delimiter*>
<LABEL=*label*>
<LET> <NAME=*name*> <OUT=*output-data-set*> <PREFIX=*prefix*>
<SUFFIX=*suffix*>;

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-2 ...*>
<NOTSORTED>;

COPY *variable(s)*;

ID *variable*;

IDLABEL *variable*;

VAR *variable(s)*;

Statement	Task	Example
PROC TRANSPOSE	Create an output data set by restructuring the values in a SAS data set, transposing selected variables into observations	Ex. 1, Ex. 2, Ex. 3, Ex. 5
BY	Transpose each BY group	Ex. 4
COPY	Copy variables directly without transposing them	Ex. 6
ID	Specify a variable whose values name the transposed variables	Ex. 2
IDLABEL	Create labels for the transposed variables	Ex. 3
VAR	List the variables to transpose	Ex. 4, Ex. 6

PROC TRANSPOSE Statement

Creates an output data set by restructuring the values in a SAS data set, transposing selected variables into observations.

Tip: You can use data set options with the DATA= and OUT= options. For more information, see Chapter 3, "Statements with the Same Function in Multiple Procedures," on page 73. You can also use any global statement. For a list, see "Dictionary of SAS Global Statements" in *SAS Global Statements: Reference*.

Examples:
"Example 1: Performing a Simple Transposition" on page 2668
"Example 2: Naming Transposed Variables" on page 2669
"Example 3: Labeling Transposed Variables" on page 2671
"Example 4: Transposing BY Groups" on page 2673
"Example 5: Naming Transposed Variables When the ID Variable Has Duplicate Values" on page 2676
"Example 6: Transposing Data for Statistical Analysis" on page 2678

Syntax

PROC TRANSPOSE <DATA=*input-data-set*> <DELIMITER=*delimiter*> <INDB=YES|NO><LABEL=*label*> <LET> <NAME=*name*> <OUT=*output-data-set*> <PREFIX=*prefix*> <SUFFIX=*suffix*>;

Optional Arguments

DATA= *input-data-set*
names the SAS data set to transpose.

Default most recently created SAS data set

DELIMITER= *delimiter*
specifies a delimiter to use in constructing names for transposed variables in the output data set. If specified, the delimiter is inserted between variable values if more than one variable has been specified in the ID statement.

Alias DELIM=

Tip You can use name literals (n-literals) for the value of DELIMITER. Name literals are helpful when specifying typographical or foreign characters, especially when VALIDVARNAME=ANY.

See "ID Statement" on page 2662

INDB=YES | NO
specifies if in-database processing is active.

YES
specifies that INDB is active.

Default YES

NO
specifies that INDB is not active.

LABEL= *label*
specifies a name for the variable in the output data set that contains the label of the variable that is being transposed to create the current observation.

Default _LABEL_

Tip You can use name literals (n-literals) for the value of LABEL. Name literals are helpful when specifying typographical or foreign characters, especially when VALIDVARNAME=ANY.

LET
allows duplicate values of an ID variable. PROC TRANSPOSE transposes the observation that contains the last occurrence of a particular ID value within the data set or BY group.

See "Example 5: Naming Transposed Variables When the ID Variable Has Duplicate Values" on page 2676

NAME= *name*
specifies the name for the variable in the output data set that contains the name of the variable that is being transposed to create the current observation.

Default _NAME_

See "Example 2: Naming Transposed Variables" on page 2669

OUT= *output-data-set*
names the output data set. If *output-data-set* does not exist, then PROC TRANSPOSE creates it by using the DATA*n* naming convention.

Default DATA*n*

See "Example 1: Performing a Simple Transposition" on page 2668

PREFIX= *prefix*
specifies a prefix to use in constructing names for transposed variables in the output data set. For example, if PREFIX=VAR, then the names of the variables are VAR1, VAR2, ...,VAR*n*.

Interaction When you use PREFIX= with an ID statement, the variable name begins with the prefix value followed by the ID value.

Tip You can use name literals (n-literals) for the value of PREFIX. Name literals are helpful when specifying typographical or foreign characters, especially when VALIDVARNAME=ANY.

See "Example 2: Naming Transposed Variables" on page 2669

SUFFIX= ***suffix***
specifies a suffix to use in constructing names for transposed variables in the output data set.

Interaction When you use SUFFIX= with an ID statement, the value is appended to the ID value.

Tip You can use name literals (n-literals) for the value of SUFFIX. Name literals are helpful when specifying typographical or foreign characters, especially when VALIDVARNAME=ANY.

BY Statement

Defines BY groups.

Restriction: Do not use PROC TRANSPOSE with a BY statement or an ID statement if another user is updating the data set at the same time.

Example: "Example 4: Transposing BY Groups" on page 2673

Syntax

BY <DESCENDING> *variable-1*
<<DESCENDING> *variable-1* ...>
<NOTSORTED>;

Required Argument

variable
specifies the variable that PROC TRANSPOSE uses to form BY groups. You can specify more than one variable. If you do not use the NOTSORTED option in the BY statement, then either the observations must be sorted by all the variables that you specify, or they must be indexed appropriately. Variables in a BY statement are called *BY variables*.

Optional Arguments

DESCENDING
specifies that the data set is sorted in descending order by the variable that immediately follows the word DESCENDING in the BY statement.

NOTSORTED
specifies that observations are not necessarily sorted in alphabetic or numeric order. The data is grouped in another way, such as chronological order.

The requirement for ordering or indexing observations according to the values of BY variables is suspended for BY-group processing when you use the NOTSORTED option. The procedure does not use an index if you specify

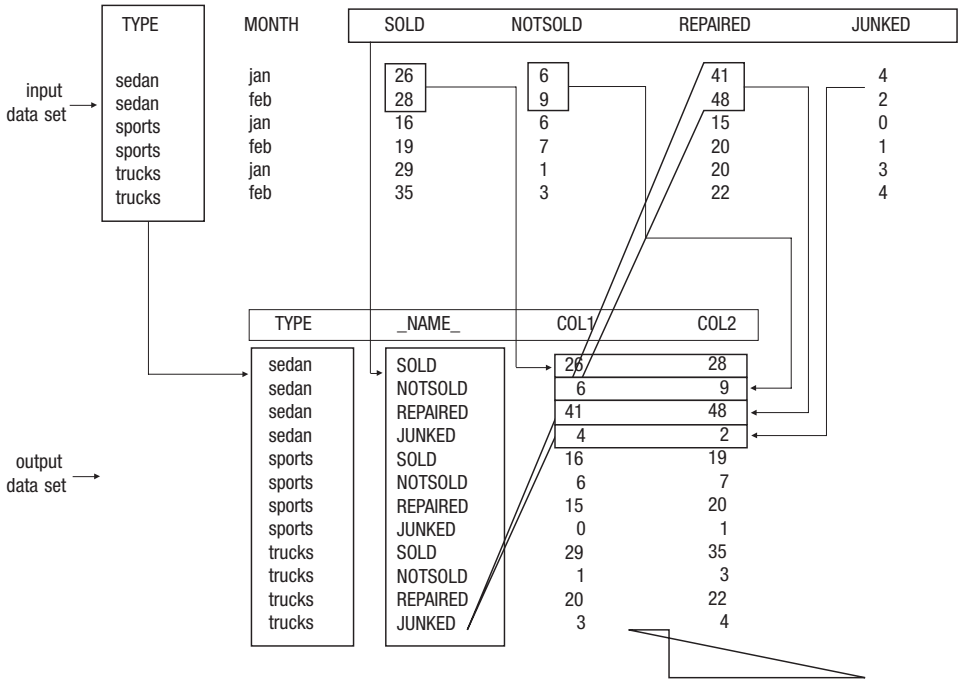
NOTSORTED. The procedure defines a BY group as a set of contiguous observations that have the same values for all BY variables. If observations with the same values for the BY variables are not contiguous, then the procedure treats each contiguous set as a separate BY group.

The NOBYSORTED system option disables observation sequence checking system-wide and applies to all procedures and BY statements. See the "BYSORTED System Option" in *SAS System Options: Reference*.

Details

The following figure shows what happens when you transpose a data set with BY groups. TYPE is the BY variable, and SOLD, NOTSOLD, REPAIRED, and JUNKED are the variables to transpose.

Figure 72.1 *Transposition with BY Groups*



- The number of observations in the output data set (12) is the number of BY groups (3) multiplied by the number of variables that are transposed (4).
- The BY variable is not transposed.
- _NAME_ contains the name of the variable in the input data set that was transposed to create the current observation in the output data set. You can use the NAME= option to specify another name for the _NAME_ variable.
- The maximum number of observations in any BY group in the input data set is two. Therefore, the output data set contains two variables, COL1 and COL2. COL1 and COL2 contain the values of SOLD, NOTSOLD, REPAIRED, and JUNKED.

Note: If a BY group in the input data set has more observations than other BY groups, then PROC TRANSPOSE assigns missing values in the output data set to the variables that have no corresponding input observations.

COPY Statement

Copies variables directly from the input data set to the output data set without transposing them.

Example: "Example 6: Transposing Data for Statistical Analysis" on page 2678

Syntax

COPY *variable(s)*;

Required Argument

variable(s)
names one or more variables that the COPY statement copies directly from the input data set to the output data set without transposing them.

Details

Because the COPY statement copies variables directly to the output data set, the number of observations in the output data set is equal to the number of observations in the input data set.

The procedure pads the output data set with missing values if the number of observations in the input data set is not equal to the number of variables that it transposes.

ID Statement

Specifies one or more variables in the input data set whose nonmissing formatted values name the transposed variables in the output data set. When a variable name is being formed in the transposed (output) data set, the formatted values of all listed ID variables are concatenated in the same order that the variables are listed in the ID statement. The PREFIX=, DELIMITER=, and SUFFIX= options can be used to modify the formed variable name. The PREFIX= option specifies a common character or character string to appear at the beginning of the formed variable names. The DELIMITER= option specifies a common character or character string to be inserted between the values of the ID variables. The SUFFIX= option specifies a common character or character string to be appended to the end of each formed variable name.

Restriction: You cannot use PROC TRANSPOSE with an ID statement or a BY statement with an engine that supports concurrent access if another user is updating the data set at the same time.

Tip: If the value of any ID variable is missing, then PROC TRANSPOSE writes a warning message to the log. The procedure does not transpose observations that have a missing value for any ID variable.

Example: "Example 2: Naming Transposed Variables" on page 2669

Syntax

ID *variable(s)*;

Required Argument

variable(s)
names one or more variables whose formatted values are used to form the names of the variables in the output data set.

Details

Duplicate Output Data Set Variable Names

A variable name formed from the input data set ID variable values, combined with the PREFIX, DELIMITER, and SUFFIX option values, should be unique within the output data set. An output data set variable name that occurs more than once indicates that two or more observations from the input data set are transposed to a single variable in the output data set and the result is data loss. This situation occurs when, in the case of a single ID variable, duplicate formatted values occur within the input data set or, if you use a BY statement, within a BY group. Similarly, this situation occurs in the case of multiple ID variables when the combination of formatted values of the ID variables occurs more than once within the input data set or BY group. To prevent data loss, if duplicate output data set variable names are formed, PROC TRANSPOSE issues an error message about duplicate ID values and stop processing. However, if the LET option is specified in the PROC TRANSPOSE statement then the procedure issues a warning message and continue processing, transposing the observation containing the last occurrence of the duplicate formatted variable values.

Note: The character substitutions and truncation required to ensure that the variable name formed from the ID variables is a valid SAS variable name, according to the VALIDVARNAME option setting, can result in duplicate output data set variable names even though the formatted value of the ID variable or combination of ID variables is unique within the input data set.

Making Variable Names Out of Numeric Values

When you use a numeric variable as an ID variable, PROC TRANSPOSE changes the formatted ID value into a valid SAS name.

SAS variable names cannot begin with a number unless you have set VALIDVARNAME=ANY. When the first character of the formatted value is numeric, the procedure prefixes an underscore to the value, this action truncates the last character of a 32-character value. Remaining invalid characters are replaced by underscores. The procedure truncates to 32 characters any ID value that is longer than 32 characters when the procedure uses that value to name a transposed variable.

If the formatted value looks like a numeric constant, then PROC TRANSPOSE changes the characters +, −, and . to P, N, and D, respectively. If the formatted value has characters that are not numeric, then PROC TRANSPOSE changes the characters +, −, and . to underscores.

Note: If the value of the VALIDVARNAME system option is V6, then PROC TRANSPOSE truncates transposed variable names to 8 characters.

Making Variable Names Out of Multiple ID Variables

When you specify a single ID variable, in forming an output data set variable name, the formatted values of the variable are made to conform with the SAS variable naming conventions imposed by the VALIDVARNAME option. The name formed by combining the ID variable values with the value of the PREFIX and SUFFIX options are also made to conform with the SAS variable naming convention. For both the formatted ID variable values and their combination with the PREFIX and SUFFIX options, invalid characters are replaced with underscores or, if the name appears to be a numeric constant, an underscore is used as a prefix and the characters +, -, and . are changed to P, N, and D. The resulting name is truncated to the maximum name length allowed by the VALIDVARNAME option setting. When you specify multiple ID variables, conformance to the SAS variable naming convention is imposed on the components of the variable name, using the formatted value of each ID variable, and also on the name composed from the ID variable values and the PREFIX, DELIMITER, and SUFFIX options. The resulting name is truncated to a length appropriate for the VALIDVARNAME option setting.

IDLABEL Statement

Creates labels for the transposed variables.

Restriction: Must appear after an ID statement.

Example: “Example 3: Labeling Transposed Variables” on page 2671

Syntax

IDLABEL *variable*;

Required Argument

variable
names the variable whose values the procedure uses to label the variables that the ID statement names. *variable* can be character or numeric.

Note: To see the effect of the IDLABEL statement, print the output data set with the PRINT procedure by using the LABEL option. You can also print the contents of the output data set by using the CONTENTS statement in the DATASETS procedure.

VAR Statement

Lists the variables to transpose.

Note: Add the special SAS variable list name _CHARACTER_ to the VAR statement to include all character variables in the transposition. See Special SAS Name Lists.

Examples: "Example 4: Transposing BY Groups" on page 2673
"Example 6: Transposing Data for Statistical Analysis" on page 2678

Syntax

VAR *variable(s)*;

Required Argument

variable(s)
names one or more variables to transpose.

Details

- If you omit the VAR statement, then the TRANSPOSE procedure transposes all numeric variables in the input data set that are not listed in another statement.
- You must list character variables in a VAR statement if you want to transpose them.

Note: If the procedure is transposing any character variable, then all transposed variables are character variables.

Results: TRANSPOSE Procedure

Output Data Set

The TRANSPOSE procedure always produces an output data set, regardless of whether you specify the OUT= option in the PROC TRANSPOSE statement. PROC TRANSPOSE does not print the output data set. Use PROC PRINT, PROC REPORT, or some other SAS reporting tool to print the output data set.

Output Data Set Variables

The output data set contains the following variables:

- variables that result from transposing the values of each variable into an observation.
- a variable that PROC TRANSPOSE creates to identify the source of the values in each observation in the output data set. This variable is a character variable whose values are the names of the variables that are transposed from the input data set. By default, PROC TRANSPOSE names this variable _NAME_. To override the default name, use the NAME= option. The label for the _NAME_ variable is **NAME OF FORMER VARIABLE**.
- variables that PROC TRANSPOSE copies from the input data set when you use either the BY or COPY statement. These variables have the same names and values as they do in the input data set. These variables also have the same attributes (for example: type, length, label, informat, and format).
- a character variable whose values are the variable labels of the variables that are being transposed (if any of the variables that the procedure is transposing have labels). Specify the name of the variable by using the LABEL= option. The default is `_LABEL_`.

Note: If the value of the LABEL= option or the NAME= option is the same as a variable that appears in a BY or COPY statement, then the output data set does not contain a variable whose values are the names or labels of the transposed variables.

Attributes of Transposed Variables

- All transposed variables are the same type and length.
- If all variables that the procedure is transposing are numeric, then the transposed variables are numeric. Thus, if the numeric variable has a character string as a formatted value, then its unformatted numeric value is transposed.
- If any variable that the procedure is transposing is character, then all transposed variables are character. If you are transposing a numeric variable that has a character string as a formatted value, then the formatted value is transposed.
- The length of the transposed variables is equal to the length of the longest variable that is being transposed.

Names of Transposed Variables

PROC TRANSPOSE uses the following rules to name transposed variables:

1. An ID statement specifies a variable or variables in the input data set whose formatted values become names for the transposed variables. If multiple ID variables are specified, the name of the transposed variable is the concatenation of the values of the ID variables. If the DELMITER= option is specified, its value is inserted between the formatted values of the ID variables when the names of the transposed variables are formed.
2. The PREFIX= option specifies a prefix to use in constructing the names of transposed variables. The SUFFIX= option also specifies a suffix to append to the names of the transposed variables.
3. If you do not use an ID statement, PREFIX= option, or the SUFFIX= option, then PROC TRANSPOSE looks for an input variable called _NAME_ to get the names of the transposed variables.
4. If you do not use an ID statement or the PREFIX= option, and if the input data set does not contain a variable named _NAME_, then PROC TRANSPOSE assigns the names COL1, COL2, ..., COL*n* to the transposed variables.

Examples: TRANSPOSE Procedure

Example 1: Performing a Simple Transposition

Features: PROC TRANSPOSE statement option
OUT=

This example performs a default transposition and uses no subordinate statements.

Program

```
options nodate pageno=1 linesize=80 pagesize=40;

data score;
   input Student $9. +1 StudentID $ Section $ Test1 Test2 Final;
   datalines;
Capalleti 0545 1  94 91 87
Dubose    1252 2  51 65 91
Engles    1167 1  95 97 97
Grant     1230 2  63 75 80
Krupski   2527 2  80 76 71
Lundsford 4860 1  92 40 86
McBane    0674 1  75 78 72
;

proc transpose data=score out=score_transposed;
run;

proc print data=score_transposed noobs;
    title 'Student Test Scores in Variables';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Create the SCORE data set. Set SCORE contains students' names, their identification numbers, and their grades on two tests and a final exam.

```
data score;
   input Student $9. +1 StudentID $ Section $ Test1 Test2 Final;
   datalines;
Capalleti 0545 1  94 91 87
Dubose    1252 2  51 65 91
Engles    1167 1  95 97 97
Grant     1230 2  63 75 80
Krupski   2527 2  80 76 71
Lundsford 4860 1  92 40 86
McBane    0674 1  75 78 72
;
```

Transpose the data set. PROC TRANSPOSE transposes only the numeric variables, Test1, Test2, and Final, because no VAR statement appears and none of the numeric variables appear in another statement. OUT= puts the result of the transposition in the data set SCORE_TRANSPOSED.

```
proc transpose data=score out=score_transposed;
run;
```

Print the SCORE_TRANSPOSED data set. The NOOBS option suppresses the printing of observation numbers

```
proc print data=score_transposed noobs;
    title 'Student Test Scores in Variables';
run;
```

Output

In the output data set SCORE_TRANSPOSED, the variables COL1 through COL7 contain the individual scores for the students. Each observation contains all the scores for one test. The variable _NAME_ contains the names of the variables from the input data set that were transposed.

Output 72.3 *Student Test Scores in Variables*

Student Test Scores in Variables

NAME	COL1	COL2	COL3	COL4	COL5	COL6	COL7
Test1	94	51	95	63	80	92	75
Test2	91	65	97	75	76	40	78
Final	87	91	97	80	71	86	72

Example 2: Naming Transposed Variables

Features: PROC TRANSPOSE statement options

NAME=
PREFIX=

ID statement

Data set: SCORE

This example uses the values of a variable and a user-supplied value to name transposed variables.

Program

```
options nodate pageno=1 linesize=80 pagesize=40;

proc transpose data=score out=idnumber name=Test
     prefix=sn;
    id studentid;
run;

proc print data=idnumber noobs;
   title 'Student Test Scores';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Transpose the data set. PROC TRANSPOSE transposes only the numeric variables, Test1, Test2, and Final, because no VAR statement appears. OUT= puts the result of the transposition in the IDNUMBER data set. NAME= specifies Test as the name for the variable that contains the names of the variables in the input data set that the procedure transposes. The procedure names the transposed variables by using the value from PREFIX=, sn, and the value of the ID variable StudentID.

```
proc transpose data=score out=idnumber name=Test
     prefix=sn;
    id studentid;
run;
```

Print the IDNUMBER data set. The NOOBS option suppresses the printing of observation numbers.

```
proc print data=idnumber noobs;
   title 'Student Test Scores';
run;
```

Output

The following data set is the output data set, IDNUMBER.

Output 72.4 *Student Test Scores*

Student Test Scores

Test	sn0545	sn1252	sn1167	sn1230	sn2527	sn4860	sn0674
Test1	94	51	95	63	80	92	75
Test2	91	65	97	75	76	40	78
Final	87	91	97	80	71	86	72

Example 3: Labeling Transposed Variables

Features: PROC TRANSPOSE statement option
PREFIX=
IDLABEL statement

Data set: SCORE

This example uses the values of the variable in the IDLABEL statement to label transposed variables.

Program 1

```
options nodate pageno=1 linesize=80 pagesize=40;

proc transpose data=score out=idlabel name=Test
     prefix=sn;
   id studentid;

     idlabel student;
run;

  proc print data=idlabel label noobs;
     title 'Student Test Scores';
  run;

proc contents data=idlabel;
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number.

LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Transpose the data set. PROC TRANSPOSE transposes only the numeric variables, Test1, Test2, and Final, because no VAR statement appears. OUT= puts the result of the transposition in the IDLABEL data set. NAME= specifies Test as the name for the variable that contains the names of the variables in the input data set that the procedure transposes. The procedure names the transposed variables by using the value from PREFIX=, sn, and the value of the ID variable StudentID.

```
proc transpose data=score out=idlabel name=Test
     prefix=sn;
   id studentid;
```

Assign labels to the output variables. PROC TRANSPOSE uses the values of the variable Student to label the transposed variables. The procedure provides the following as the label for the _NAME_ variable:NAME OF FORMER VARIABLE

```
      idlabel student;
run;
```

Print the IDLABEL data set. The LABEL option causes PROC PRINT to print variable labels for column headings. The NOOBS option suppresses the printing of observation numbers.

```
  proc print data=idlabel label noobs;
     title 'Student Test Scores';
  run;
```

Display the IDLABEL variable names and label. PROC CONTENTS displays the variable names and labels.

```
proc contents data=idlabel;
run;
```

Output 1

This data set is the output data set, IDLABEL.

Output 72.5 *Student Test Scores, IDLABEL*

Student Test Scores

NAME OF FORMER VARIABLE	Capalleti	Dubose	Engles	Grant	Krupski	Lundsford	McBane
Test1	94	51	95	63	80	92	75
Test2	91	65	97	75	76	40	78
Final	87	91	97	80	71	86	72

Program 2

Display the variable and label names. PROC CONTENTS displays the variable names and the labels used in the first program.

```
proc contents data=idlabel;
run;
```

Output 2

In the following output, PROC CONTENTS displays the variables and labels.

Output 72.6 *The Contents Procedure*

Alphabetic List of Variables and Attributes				
#	Variable	Type	Len	Label
1	Test	Char	8	NAME OF FORMER VARIABLE
2	sn0545	Num	8	Capalleti
8	sn0674	Num	8	McBane
4	sn1167	Num	8	Engles
5	sn1230	Num	8	Grant
3	sn1252	Num	8	Dubose
6	sn2527	Num	8	Krupski
7	sn4860	Num	8	Lundsford

Example 4: Transposing BY Groups

Features:

BY statement

VAR statement

Data set option
RENAME=

This example illustrates transposing BY groups and selecting variables to transpose.

Program

```
options nodate pageno=1 linesize=80 pagesize=40;
data fishdata;
   infile datalines missover;
   input Location & $10. Date date7.
```

```
         Length1 Weight1 Length2 Weight2 Length3 Weight3
         Length4 Weight4;
   format date date7.;
   datalines;
Cole Pond   2JUN95 31 .25 32 .3  32 .25 33 .3
Cole Pond   3JUL95 33 .32 34 .41 37 .48 32 .28
Cole Pond   4AUG95 29 .23 30 .25 34 .47 32 .3
Eagle Lake  2JUN95 32 .35 32 .25 33 .30
Eagle Lake  3JUL95 30 .20 36 .45
Eagle Lake  4AUG95 33 .30 33 .28 34 .42
;

proc transpose data=fishdata
     out=fishlength(rename=(col1=Measurement));

   var length1-length4;

   by location date;
run;

proc print data=fishlength noobs;
   title 'Fish Length Data for Each Location and Date';
run;
```

Program Description

Create the FISHDATA data set and set the SAS system options. The data in FISHDATA represents length and weight measurements of fish that were caught at two ponds on three separate days. The raw data is sorted by Location and Date. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
data fishdata;
   infile datalines missover;
   input Location & $10. Date date7.
         Length1 Weight1 Length2 Weight2 Length3 Weight3
         Length4 Weight4;
   format date date7.;
   datalines;
Cole Pond   2JUN95 31 .25 32 .3  32 .25 33 .3
Cole Pond   3JUL95 33 .32 34 .41 37 .48 32 .28
Cole Pond   4AUG95 29 .23 30 .25 34 .47 32 .3
Eagle Lake  2JUN95 32 .35 32 .25 33 .30
Eagle Lake  3JUL95 30 .20 36 .45
Eagle Lake  4AUG95 33 .30 33 .28 34 .42
;
```

Transpose the data set. OUT= puts the result of the transposition in the FISHLENGTH data set. RENAME= renames COL1 in the output data set to Measurement.

```
proc transpose data=fishdata
     out=fishlength(rename=(col1=Measurement));
```

Specify the variables to transpose. The VAR statement limits the variables that PROC TRANSPOSE transposes.

```
   var length1-length4;
```

Organize the output data set into BY groups. The BY statement creates BY groups for each unique combination of values of Location and Date. The procedure does not transpose the BY variables.

```
   by location date;
run;
```

Print the FISHLENGTH data set. The NOOBS option suppresses the printing of observation numbers.

```
proc print data=fishlength noobs;
   title 'Fish Length Data for Each Location and Date';
run;
```

Output

The following data set is the output data set, FISHLENGTH. For each BY group in the original data set, PROC TRANSPOSE creates four observations, one for each variable that it is transposing. Missing values appear for the variable Measurement (renamed from COL1) when the variables that are being transposed have no value in the input data set for that BY group. Several observations have a missing value for Measurement. For example, in the last observation, a missing value appears because the input data contained no value for Length4 on 04AUG95 at Eagle Lake.

Output 72.7 *Fish Length Data*

Fish Length Data for Each Location and Date

Location	Date	_NAME_	Measurement
Cole Pond	02JUN95	Length1	31
Cole Pond	02JUN95	Length2	32
Cole Pond	02JUN95	Length3	32
Cole Pond	02JUN95	Length4	33
Cole Pond	03JUL95	Length1	33
Cole Pond	03JUL95	Length2	34
Cole Pond	03JUL95	Length3	37
Cole Pond	03JUL95	Length4	32
Cole Pond	04AUG95	Length1	29
Cole Pond	04AUG95	Length2	30
Cole Pond	04AUG95	Length3	34
Cole Pond	04AUG95	Length4	32
Eagle Lake	02JUN95	Length1	32
Eagle Lake	02JUN95	Length2	32
Eagle Lake	02JUN95	Length3	33
Eagle Lake	02JUN95	Length4	.
Eagle Lake	03JUL95	Length1	30
Eagle Lake	03JUL95	Length2	36
Eagle Lake	03JUL95	Length3	.
Eagle Lake	03JUL95	Length4	.
Eagle Lake	04AUG95	Length1	33
Eagle Lake	04AUG95	Length2	33
Eagle Lake	04AUG95	Length3	34
Eagle Lake	04AUG95	Length4	.

Example 5: Naming Transposed Variables When the ID Variable Has Duplicate Values

Features: PROC TRANSPOSE statement option
LET

This example shows how to use values of a variable (ID) to name transposed variables even when the ID variable has duplicate values.

Program

```
options nodate pageno=1 linesize=64 pagesize=40;

data stocks;
    input Company $14. Date $ Time $ Price;
    datalines;
Horizon Kites jun11 opening 29
Horizon Kites jun11 noon    27
Horizon Kites jun11 closing 27
Horizon Kites jun12 opening 27
Horizon Kites jun12 noon    28
Horizon Kites jun12 closing 30
SkyHi Kites   jun11 opening 43
SkyHi Kites   jun11 noon    43
SkyHi Kites   jun11 closing 44
SkyHi Kites   jun12 opening 44
SkyHi Kites   jun12 noon    45
SkyHi Kites   jun12 closing 45
;

proc transpose data=stocks out=close let;

   by company;

   id date;
 run;

proc print data=close noobs;
   title 'Closing Prices for Horizon Kites and SkyHi Kites';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=64 pagesize=40;
```

Create the STOCKS data set. STOCKS contains stock prices for two competing kite manufacturers. The prices are recorded for two days, three times a day: at opening, at noon, and at closing. Notice that the input data set contains duplicate values for the Date variable.

```
data stocks;
    input Company $14. Date $ Time $ Price;
    datalines;
Horizon Kites jun11 opening 29
Horizon Kites jun11 noon    27
Horizon Kites jun11 closing 27
Horizon Kites jun12 opening 27
Horizon Kites jun12 noon    28
Horizon Kites jun12 closing 30
SkyHi Kites   jun11 opening 43
```

```
SkyHi Kites   jun11 noon    43
SkyHi Kites   jun11 closing 44
SkyHi Kites   jun12 opening 44
SkyHi Kites   jun12 noon    45
SkyHi Kites   jun12 closing 45
;
```

Transpose the data set. LET transposes only the last observation for each BY group. PROC TRANSPOSE transposes only the Price variable. OUT= puts the result of the transposition in the CLOSE data set.

```
proc transpose data=stocks out=close let;
```

Organize the output data set into BY groups. The BY statement creates two BY groups, one for each company.

```
   by company;
```

Name the transposed variables. The values of Date are used as names for the transposed variables.

```
   id date;
run;
```

Print the CLOSE data set. The NOOBS option suppresses the printing of observation numbers..

```
proc print data=close noobs;
   title 'Closing Prices for Horizon Kites and SkyHi Kites';
run;
```

Output

The following data set is the output data set, CLOSE.

Output 72.8 *Closing Prices*

Closing Prices for Horizon Kites and SkyHi Kites

Company	_NAME_	jun11	jun12
Horizon Kites	Price	27	30
SkyHi Kites	Price	44	45

Example 6: Transposing Data for Statistical Analysis

Features: COPY statement
VAR statement

This example arranges data to make it suitable for either a multivariate or a univariate repeated-measures analysis.

The data is from Chapter 8, “Repeated-Measures Analysis of Variance,” in SAS System for Linear Models, Third Edition.

Program 1

```
options nodate pageno=1 linesize=80 pagesize=40;

data weights;
   input Program $ s1-s7;
   datalines;
CONT  85 85 86 85 87 86 87
CONT  80 79 79 78 78 79 78
CONT  78 77 77 77 76 76 77
CONT  84 84 85 84 83 84 85
CONT  80 81 80 80 79 79 80
RI    79 79 79 80 80 78 80
RI    83 83 85 85 86 87 87
RI    81 83 82 82 83 83 82
RI    81 81 81 82 82 83 81
RI    80 81 82 82 82 84 86
WI    84 85 84 83 83 83 84
WI    74 75 75 76 75 76 76
WI    83 84 82 81 83 83 82
WI    86 87 87 87 87 87 86
WI    82 83 84 85 84 85 86
;

data split;
   set weights;
   array s{7} s1-s7;
   Subject + 1;
   do Time=1 to 7;
      Strength=s{time};
      output;
   end;
   drop s1-s7;
run;

proc print data=split(obs=15) noobs;
   title 'SPLIT Data Set';
   title2 'First 15 Observations Only';
run;
```

Program Description

Set the SAS system options. The NODATE option suppresses the display of the date and time in the output. PAGENO= specifies the starting page number. LINESIZE= specifies the output line length, and PAGESIZE= specifies the number of lines on an output page.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Create the WEIGHTS data set. The data in WEIGHTS represents the results of an exercise therapy study of three weight-lifting programs: CONT is a control group, RI is a program in which the number of repetitions is increased, and WI is a program in which the weight is increased.

```
data weights;
   input Program $ s1-s7;
   datalines;
CONT  85 85 86 85 87 86 87
CONT  80 79 79 78 78 79 78
CONT  78 77 77 77 76 76 77
CONT  84 84 85 84 83 84 85
CONT  80 81 80 80 79 79 80
RI    79 79 79 80 80 78 80
RI    83 83 85 85 86 87 87
RI    81 83 82 82 83 83 82
RI    81 81 81 82 82 83 81
RI    80 81 82 82 82 84 86
WI    84 85 84 83 83 83 84
WI    74 75 75 76 75 76 76
WI    83 84 82 81 83 83 82
WI    86 87 87 87 87 87 86
WI    82 83 84 85 84 85 86
;
```

Create the SPLIT data set. This DATA step rearranges WEIGHTS to create the data set SPLIT. The DATA step transposes the strength values and creates two new variables: Time and Subject. SPLIT contains one observation for each repeated measure. SPLIT can be used in a PROC GLM step for a univariate repeated-measures analysis.

```
data split;
   set weights;
   array s{7} s1-s7;
   Subject + 1;
   do Time=1 to 7;
      Strength=s{time};
      output;
   end;
   drop s1-s7;
run;
```

Print the SPLIT data set. The NOOBS options suppresses the printing of observation numbers. The OBS= data set option limits the printing to the first 15 observations. SPLIT has 105 observations.

```
proc print data=split(obs=15) noobs;
   title 'SPLIT Data Set';
   title2 'First 15 Observations Only';
run;
```

Output 1

Output 72.9 *Split Data Set*

SPLIT Data Set
First 15 Observations Only

Program	Subject	Time	Strength
CONT	1	1	85
CONT	1	2	85
CONT	1	3	86
CONT	1	4	85
CONT	1	5	87
CONT	1	6	86
CONT	1	7	87
CONT	2	1	80
CONT	2	2	79
CONT	2	3	79
CONT	2	4	78
CONT	2	5	78
CONT	2	6	79
CONT	2	7	78
CONT	3	1	78

Program 2

```
options nodate pageno=1 linesize=80 pagesize=40;

proc transpose data=split out=totsplit prefix=Str;

   by program subject;
   copy time strength;

   var strength;
run;

proc print data=totsplit(obs=15) noobs;
   title  'TOTSPLIT Data Set';
   title2 'First 15 Observations Only';
run;
```

Program Description

Set the SAS system options.

```
options nodate pageno=1 linesize=80 pagesize=40;
```

Transpose the SPLIT data set. PROC TRANSPOSE transposes SPLIT to create TOTSPLIT. The TOTSPLIT data set contains the same variables as SPLIT and a variable for each strength measurement (Str1-Str7). TOTSPLIT can be used for either a multivariate repeated-measures analysis or a univariate repeated-measures analysis.

```
proc transpose data=split out=totsplit prefix=Str;
```

Organize the output data set into BY groups, and populate each BY group with untransposed values. The variables in the BY and COPY statements are not transposed. TOTSPLIT contains the variables Program, Subject, Time, and Strength with the same values that are in SPLIT. The BY statement creates the first observation in each BY group, which contains the transposed values of Strength. The COPY statement creates the other observations in each BY group by copying the values of Time and Strength without transposing them.

```
   by program subject;
   copy time strength;
```

Specify the variable to transpose. The VAR statement specifies the Strength variable as the only variable to be transposed.

```
   var strength;
run;
```

Print the TOTSPLIT data set. The NOOBS options suppresses the printing of observation numbers. The OBS= data set option limits the printing to the first 15 observations. SPLIT has 105 observations.

```
proc print data=totsplit(obs=15) noobs;
   title  'TOTSPLIT Data Set';
   title2 'First 15 Observations Only';
run;
```

Output 2

In the following output, the variables in TOTSPLIT with missing values are used only in a multivariate repeated-measures analysis. The missing values do not preclude this data set from being used in a repeated-measures analysis because the MODEL statement in PROC GLM ignores observations with missing values.

Output 72.10 *TOTSPLIT Data Set*

TOTSPLIT Data Set
First 15 Observations Only

Program	Subject	Time	Strength	_NAME_	Str1	Str2	Str3	Str4	Str5	Str6	Str7
CONT	1	1	85	Strength	85	85	86	85	87	86	87
CONT	1	2	85		.	.	.	.	.	.	.
CONT	1	3	86		.	.	.	.	.	.	.
CONT	1	4	85		.	.	.	.	.	.	.
CONT	1	5	87		.	.	.	.	.	.	.
CONT	1	6	86		.	.	.	.	.	.	.
CONT	1	7	87		.	.	.	.	.	.	.
CONT	2	1	80	Strength	80	79	79	78	78	79	78
CONT	2	2	79		.	.	.	.	.	.	.
CONT	2	3	79		.	.	.	.	.	.	.
CONT	2	4	78		.	.	.	.	.	.	.
CONT	2	5	78		.	.	.	.	.	.	.
CONT	2	6	79		.	.	.	.	.	.	.
CONT	2	7	78		.	.	.	.	.	.	.
CONT	3	1	78	Strength	78	77	77	77	76	76	77

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XSL Procedure

Overview: XSL Procedure

What Does the Extensible Style Sheet Language (XSL) Procedure Do?

The XSL procedure transforms an XML document into another format, such as HTML, text, or another XML document type. PROC XSL reads an input XML document, transforms it by using an XSL style sheet, and then writes the output.

To transform the XML document, PROC XSL uses the Saxon-EE version 9.3 software application from Saxonica, which is a collection of tools for processing XML documents. The XSLT processor implements the XSLT 2.0 standard. For information about Saxon, see the website About Saxon.

Understanding XSL

XSL is a family of transformation languages that enables you to describe how to convert files that are encoded in XML. The languages include the following:

- XSL Transformations (XSLT) for transforming an XML document
- XML Path Language (XPath), which is used by XSLT, for selecting parts of an XML document

For information about XSLT standards, see the website XSL Transformations (XSLT) Version 2.0.

Syntax: XSL Procedure

Restriction: This procedure is not available in SAS Viya orders that include only SAS Visual Analytics.

PROC XSL IN=*fileref* | '*external-file*' OUT=*fileref* | '*external-file*' XSL=*fileref* | '*external-file*';

PARAMETER '*parameter*'='*value*';

Statement	Task	Example
PROC XSL	Transform an XML document	Ex. 1, Ex. 2, Ex. 3
PARAMETER	Pass a parameter to the XSL style sheet to set a value	Ex. 2, Ex. 3

PROC XSL Statement

Transforms an XML document.

Example: "Example 1: Transforming an XML Document into Another XML Document" on page 2688

Syntax

PROC XSL IN=*fileref* | *'external-file'* OUT=*fileref* | *'external-file'* XSL=*fileref* | *'external-file'*;

Required Arguments

IN=*fileref* | *'external-file'*
specifies the input file. The file must be a well-formed XML document.

fileref
specifies the SAS fileref that is assigned to the input XML document. To assign a fileref, use the FILENAME statement.

'external-file'
is the physical location of the input XML document. Include the complete pathname and the filename. Enclose the physical name in single or double quotation marks. The maximum length is 200 characters.

Interaction When the LOCKDOWN option or NOXCMD option is set on a session, any operating system commands that are specified in the XSL file fail with an ERROR.

Example "Example 1: Transforming an XML Document into Another XML Document" on page 2688

OUT=*fileref* | *'external-file'*
specifies the output file.

fileref
specifies the SAS fileref that is assigned to the output file. To assign a fileref, use the FILENAME statement.

'external-file'
is the physical location of the output file. Include the complete pathname and the filename. Enclose the physical name in single or double quotation marks. The maximum length is 200 characters.

Example "Example 1: Transforming an XML Document into Another XML Document" on page 2688

XSL=*fileref* | *'external-file'*
specifies the XSL style sheet to transform the XML document. The XSL style sheet is a file that describes how to transform the XML document by using the XSLT language. The XSL style sheet must be a well-formed XML document.

fileref
specifies the SAS fileref that is assigned to the XSL style sheet. To assign a fileref, use the FILENAME statement.

'external-file'
is the physical location of the XSL style sheet. Include the complete pathname and the filename. Enclose the physical name in single or double quotation marks. The maximum length is 200 characters.

Alias XSLT=

Example "Example 1: Transforming an XML Document into Another XML Document" on page 2688

PARAMETER Statement

Changes instances of a parameter in an XSL style sheet to a specified value.

Examples: "Example 2: Passing a Character String Parameter Value to the XSL Style Sheet" on page 2690
"Example 3: Passing a Numeric Parameter Value to the XSL Style Sheet" on page 2693

Syntax

PARAMETER '*parameter*'='*value*';

Required Argument

'parameter'='value'
specifies the parameter name and a value to be passed to the XSL style sheet. PROC XSL changes instances of the parameter in the style sheet to the specified value. The specified parameter must exist in the XSL style sheet. Enclose the parameter name in single or double quotation marks. The specified value can be a character string or a numeric value. Enclose the value in single or double quotation marks if the value is a character string.

Examples: XSL Procedure

Example 1: Transforming an XML Document into Another XML Document

Features: PROC XSL statement

Details

The following PROC XSL example transforms an XML document into another XML document.

This is the input XML document named XMLInput.xml, which contains data about vehicles. Each second-level repeating element describes a particular car, with the nested elements that contain information about the model and year. The make information is an attribute on the second-level repeating element.

```
<?xml version="1.0" ?>
<vehicles>
  <car make="Ford">
    <model>Mustang</model>
    <year>1965</year>
  </car>
  <car make="Chevrolet">
    <model>Nova</model>
    <year>1967</year>
  </car>
</vehicles>
```

This is the XSL style sheet named XSLTransform.xsl that describes how to transform the XML. The conversion creates <root> as the root-enclosing element and <model> as the second-level repeating element. Each <model> element in the output XML document will include the values from the <car> element and the make= attribute from the input XML document.

```
<?xml version="1.0" ?>
<xsl:stylesheet xmlns:xsl="http://www.w3.org/1999/XSL/Transform" version="1.0">
<xsl:output method="xml" indent="yes"/>

<xsl:template match="/vehicles">
       <root> <xsl:apply-templates select="car"/> </root>
</xsl:template>

<xsl:template match="car">
    <model make="{@make}">
       <xsl:value-of select="model" />
    </model>
</xsl:template>

</xsl:stylesheet>
```

Program

Execute the PROC XSL statement. The PROC XSL statement specifies the input XML document, the XSL style sheet, and the output XML document.

```
proc xsl
   in='C:\XmlInput.xml'
   xsl='C:\XslTransform.xsl'
   out='C:\XmlOutput.xml';
run;
```

Output: Transforming an XML Document into Another XML Document

Output 73.1 *PROC XSL Output of Transformed XML Document*

```
<?xml version="1.0" encoding="UTF-8"?>
<root>
<model make="Ford">Mustang</model>
<model make="Chevrolet">Nova</model>
</root>
```

Example 2: Passing a Character String Parameter Value to the XSL Style Sheet

Features: PROC XSL statement
PARAMETER statement

Details

This example shows how to use PROC XSL to pass a character string value to a parameter in an XSL style sheet. A parameter, which is a named variable in the style sheet for which you can set a value, is an easy way to customize generated output.

This is the XSL style sheet named Format.xsl. The XSL style sheet extracts elements and attributes from an input XML document to generate HTML output. The style sheet contains the declared parameter DateVar.

```
<?xml version="1.0" encoding="UTF-8"?>
  <xsl:stylesheet version="1.0"
     xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
    <xsl:param name="DateVar"/>
    <xsl:template match="TABLE">
     <html>
     <head/>
     <body>
```

```
  <h2><xsl:value-of select="$DateVar"/></h2>
  <table border="1" rules="all">
  <tr>
     <td>Name</td>
     <td>Sex</td>
     <td>Age</td>
     <td>Height</td>
     <td>Weight</td>
  </tr>
  <xsl:apply-templates/>
  </table>
  </body>
 </html>
 </xsl:template>
 <xsl:template match="CLASS">
  <tr>
      <td><xsl:value-of select="Name"/></td>
      <td><xsl:value-of select="Sex"/></td>
      <td><xsl:value-of select="Age"/></td>
      <td><xsl:value-of select="Height"/></td>
      <td><xsl:value-of select="Weight"/></td>
  </tr>
 </xsl:template>
</xsl:stylesheet>
```

The input XML document named Class.xml contains classroom data.

```
<?xml version="1.0" encoding="windows-1252" ?>
<TABLE>
   <CLASS>
      <Name> Alfred </Name>
      <Sex> M </Sex>
      <Age> 14 </Age>
      <Height> 69 </Height>
      <Weight> 112.5 </Weight>
   </CLASS>
   <CLASS>
      <Name> Alice </Name>
      <Sex> F </Sex>
      <Age> 13 </Age>
      <Height> 56.5 </Height>
      <Weight> 84 </Weight>
   </CLASS>
   <CLASS>
      <Name> Barbara </Name>
      <Sex> F </Sex>
      <Age> 13 </Age>
      <Height> 65.3 </Height>
      <Weight> 98 </Weight>
   </CLASS>
   .
   .
   .
   <CLASS>
      <Name> Thomas </Name>
      <Sex> M </Sex>
      <Age> 11 </Age>
```

```
      <Height> 57.5 </Height>
      <Weight> 85 </Weight>
   </CLASS>
   <CLASS>
      <Name> William </Name>
      <Sex> M </Sex>
      <Age> 15 </Age>
      <Height> 66.5 </Height>
      <Weight> 112 </Weight>
   </CLASS>
</TABLE>
```

Program

```
proc xsl
   in='C:\XSL\Class.xml'
   xsl='C:\XSL\Format.xsl'
   out='C:\XSL\Class.html';

   parameter 'DateVar'="Report Date: &sysdate";
run;
```

Program Description

Execute the PROC XSL statement. The PROC XSL statement specifies the input XML document, the XSL style sheet, and the output HTML file.

```
proc xsl
   in='C:\XSL\Class.xml'
   xsl='C:\XSL\Format.xsl'
   out='C:\XSL\Class.html';
```

Pass the parameter value to the XSL style sheet. The PARAMETER statement passes a character string value for the parameter DateVar to the XSL style sheet. Note that because the value includes a macro variable reference, the value must be in double quotation marks.

```
   parameter 'DateVar'="Report Date: &sysdate";
run;
```

Output: Passing a Character String Parameter Value to the XSL Style Sheet

Output 73.2 *PROC XSL Output Class.html*

Report Date: 15NOV12

Name	Sex	Age	Height	Weight
Alfred	M	14	69	112.5
Alice	F	13	56.5	84
Barbara	F	13	65.3	98
Carol	F	14	62.8	102.5
Henry	M	14	63.5	102.5
James	M	12	57.3	83
Jane	F	12	59.8	84.5
Janet	F	15	62.5	112.5
Jeffrey	M	13	62.5	84
John	M	12	59	99.5
Joyce	F	11	51.3	50.5
Judy	F	14	64.3	90
Louise	F	12	56.3	77
Mary	F	15	66.5	112
Philip	M	16	72	150
Robert	M	12	64.8	128
Ronald	M	15	67	133
Thomas	M	11	57.5	85
William	M	15	66.5	112

Example 3: Passing a Numeric Parameter Value to the XSL Style Sheet

Features: PROC XSL statement
PARAMETER statement

Details

This example shows how to use PROC XSL to pass a numeric value to a parameter in an XSL style sheet.

This is the XSL style sheet named Discount.xsl. The XSL style sheet extracts elements and attributes from an input XML document to generate XML output. The style sheet contains the declared parameter DiscountPct. PROC XSL passes in a numeric value to the parameter, and a discount amount is calculated.

```
<?xml version="1.0" encoding="UTF-8"?>
<xsl:stylesheet version="1.0"
  xmlns:xsl="http://www.w3.org/1999/XSL/Transform">
  <xsl:output method="xml" indent="yes" />
  <xsl:param name="DiscountPct" />

  <xsl:template match="table">
    <xsl:copy>
      <xsl:apply-templates select="product" />
    </xsl:copy>
  </xsl:template>

  <xsl:template match="product">
    <xsl:copy>
      <xsl:copy-of select="category|type|size|gender|price" />
      <discount>
        <xsl:value-of select="$DiscountPct" />
      </discount>
      <discountAmount>
        <xsl:value-of select="(price * $DiscountPct)" />
      </discountAmount>
      <xsl:copy-of select="in_stock|ship_type" />
    </xsl:copy>
  </xsl:template>

</xsl:stylesheet>
```

The input XML document named Product.xml contains product data:

```
<?xml version="1.0"?>
<table>
 <product>
   <category>shoe</category>
   <type>Nike Air</type>
   <size>12</size>
   <gender>male</gender>
   <price>99</price>
   <in_stock>yes</in_stock>
   <ship_type>overnight</ship_type>
 </product>
</table>
```

Program

```
proc xsl
   in='C:\XSL\Product.xml'
   xsl='C:\XSL\Discount.xsl'
   out='C:\XSL\Calculated.xml';

   parameter 'DiscountPct'=.20;
run;
```

Program Description

Execute the PROC XSL statement. The PROC XSL statement specifies the input XML document, the XSL style sheet, and the output XML document.

```
proc xsl
   in='C:\XSL\Product.xml'
   xsl='C:\XSL\Discount.xsl'
   out='C:\XSL\Calculated.xml';
```

Pass the parameter to the XSL style sheet. The PARAMETER statement passes a numeric value for the parameter DiscountPct to the XSL style sheet. The output XML document will contain the discount value and a calculated discount amount.

```
   parameter 'DiscountPct'=.20;
run;
```

Output: Passing a Numeric Parameter Value to the XSL Style Sheet

Output 73.3 *PROC XSL Output Calculated.xml*

```
<?xml version="1.0" encoding="UTF-8"?>
<table>
   <product>
      <category>shoe</category>
      <type>Nike Air</type>
      <size>12</size>
      <gender>male</gender>
      <price>99</price>
      <discount>0.2</discount>
      <discountAmount>19.8</discountAmount>
      <in_stock>yes</in_stock>
      <ship_type>overnight</ship_type>
   </product>
</table>
```

PART 3

Appendixes

Appendix 1

SAS Elementary Statistics Procedures

Overview of SAS Elementary Statistics Procedures

This appendix provides a brief description of some of the statistical concepts necessary for you to interpret the output of Base SAS procedures for elementary statistics. In addition, this appendix lists statistical notation, formulas, and standard keywords used for common statistics in Base SAS procedures. Brief examples illustrate the statistical concepts.

Table A1.1 on page 2701 lists the most common statistics and the procedures that compute them.

Keywords and Formulas

Simple Statistics

The Base SAS procedures use a standardized set of keywords to refer to statistics. You specify these keywords in SAS statements to request the statistics to be displayed or stored in an output data set.

In the following notation, summation is over observations that contain nonmissing values of the analyzed variable and, except where shown, over nonmissing weights and frequencies of one or more:

x_i
: is the nonmissing value of the analyzed variable for observation *i*.

f_i
: is the frequency that is associated with x_i if you use a FREQ statement. If you omit the FREQ statement, then $f_i = 1$ for all *i*.

w_i
: is the weight that is associated with x_i if you use a WEIGHT statement. The base procedures automatically exclude the values of x_i with missing weights from the analysis.

  By default, the base procedures treat a negative weight as if it is equal to zero. However, if you use the EXCLNPWGT option in the PROC statement, then the procedure also excludes those values of x_i with nonpositive weights. Note that

most SAS/STAT procedures, such as PROC TTEST and PROC GLM, exclude values with nonpositive weights by default.

If you omit the WEIGHT statement, then $w_i = 1$ for all *i*.

n

is the number of nonmissing values of x_i, Σf_i. If you use the EXCLNPWGT option and the WEIGHT statement, then n is the number of nonmissing values with positive weights.

$\overline{x}$

is the mean

$$\Sigma w_i x_i / \Sigma w_i$$

s^2

is the variance

$$\frac{1}{d} \Sigma w_i (x_i - \overline{x})^2$$

where d is the variance divisor (the VARDEF= option) that you specify in the PROC statement. Valid values are as follows:

When VARDEF=	d equals
N	n
DF	$n - 1$
WEIGHT	Σw_i
WDF	$\Sigma w_i - 1$

The default is DF.

z_i

is the standardized variable

$$(x_i - \overline{x})/s$$

The standard keywords and formulas for each statistic follow. Some formulas use keywords to designate the corresponding statistic.

Table A66.1 *The Most Common Simple Statistics*

Statistic	PROC MEANS and SUMMARY	PROC UNIVARIATE	PROC TABULATE	PROC REPORT	PROC CORR	PROC SQL
Number of missing values	X	X	X	X		X

Statistic	PROC MEANS and SUMMARY	PROC UNIVARIATE	PROC TABULATE	PROC REPORT	PROC CORR	PROC SQL
Number of nonmissing values	X	X	X	X	X	X
Number of observations	X	X				X
Sum of weights	X	X	X	X	X	X
Mean	X	X	X	X	X	X
Sum	X	X	X	X	X	X
Extreme values	X	X				
Minimum	X	X	X	X	X	X
Maximum	X	X	X	X	X	X
Range	X	X	X	X		X
Uncorrected sum of squares	X	X	X	X	X	X
Corrected sum of squares	X	X	X	X	X	X
Variance	X	X	X	X	X	X
Covariance					X	
Standard deviation	X	X	X	X	X	X
Standard error of the mean	X	X	X	X		X
Coefficient of variation	X	X	X	X		X
Skewness	X	X	X			
Kurtosis	X	X	X			
Confidence Limits						
of the mean	X	X	X			
of the variance		X				
of quantiles		X				
Median	X	X	X	X	X	

Statistic		PROC MEANS and SUMMARY	PROC UNIVARIATE	PROC TABULATE	PROC REPORT	PROC CORR	PROC SQL
Mode		X	X	X	X		
Percentiles/Deciles/ Quartiles		X	X	X	X		
t test							
	for mean=0	X	X	X	X		X
	for mean= μ_0		X				
Nonparametric tests for location			X				
Tests for normality			X				
Correlation coefficients						X	
Cronbach's alpha						X	

Descriptive Statistics

The keywords for descriptive statistics are

CSS
is the sum of squares corrected for the mean, computed as

$$\Sigma\, w_i(x_i - \overline{x})^2$$

CV
is the percent coefficient of variation, computed as

$$(100s)/\overline{x}$$

KURTOSIS | KURT
is the kurtosis, which measures heaviness of tails. When VARDEF=DF, the kurtosis is computed as

$$c_{4_n}\, \Sigma\, z_i^4 - \frac{3(n-1)^2}{(n-2)(n-3)}$$

where c_{4_n} is $\frac{n(n+1)}{(n-1)(n-2)(n-3)}$. The weighted kurtosis is computed as

$$= c_{4_n} \Sigma \left((x_i - \bar{x})/\widehat{\sigma_i}\right)^4 - \frac{3(n-1)^2}{(n-2)(n-3)}$$

$$= c_{4_n} \Sigma\, w_i^2((x_i - \bar{x})/\widehat{\sigma})^4 - \frac{3(n-1)^2}{(n-2)(n-3)}$$

When VARDEF=N, the kurtosis is computed as

$$= \frac{1}{n} \Sigma\, z_i^4 - 3$$

and the weighted kurtosis is computed as

$$= \frac{1}{n} \Sigma \left((x_i - \bar{x})/\widehat{\sigma_i}\right)^4 - 3$$

$$= \frac{1}{n} \Sigma\, w_i^2((x_i - \bar{x})/\widehat{\sigma})^4 - 3$$

where σ_i^2 is σ^2/w_i. The formula is invariant under the transformation $w_i^* = zw_i,\ z > 0$. When you use VARDEF=WDF or VARDEF=WEIGHT, the kurtosis is set to missing.

Note: PROC MEANS and PROC TABULATE do not compute weighted kurtosis.

MAX
is the maximum value of x_i.

MEAN
is the arithmetic mean $\bar{x}$.

MIN
is the minimum value of x_i.

MODE
is the most frequent value of x_i.

Note: When QMETHOD=P2, PROC REPORT, PROC MEANS, and PROC TABULATE do not compute MODE.

N
is the number of x_i values that are not missing. Observations with f_i less than one and w_i equal to missing or $w_i \leq 0$ (when you use the EXCLNPWGT option) are excluded from the analysis and are not included in the calculation of N.

NMISS
is the number of x_i values that are missing. Observations with f_i less than one and w_i equal to missing or $w_i \leq 0$ (when you use the EXCLNPWGT option) are excluded from the analysis and are not included in the calculation of NMISS.

NOBS
is the total number of observations and is calculated as the sum of N and NMISS. However, if you use the WEIGHT statement, then NOBS is calculated as the sum of N, NMISS, and the number of observations excluded because of missing or nonpositive weights.

RANGE
is the range and is calculated as the difference between maximum value and minimum value.

SKEWNESS | SKEW
is skewness, which measures the tendency of the deviations to be larger in one direction than in the other. When VARDEF=DF, the skewness is computed as

$$c_{3_n} \Sigma z_i^3$$

where c_{3_n} is $\frac{n}{(n-1)(n-2)}$. The weighted skewness is computed as

$$= c_{3_n} \Sigma \left((x_i - \overline{x})/\widehat{\sigma_j}\right)^3$$
$$= c_{3_n} \Sigma w_i^{3/2}((x_i - \overline{x})/\widehat{\sigma})^3$$

When VARDEF=N, the skewness is computed as

$$= \frac{1}{n} \Sigma z_i^3$$

and the weighted skewness is computed as

$$= \frac{1}{n} \Sigma \left((x_i - \overline{x})/\widehat{\sigma_j}\right)^3$$
$$= \frac{1}{n} \Sigma w_i^{3/2}((x_i - \overline{x})/\widehat{\sigma})^3$$

The formula is invariant under the transformation $w_i^* = zw_i,\ z > 0$. When you use VARDEF=WDF or VARDEF=WEIGHT, the skewness is set to missing.

Note: PROC MEANS and PROC TABULATE do not compute weighted skewness.

STDDEV | STD
is the standard deviation *s* and is computed as the square root of the variance, s^2 .

STDERR | STDMEAN
is the standard error of the mean, computed as

$$s/\sqrt{\Sigma w_i}$$

when VARDEF=DF, which is the default. Otherwise, STDERR is set to missing.

SUM
is the sum, computed as

$$\Sigma w_i x_i$$

SUMWGT
is the sum of the weights, W , computed as

$$\Sigma w_i$$

USS
is the uncorrected sum of squares, computed as

$$\Sigma\, w_i x_i^2$$

VAR
is the variance s^2 .

Quantile and Related Statistics

The keywords for quantiles and related statistics are

MEDIAN
is the middle value.

P1
is the 1st percentile.

P5
is the 5th percentile.

P10
is the 10th percentile.

P90
is the 90th percentile.

P95
is the 95th percentile.

P99
is the 99th percentile.

Q1
is the lower quartile (25th percentile).

Q3
is the upper quartile (75th percentile).

QRANGE
is interquartile range and is calculated as

$$Q_3 - Q_1$$

You use the QNTLDEF= option (PCTLDEF= in PROC UNIVARIATE) to specify the method that the procedure uses to compute percentiles. Let n be the number of nonmissing values for a variable, and let $x_1, x_2, \ldots, x_n$ represent the ordered values of the variable such that x_1 is the smallest value, x_2 is next smallest value, and x_n is the largest value. For the tth percentile between 0 and 1, let $p = t/100$. Then specify j as the integer part of np and g as the fractional part of np or $(n+1)p$, so that

$$\begin{aligned} np &= j + g && \text{when QNTLDEF} = 1, 2, 3, \text{or } 5 \\ (n+1)p &= j + g && \text{when QNTLDEF} = 4 \end{aligned}$$

Here, QNTLDEF= specifies the method that the procedure uses to compute the *t*th percentile, as shown in the table that follows.

When you use the WEIGHT statement, the *t*th percentile is computed as

$$y = \begin{cases} \frac{1}{2}(x_i + x_{i+1}) & \text{if } \sum_{j=1}^{i} w_j = pW \\ x_{i+1} & \text{if } \sum_{j=1}^{i} w_j < pW < \sum_{j=1}^{i+1} w_j \end{cases}$$

where w_j is the weight associated with x_i and $W = \sum_{i=1}^{n} w_i$ is the sum of the weights.

When the observations have identical weights, the weighted percentiles are the same as the unweighted percentiles with QNTLDEF=5.

Table A66.2 *Methods for Computing Quantile Statistics*

QNTLDEF =	Description	Formula	
1	weighted average at x_{np}	$y = (1-g)x_j + gx_{j+1}$	
		where x_o is taken to be x_1	
2	observation numbered closest to np	$y = x_i$	if $g \neq \frac{1}{2}$
		$y = x_j$	if $g = \frac{1}{2}$ and j is even
		$y = x_{j+1}$	if $g = \frac{1}{2}$ and j is odd
		where *i* is the integer part of $np + \frac{1}{2}$	
3	empirical distribution function	$y = x_j$	if $g = 0$
		$y = x_{j+1}$	if $g > 0$
4	weighted average aimed at $x_{(n+1)p}$	$y = (1-g)x_j + gx_{j+1}$	
		where x_{n+1} is taken to be x_n	
5	empirical distribution function with averaging	$y = \frac{1}{2}(x_j + x_{j+1})$	if $g = 0$
		$y = x_{j+1}$	if $g > 0$

Hypothesis Testing Statistics

The keywords for hypothesis testing statistics are

T
is the Student's *t* statistic to test the null hypothesis that the population mean is equal to μ_0 and is calculated as

$$\frac{\overline{x} - \mu_0}{s/\sqrt{\Sigma\, w_i}}$$

By default, μ_0 is equal to zero. You can use the MU0= option in the PROC UNIVARIATE statement to specify μ_0 . You must use VARDEF=DF, which is the default variance divisor, otherwise T is set to missing.

By default, when you use a WEIGHT statement, the procedure counts the x_i values with nonpositive weights in the degrees of freedom. Use the EXCLNPWGT option in the PROC statement to exclude values with nonpositive weights. Most SAS/STAT procedures, such as PROC TTEST and PROC GLM automatically exclude values with nonpositive weights.

PROBT | PRT
is the two-tailed *p*-value for Student's *t* statistic, T, with $n - 1$ degrees of freedom. This value is the probability under the null hypothesis of obtaining a more extreme value of T than is observed in this sample.

Confidence Limits for the Mean

The keywords for confidence limits are

CLM
is the two-sided confidence limit for the mean. A two-sided $100(1 - \alpha)$ percent confidence interval for the mean has upper and lower limits

$$\overline{x} \pm t_{(1 - \alpha/2;\, n - 1)} \frac{s}{\sqrt{\Sigma\, w_i}}$$

where s is $\sqrt{\frac{1}{n-1}\,\Sigma\,(x_i - \overline{x})^2}$, $t_{(1 - \alpha/2;\, n - 1)}$ is the ($1 - \alpha/2$) critical value of the Student's *t* statistics with $n - 1$ degrees of freedom, and α is the value of the ALPHA= option which by default is 0.05. Unless you use VARDEF=DF, which is the default variance divisor, CLM is set to missing.

LCLM
is the one-sided confidence limit below the mean. The one-sided $100(1 - \alpha)$ percent confidence interval for the mean has the lower limit

$$\overline{x} - t_{(1 - \alpha;\, n - 1)} \frac{s}{\sqrt{\Sigma\, w_i}}$$

Unless you use VARDEF=DF, which is the default variance divisor, LCLM is set to missing.

UCLM
is the one-sided confidence limit above the mean. The one-sided $100(1-\alpha)$ percent confidence interval for the mean has the upper limit

$$\overline{x} + t_{(1-\alpha;n-1)}\frac{s}{\sqrt{\Sigma w_i}}$$

Unless you use VARDEF=DF, which is the default variance divisor, UCLM is set to missing.

Using Weights

For more information about using weights and an example, see "WEIGHT" on page 82.

Data Requirements for Summarization Procedures

Here are the minimal data requirements to compute unweighted statistics and do not describe recommended sample sizes. Statistics are reported as missing if VARDEF=DF (the default) and the following requirements are not met:

- N and NMISS are computed regardless of the number of missing or nonmissing observations.
- SUM, MEAN, MAX, MIN, RANGE, USS, and CSS require at least one nonmissing observation.
- VAR, STD, STDERR, CV, T, PRT, and PROBT require at least two nonmissing observations.
- SKEWNESS requires at least three nonmissing observations.
- KURTOSIS requires at least four nonmissing observations.
- SKEWNESS, KURTOSIS, T, PROBT, and PRT require that STD is greater than zero.
- CV requires that MEAN is not equal to zero.
- CLM, LCLM, UCLM, STDERR, T, PRT, and PROBT require that VARDEF=DF.

Statistical Background

Populations and Parameters

Usually, there is a clearly defined set of elements in which you are interested. This set of elements is called the *universe*, and a set of values associated with these elements is called a *population* of values. The statistical term *population* has nothing to do with people. A statistical population is a collection of values, not a collection of people. For example, a universe is all the students at a particular school, and there could be two populations of interest: one of height values and one of weight values. Or, a universe is the set of all widgets manufactured by a particular company, and the population of values could be the length of time each widget is used before it fails.

A population of values can be described in terms of its *cumulative distribution function*, which gives the proportion of the population less than or equal to each possible value. A discrete population can also be described by a *probability function*, which gives the proportion of the population equal to each possible value. A continuous population can often be described by a *density function*, which is the derivative of the cumulative distribution function. A density function can be approximated by a histogram that gives the proportion of the population lying within each of a series of intervals of values. A probability density function is like a histogram with an infinite number of infinitely small intervals.

In technical literature, when the term *distribution* is used without qualification, it generally refers to the cumulative distribution function. In informal writing, *distribution* sometimes means the density function instead. Often the word *distribution* is used simply to refer to an abstract population of values rather than some concrete population. Thus, the statistical literature refers to many types of abstract distributions, such as normal distributions, exponential distributions, Cauchy distributions, and so on. When a phrase such as *normal distribution* is used, it frequently does not matter whether the cumulative distribution function or the density function is intended.

It might be expedient to describe a population in terms of a few measures that summarize interesting features of the distribution. One such measure, computed from the population values, is called a *parameter*. Many different parameters can be specified to measure different aspects of a distribution.

The most commonly used parameter is the (arithmetic) *mean*. If the population contains a finite number of values, then the population mean is computed as the sum of all the values in the population divided by the number of elements in the population. For an infinite population, the concept of the mean is similar but requires more complicated mathematics.

E(x) denotes the mean of a population of values symbolized by x, such as height, where E stands for *expected value*. You can also consider expected values of derived functions of the original values. For example, if x represents height, then $\mathrm{E}(x^2)$ is the expected value of height squared, that is, the mean value of the population obtained by squaring every value in the population of heights.

Samples and Statistics

It is often impossible to measure all of the values in a population. A collection of measured values is called a *sample*. A mathematical function of a sample of values is called a *statistic*. A statistic is to a sample as a parameter is to a population. It is customary to denote statistics by Roman letters and parameters by Greek letters. For example, the population mean is often written as μ, whereas the sample mean is written as $\bar{x}$. The field of *statistics* is largely concerned with the study of the behavior of sample statistics.

Samples can be selected in a variety of ways. Most SAS procedures assume that the data constitute a *simple random sample*, which means that the sample was selected in such a way that all possible samples were equally likely to be selected.

Statistics from a sample can be used to make inferences, or reasonable guesses, about the parameters of a population. For example, if you take a random sample of 30 students from the high school, then the mean height for those 30 students is a reasonable guess, or *estimate*, of the mean height of all the students in the high school. Other statistics, such as the standard error, can provide information about how good an estimate is likely to be.

For any population parameter, several statistics can estimate it. Often, however, there is one particular statistic that is customarily used to estimate a given parameter. For example, the sample mean is the usual estimator of the population mean. In the case of the mean, the formulas for the parameter and the statistic are the same. In other cases, the formula for a parameter might be different from that of the most commonly used estimator. The most commonly used estimator is not necessarily the best estimator in all applications.

Measures of Location

Overview of Measures of Location

Measures of location include the mean, the median, and the mode. These measures describe the center of a distribution. In the definitions that follow, notice that if the entire sample changes by adding a fixed amount to each observation, then these measures of location are shifted by the same fixed amount.

The Mean

The population mean $\mu = \mathrm{E}(x)$ is usually estimated by the sample mean $\overline{x}$.

The Median

The population median is the central value, lying above and below half of the population values. The sample median is the middle value when the data are arranged in ascending or descending order. For an even number of observations, the midpoint between the two middle values is usually reported as the median.

The Mode

The mode is the value at which the density of the population is at a maximum. Some densities have more than one local maximum (peak) and are said to be *multimodal*. The sample mode is the value that occurs most often in the sample. By default, PROC UNIVARIATE reports the lowest such value if there is a tie for the most-often-occurring sample value. PROC UNIVARIATE lists all possible modes when you specify the MODES option in the PROC statement. If the population is continuous, then all sample values occur once, and the sample mode has little use.

Percentiles

Percentiles, including quantiles, quartiles, and the median, are useful for a detailed study of a distribution. For a set of measurements arranged in order of magnitude, the *p*th percentile is the value that has *p* percent of the measurements below it and (100–*p*) percent above it. The median is the 50th percentile. Because it might not be possible to divide your data so that you get exactly the desired percentile, the UNIVARIATE procedure uses a more precise definition.

The upper quartile of a distribution is the value below which 75% of the measurements fall (the 75th percentile). Twenty-five percent of the measurements fall below the lower quartile value.

Quantiles

In the following example, SAS artificially generates the data with a pseudorandom number function. The UNIVARIATE procedure computes a variety of quantiles and measures of location and writes the values to a SAS data set. A DATA step then

uses the SYMPUT routine to assign the values of the statistics to macro variables. The macro %FORMGEN uses these macro variables to produce value labels for the FORMAT procedure. PROC CHART uses the resulting format to display the values of the statistics on a histogram.

```
options nodate pageno=1 linesize=80 pagesize=52;

title 'Example of Quantiles and Measures of Location';

data random;
   drop n;
   do n=1 to 1000;
      X=floor(exp(rannor(314159)*.8+1.8));
      output;
   end;
run;

proc univariate data=random nextrobs=0;
   var x;
   output out=location
          mean=Mean mode=Mode median=Median
          q1=Q1 q3=Q3 p5=P5 p10=P10 p90=P90 p95=P95
          max=Max;
run;

proc print data=location noobs;
run;

data _null_;
   set location;
   call symput('MEAN',round(mean,1));
   call symput('MODE',mode);
   call symput('MEDIAN',round(median,1));
   call symput('Q1',round(q1,1));
   call symput('Q3',round(q3,1));
   call symput('P5',round(p5,1));
   call symput('P10',round(p10,1));
   call symput('P90',round(p90,1));
   call symput('P95',round(p95,1));
   call symput('MAX',min(50,max));
run;

%macro formgen;
%do i=1 %to &max;
   %let value=&i;
   %if &i=&p5     %then %let value=&value  P5;
   %if &i=&p10    %then %let value=&value  P10;
   %if &i=&q1     %then %let value=&value  Q1;
   %if &i=&mode   %then %let value=&value  Mode;
   %if &i=&median %then %let value=&value  Median;
   %if &i=&mean   %then %let value=&value  Mean;
   %if &i=&q3     %then %let value=&value  Q3;
   %if &i=&p90    %then %let value=&value  P90;
   %if &i=&p95    %then %let value=&value  P95;
   %if &i=&max    %then %let value=>=&value;
   &i="&value"
%end;
%mend;
```

```
proc format print;
   value stat %formgen;
run;
options pagesize=42 linesize=80;

proc chart data=random;
   vbar x / midpoints=1 to &max by 1;
   format x stat.;
   footnote  'P5  =  5TH PERCENTILE';
   footnote2 'P10 = 10TH PERCENTILE';
   footnote3 'P90 = 90TH PERCENTILE';
   footnote4 'P95 = 95TH PERCENTILE';
   footnote5 'Q1  =  1ST QUARTILE  ';
   footnote6 'Q3  =  3RD QUARTILE  ';
run;
```

Example of Quantiles and Measures of Location

The UNIVARIATE Procedure
Variable: X

Moments			
N	1000	Sum Weights	1000
Mean	7.605	Sum Observations	7605
Std Deviation	7.38169794	Variance	54.4894645
Skewness	2.73038523	Kurtosis	11.1870588
Uncorrected SS	112271	Corrected SS	54434.975
Coeff Variation	97.0637467	Std Error Mean	0.23342978

Basic Statistical Measures			
Location		Variability	
Mean	7.605000	Std Deviation	7.38170
Median	5.000000	Variance	54.48946
Mode	3.000000	Range	62.00000
		Interquartile Range	6.00000

Tests for Location: Mu0=0				
Test	Statistic		p Value	
Student's t	t	32.57939	Pr > |t|	<.0001
Sign	M	494.5	Pr >= |M|	<.0001
Signed Rank	S	244777.5	Pr >= |S|	<.0001

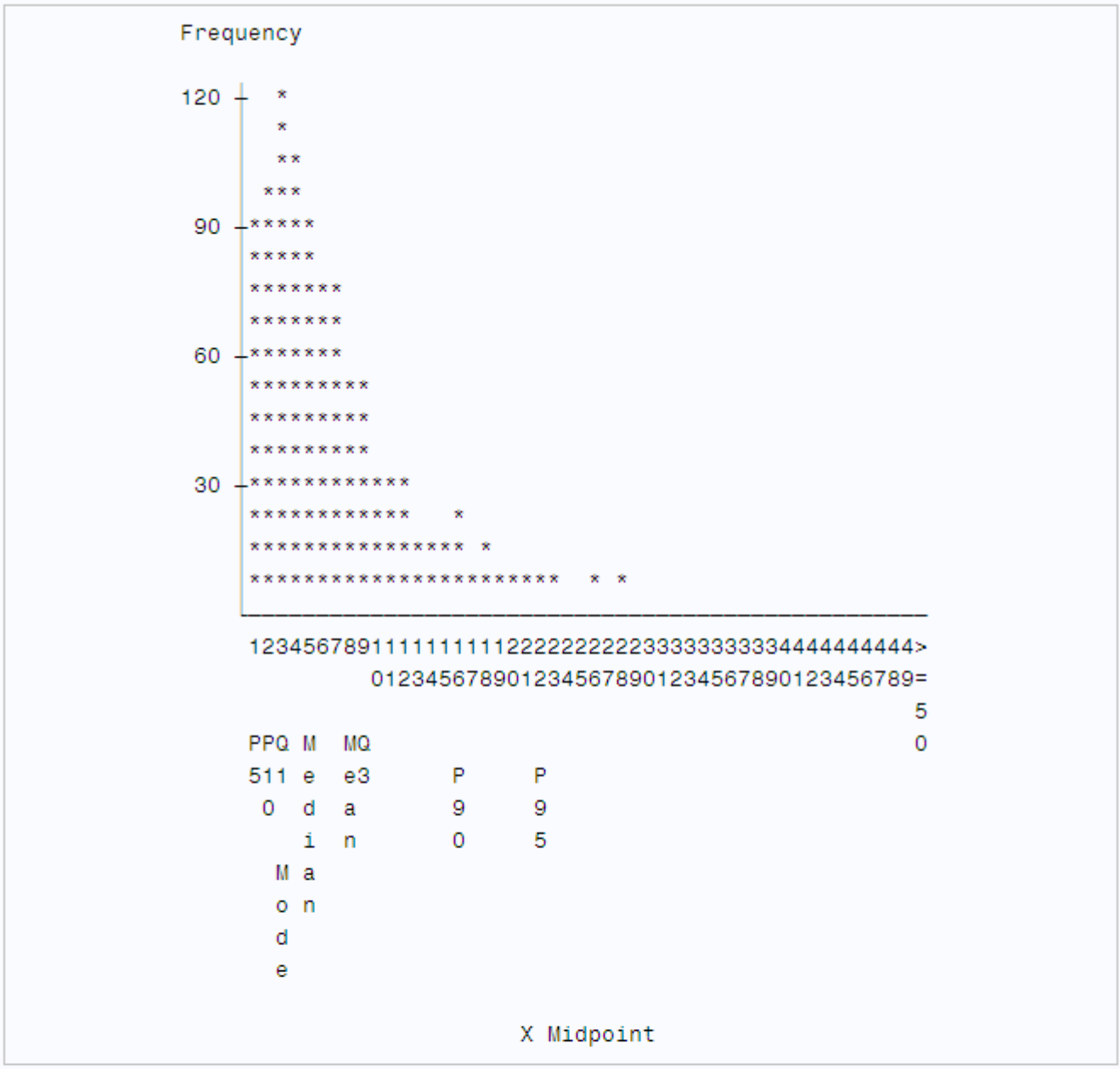
Tests for Location: Mu0=0				
Test	Statistic		p Value	
Student's t	t	32.57939	Pr > |t|	<.0001
Sign	M	494.5	Pr >= |M|	<.0001
Signed Rank	S	244777.5	Pr >= |S|	<.0001

Quantiles (Definition 5)	
Quantile	Estimate
100% Max	62.0
99%	37.5
95%	21.5
90%	16.0
75% Q3	9.0
50% Median	5.0
25% Q1	3.0
10%	2.0
5%	1.0
1%	0.0
0% Min	0.0

Example of Quantiles and Measures of Location

Mean	Max	P95	P90	Q3	Median	Q1	P10	P5	Mode
7.605	62	21.5	16	9	5	3	2	1	3

Example of Quantiles and Measures of Location



P5 = 5TH PERCENTILE
P10 = 10TH PERCENTILE
P90 = 90TH PERCENTILE
P95 = 95TH PERCENTILE
Q1 = 1ST QUARTILE
Q3 = 3RD QUARTILE

Measures of Variability

Overview of Measures of Variability

Another group of statistics is important in studying the distribution of a population. These statistics measure the *variability*, also called the spread, of values. In the definitions given in the sections that follow, notice that if the entire sample is changed by the addition of a fixed amount to each observation, then the values of these statistics are unchanged. If each observation in the sample is multiplied by a constant, however, then the values of these statistics are appropriately rescaled.

The Range

The sample range is the difference between the largest and smallest values in the sample. For many populations, at least in statistical theory, the range is infinite, so the sample range might not tell you much about the population. The sample range tends to increase as the sample size increases. If all sample values are multiplied by a constant, then the sample range is multiplied by the same constant.

The Interquartile Range

The interquartile range is the difference between the upper and lower quartiles. If all sample values are multiplied by a constant, then the sample interquartile range is multiplied by the same constant.

The Variance

The population variance, usually denoted by σ^2, is the expected value of the squared difference of the values from the population mean:

$$\sigma^2 = \mathrm{E}(x - \mu)^2$$

The sample variance is denoted by s^2. The difference between a value and the mean is called a *deviation from the mean*. Thus, the variance approximates the mean of the squared deviations.

When all the values lie close to the mean, the variance is small but never less than zero. When values are more scattered, the variance is larger. If all sample values are multiplied by a constant, then the sample variance is multiplied by the square of the constant.

Sometimes values other than $n - 1$ are used in the denominator. The VARDEF= option controls what divisor the procedure uses.

The Standard Deviation

The standard deviation is the square root of the variance, or root-mean-square deviation from the mean, in either a population or a sample. The usual symbols are σ for the population and *s* for a sample. The standard deviation is expressed in the same units as the observations, rather than in squared units. If all sample values are multiplied by a constant, then the sample standard deviation is multiplied by the same constant.

Coefficient of Variation

The coefficient of variation is a unitless measure of relative variability. It is defined as the ratio of the standard deviation to the mean expressed as a percentage. The coefficient of variation is meaningful only if the variable is measured on a ratio scale. If all sample values are multiplied by a constant, then the sample coefficient of variation remains unchanged.

Measures of Shape

Skewness

The variance is a measure of the overall size of the deviations from the mean. Since the formula for the variance squares the deviations, both positive and negative deviations contribute to the variance in the same way. In many distributions, positive deviations might tend to be larger in magnitude than negative deviations, or vice versa. *Skewness* is a measure of the tendency of the deviations to be larger in one direction than in the other. For example, the data in the last example are skewed to the right.

Population skewness is defined as

$$\mathrm{E}(x - \mu)^3/\sigma^3$$

Because the deviations are cubed rather than squared, the signs of the deviations are maintained. Cubing the deviations also emphasizes the effects of large deviations. The formula includes a divisor of σ^3 to remove the effect of scale, so multiplying all values by a constant does not change the skewness. Skewness can thus be interpreted as a tendency for one tail of the population to be heavier than the other. Skewness can be positive or negative and is unbounded.

Kurtosis

The heaviness of the tails of a distribution affects the behavior of many statistics. Therefore, it is useful to have a measure of tail heaviness. One such measure is *kurtosis*. The population kurtosis is usually defined as

$$\frac{\mathrm{E}(x-\mu)^4}{\sigma^4} - 3$$

Note: Some statisticians omit the subtraction of 3.

Because the deviations are raised to the fourth power, positive and negative deviations make the same contribution, and large deviations are strongly emphasized. Because of the divisor σ^4 , multiplying each value by a constant has no effect on kurtosis.

Population kurtosis must lie between -2 and $+\infty$, inclusive. If M_3 represents population skewness and M_4 represents population kurtosis, then

$$M_4 > (M_3)^2 - 2$$

Statistical literature sometimes reports that kurtosis measures the *peakedness* of a density. However, heavy tails have much more influence on kurtosis than does the shape of the distribution near the mean (Kaplansky 1945; Ali 1974; Johnson, et al. 1980).

Sample skewness and kurtosis are rather unreliable estimators of the corresponding parameters in small samples. They are better estimators when your sample is very large. However, large values of skewness or kurtosis might merit attention even in small samples because such values indicate that statistical methods that are based on normality assumptions might be inappropriate.

The Normal Distribution

One especially important family of theoretical distributions is the *normal* or *Gaussian* distribution. A normal distribution is a smooth symmetric function often referred to as "bell-shaped." Its skewness and kurtosis are both zero. A normal distribution can be completely specified by only two parameters: the mean and the standard deviation. Approximately 68% of the values in a normal population are within one standard deviation of the population mean; approximately 95% of the values are within two standard deviations of the mean; and about 99.7% are within three standard deviations. Use of the term *normal* to describe this particular type of distribution does not imply that other types of distributions are necessarily abnormal or pathological.

Many statistical methods are designed under the assumption that the population being sampled is normally distributed. Nevertheless, most real-life populations do

not have normal distributions. Before using any statistical method based on normality assumptions, you should consult the statistical literature to find out how sensitive the method is to nonnormality and, if necessary, check your sample for evidence of nonnormality.

In the following example, SAS generates a sample from a normal distribution with a mean of 50 and a standard deviation of 10. The UNIVARIATE procedure performs tests for location and normality. Because the data are from a normal distribution, all *p*-values from the tests for normality are greater than 0.15. The CHART procedure displays a histogram of the observations. The shape of the histogram is a bell-like, normal density.

```
options nodate pageno=1 linesize=80 pagesize=52;

title '10000 Obs Sample from a Normal Distribution';
title2 'with Mean=50 and Standard Deviation=10';

data normaldat;
   drop n;
   do n=1 to 10000;
      X=10*rannor(53124)+50;
      output;
   end;
run;

proc univariate data=normaldat nextrobs=0 normal
                          mu0=50 loccount;
   var x;
run;

proc format;
   picture msd
      20='20 3*Std' (noedit)
      30='30 2*Std' (noedit)
      40='40 1*Std' (noedit)
      50='50 Mean ' (noedit)
      60='60 1*Std' (noedit)
      70='70 2*Std' (noedit)
      80='80 3*Std' (noedit)
   other=' ';
run;
options linesize=80 pagesize=42;

proc chart;
   vbar x / midpoints=20 to 80 by 2;
   format x msd.;
run;
```

10000 Obs Sample from a Normal Distribution with Mean=50 and Standard Deviation=10

The UNIVARIATE Procedure
Variable: X

Moments			
N	10000	Sum Weights	10000
Mean	50.0323744	Sum Observations	500323.744
Std Deviation	9.92013874	Variance	98.4091525
Skewness	-0.019929	Kurtosis	-0.0163755
Uncorrected SS	26016378	Corrected SS	983993.116
Coeff Variation	19.8274395	Std Error Mean	0.09920139

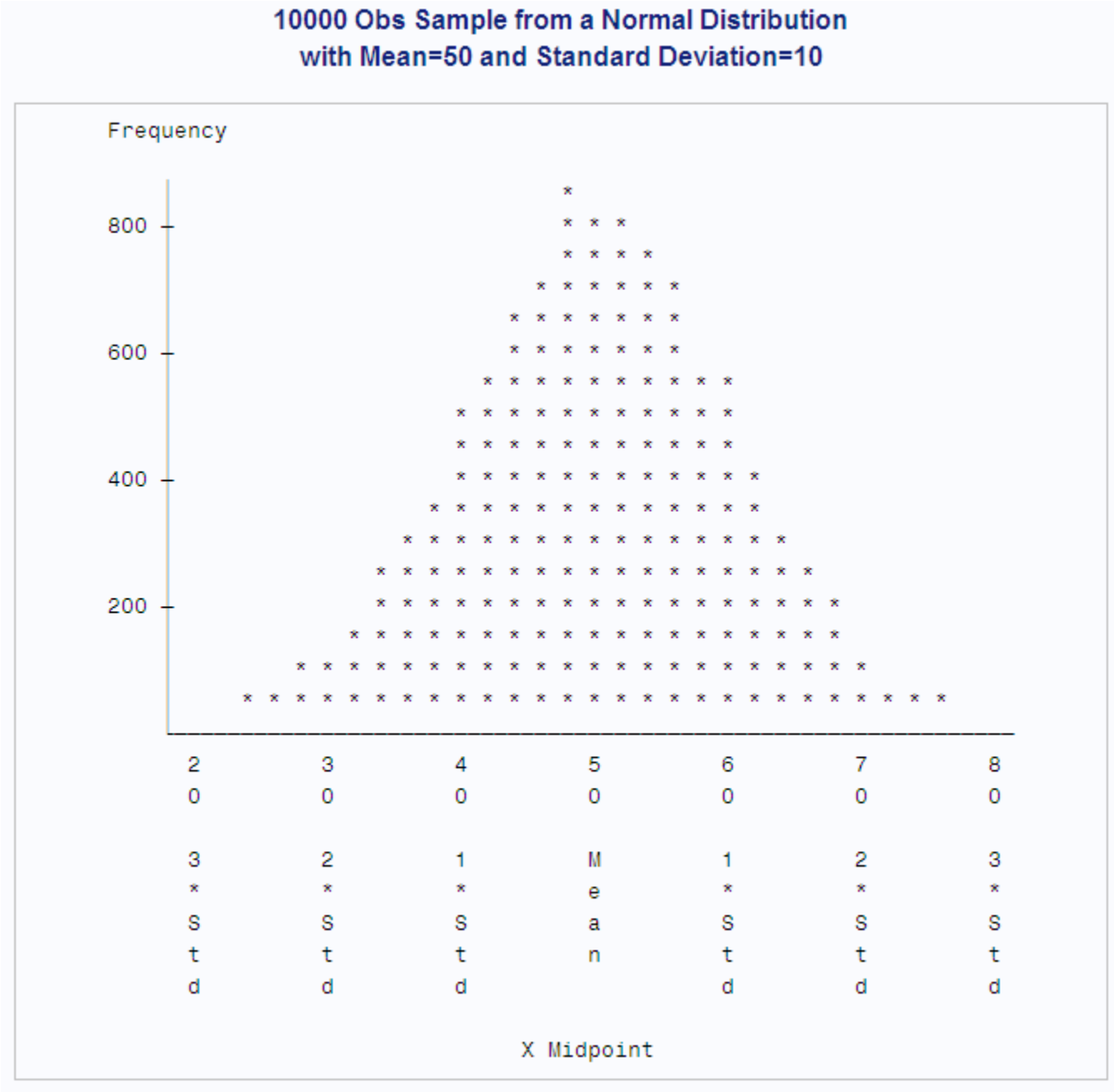
Basic Statistical Measures			
Location		Variability	
Mean	50.03237	Std Deviation	9.92014
Median	50.06492	Variance	98.40915
Mode	.	Range	76.51343
		Interquartile Range	13.28179

Tests for Location: Mu0=50				
Test	Statistic		p Value	
Student's t	t	0.32635	Pr > |t|	0.7442
Sign	M	26	Pr >= |M|	0.6101
Signed Rank	S	174063	Pr >= |S|	0.5466

Location Counts: Mu0=50.00	
Count	Value
Num Obs > Mu0	5026
Num Obs ^= Mu0	10000
Num Obs < Mu0	4974

Tests for Normality				
Test	Statistic		p Value	
Kolmogorov-Smirnov	D	0.006595	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.049963	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.371151	Pr > A-Sq	>0.2500

Quantiles (Definition 5)	
Quantile	Estimate
100% Max	90.2105
99%	72.6780
95%	66.2221
90%	62.6678
75% Q3	56.7280
50% Median	50.0649
25% Q1	43.4462
10%	37.1139
5%	33.5454
1%	26.9189
0% Min	13.6971



Sampling Distribution of the Mean

If you repeatedly draw samples of size *n* from a population and compute the mean of each sample, then the sample means themselves have a distribution. Consider a new population consisting of the means of all the samples that could possibly be drawn from the original population. The distribution of this new population is called a *sampling distribution*.

It can be proven mathematically that if the original population has mean μ and standard deviation σ, then the sampling distribution of the mean also has mean μ,

but its standard deviation is $\sigma/\sqrt{n}$. The standard deviation of the sampling distribution of the mean is called the *standard error of the mean*. The standard error of the mean provides an indication of the accuracy of a sample mean as an estimator of the population mean.

If the original population has a normal distribution, then the sampling distribution of the mean is also normal. If the original distribution is not normal but does not have excessively long tails, then the sampling distribution of the mean can be approximated by a normal distribution for large sample sizes.

The following example consists of three separate programs that show how the sampling distribution of the mean can be approximated by a normal distribution as the sample size increases. The first DATA step uses the RANEXP function to create a sample of 1000 observations from an exponential distribution. The theoretical population mean is 1.00, and the sample mean is 1.01, to two decimal places. The population standard deviation is 1.00; the sample standard deviation is 1.04.

The following example is an example of a nonnormal distribution. The population skewness is 2.00, which is close to the sample skewness of 1.97. The population kurtosis is 6.00, but the sample kurtosis is only 4.80.

```
options nodate pageno=1 linesize=80 pagesize=42;

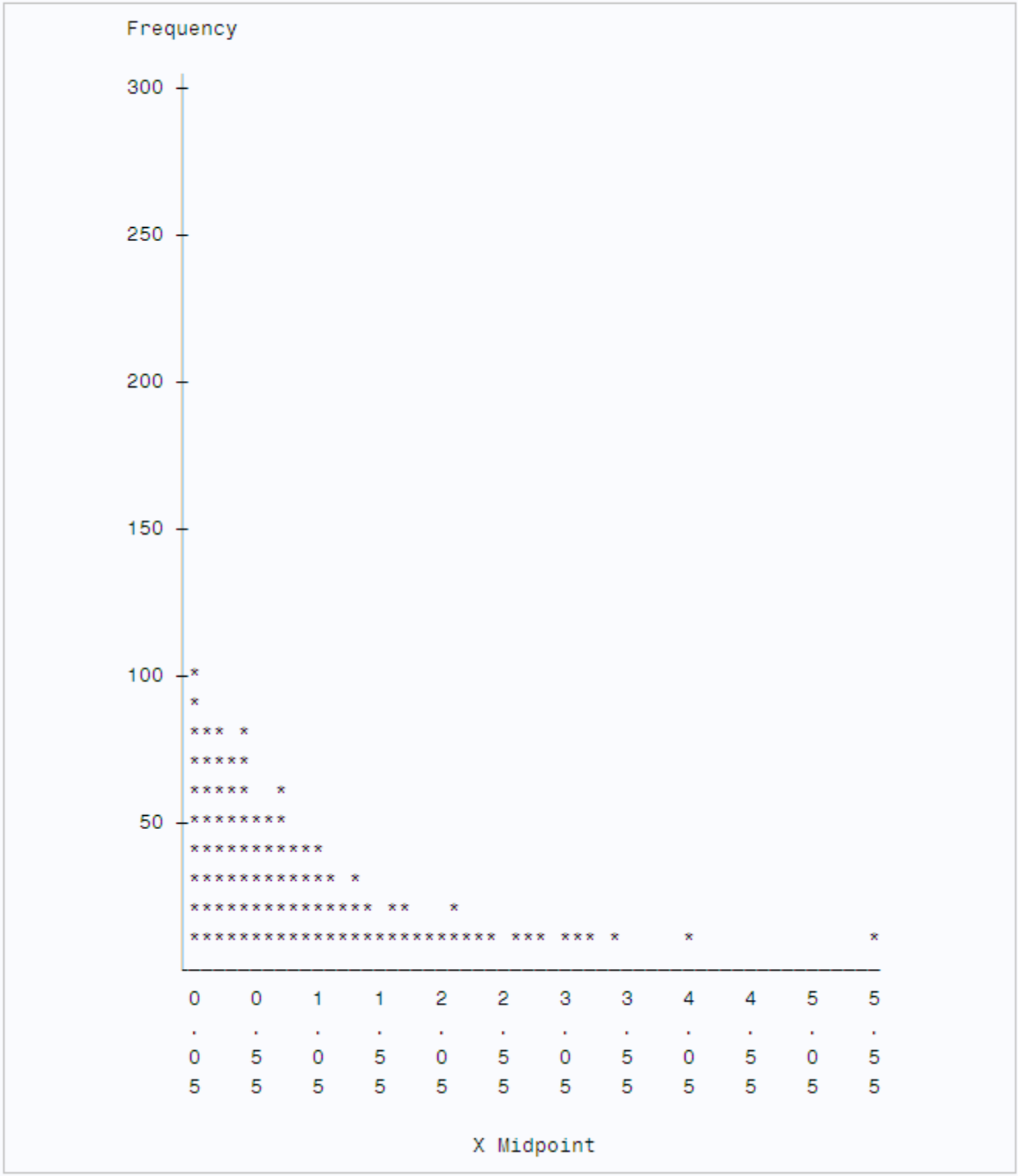
title '1000 Observation Sample';
title2 'from an Exponential Distribution';

data expodat;
   drop n;
   do n=1 to 1000;
      X=ranexp(18746363);
      output;
   end;
run;
proc format;
    value axisfmt
      .05='0.05'
      .55='0.55'
     1.05='1.05'
     1.55='1.55'
     2.05='2.05'
     2.55='2.55'
     3.05='3.05'
     3.55='3.55'
     4.05='4.05'
     4.55='4.55'
     5.05='5.05'
     5.55='5.55'
     other=' ';
run;

proc chart data=expodat ;
   vbar x / axis=300
            midpoints=0.05 to 5.55 by .1;
   format x axisfmt.;
run;

options pagesize=64;
```

```
proc univariate data=expodat noextrobs=0 normal
                mu0=1;
   var x;
run;
```


1000 Observation Sample
from an Exponential Distribution
Frequency
300
250
200
150
100
50
0 0 1 1 2 2 3 3 4 4 5 5
. . . .
0 5 0 5 0 5 0 5 0 5 0 5
5 5 5 5 5 5 5 5 5 5 5 5
X Midpoint

1000 Observation Sample from an Exponential Distribution

The UNIVARIATE Procedure
Variable: X

Moments			
N	1000	Sum Weights	1000
Mean	1.01176214	Sum Observations	1011.76214
Std Deviation	1.04371187	Variance	1.08933447
Skewness	1.96963112	Kurtosis	4.80150594
Uncorrected SS	2111.90777	Corrected SS	1088.24514
Coeff Variation	103.15783	Std Error Mean	0.03300507

Basic Statistical Measures			
Location		Variability	
Mean	1.011762	Std Deviation	1.04371
Median	0.689502	Variance	1.08933
Mode	.	Range	6.63851
		Interquartile Range	1.06252

Tests for Location: Mu0=1				
Test	Statistic		p Value	
Student's t	t	0.356374	Pr > |t|	0.7216
Sign	M	-140	Pr >= |M|	<.0001
Signed Rank	S	-50781	Pr >= |S|	<.0001

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.801498	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.166308	Pr > D	<0.0100
Cramer-von Mises	W-Sq	9.507975	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	54.5478	Pr > A-Sq	<0.0050

Quantiles (Definition 5)	
Quantile	Estimate
100% Max	6.63906758
99%	5.04491651
95%	3.13482318
90%	2.37803632
75% Q3	1.35733401
50% Median	0.68950221
25% Q1	0.29481436
10%	0.10219011
5%	0.05192799
1%	0.01195590
0% Min	0.00055441

The next DATA step generates 1000 different samples from the same exponential distribution. Each sample contains ten observations. The MEANS procedure computes the mean of each sample. In the data set that is created by PROC MEANS, each observation represents the mean of a sample of ten observations from an exponential distribution. Thus, the data set is a sample from the sampling distribution of the mean for an exponential population.

PROC UNIVARIATE displays statistics for this sample of means. Notice that the mean of the sample of means is .99, almost the same as the mean of the original population. Theoretically, the standard deviation of the sampling distribution is $\sigma/\sqrt{n} = 1.00/\sqrt{10} = .32$, whereas the standard deviation of this sample from the sampling distribution is .30. The skewness (.55) and kurtosis (-.006) are closer to zero in the sample from the sampling distribution than in the original sample from the exponential distribution because the sampling distribution is closer to a normal distribution than is the original exponential distribution. The CHART procedure displays a histogram of the 1000-sample means. The shape of the histogram is much closer to a bell-like, normal density, but it is still distinctly lopsided.

```
options nodate pageno=1 linesize=80 pagesize=48;

title '1000 Sample Means with 10 Obs per Sample';
title2 'Drawn from an Exponential Distribution';

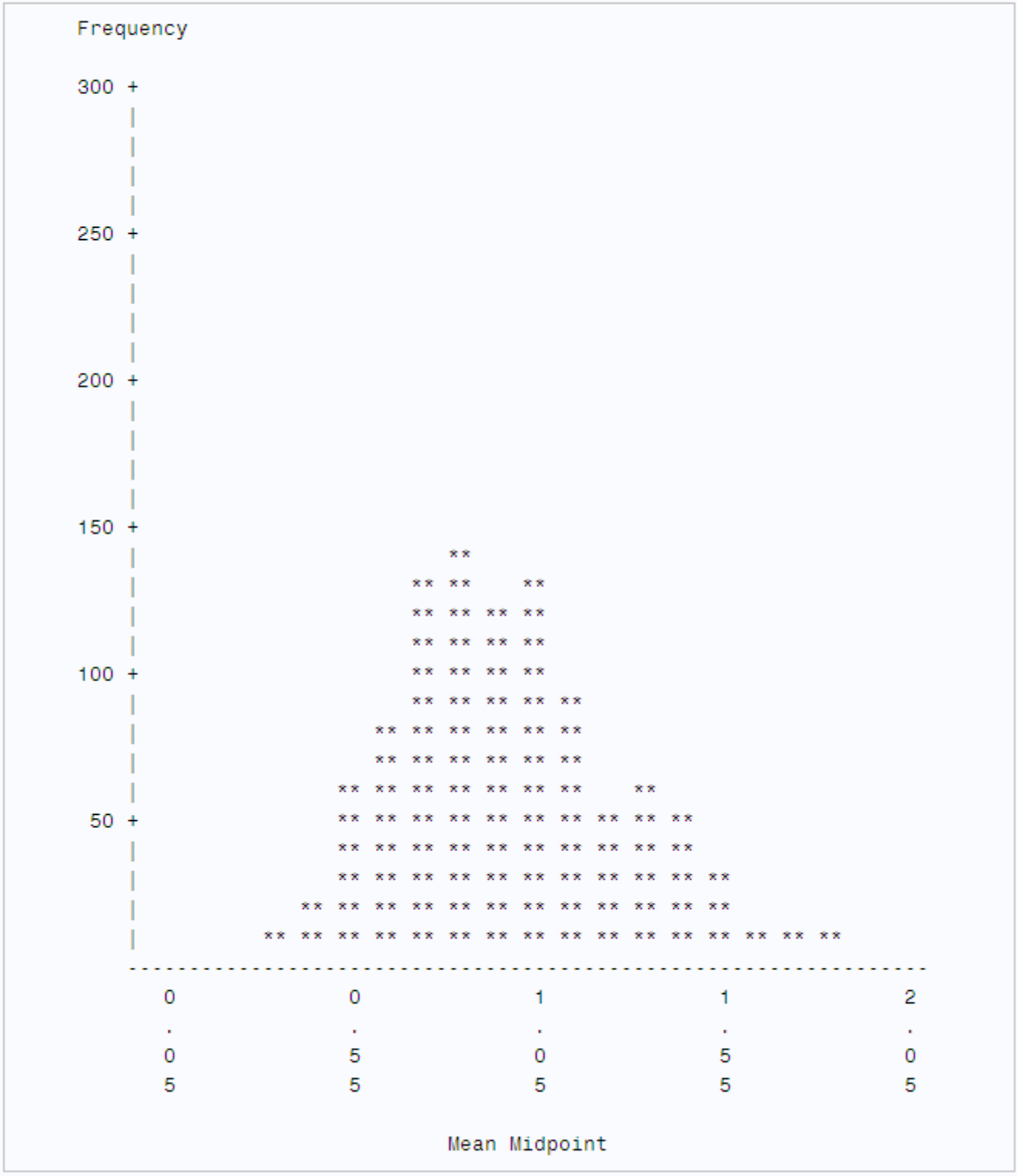
data samp10;
   drop n;
   do Sample=1 to 1000;
      do n=1 to 10;
         X=ranexp(433879);
         output;
      end;
   end;
```

```
proc means data=samp10 noprint;
   output out=mean10 mean=Mean;
   var x;
   by sample;
run;

proc format;
     value axisfmt
       .05='0.05'
       .55='0.55'
      1.05='1.05'
      1.55='1.55'
      2.05='2.05'
      other=' ';
 run;

proc chart data=mean10;
   vbar mean/axis=300
             midpoints=0.05 to 2.05 by .1;
   format mean axisfmt.;
run;

options pagesize=64;
proc univariate data=mean10 nextrobs=0 normal
                mu0=1;
   var mean;
run;
```


1000 Sample Means with 10 Obs per Sample
Drawn from an Exponential Distribution
Frequency
300
250
200
150
100
50
0 0 1 1 2
. . . . .
0 5 0 5 0
5 5 5 5 5
Mean Midpoint

1000 Sample Means with 10 Obs per Sample Drawn from an Exponential Distribution

The UNIVARIATE Procedure
Variable: Mean

Moments			
N	1000	Sum Weights	1000
Mean	0.9906857	Sum Observations	990.685697
Std Deviation	0.30732649	Variance	0.09444957
Skewness	0.54575615	Kurtosis	-0.0060892
Uncorrected SS	1075.81327	Corrected SS	94.3551193
Coeff Variation	31.0215931	Std Error Mean	0.00971852

Basic Statistical Measures			
Location		Variability	
Mean	0.990686	Std Deviation	0.30733
Median	0.956152	Variance	0.09445
Mode	.	Range	1.79783
		Interquartile Range	0.41703

Tests for Location: Mu0=1				
Test	Statistic		p Value	
Student's t	t	-0.95841	Pr > |t|	0.3381
Sign	M	-53	Pr >= |M|	0.0009
Signed Rank	S	-22687	Pr >= |S|	0.0129

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.9779	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.055498	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.953926	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.945023	Pr > A-Sq	<0.0050

Quantiles (Definition 5)	
Quantile	Estimate
100% Max	2.053899
99%	1.827503
95%	1.557175
90%	1.416611
75% Q3	1.181006
50% Median	0.956152
25% Q1	0.763973
10%	0.621787
5%	0.553568
1%	0.433820
0% Min	0.256069

In the following DATA step, the size of each sample from the exponential distribution is increased to 50. The standard deviation of the sampling distribution is smaller than in the previous example because the size of each sample is larger. Also, the sampling distribution is even closer to a normal distribution, as can be seen from the histogram and the skewness.

```
options nodate pageno=1 linesize=80 pagesize=48;

title '1000 Sample Means with 50 Obs per Sample';
title2 'Drawn from an Exponential Distribution';

data samp50;
   drop n;
   do sample=1 to 1000;
      do n=1 to 50;
         X=ranexp(72437213);
         output;
      end;
   end;

proc means data=samp50 noprint;
   output out=mean50 mean=Mean;
   var x;
   by sample;
run;

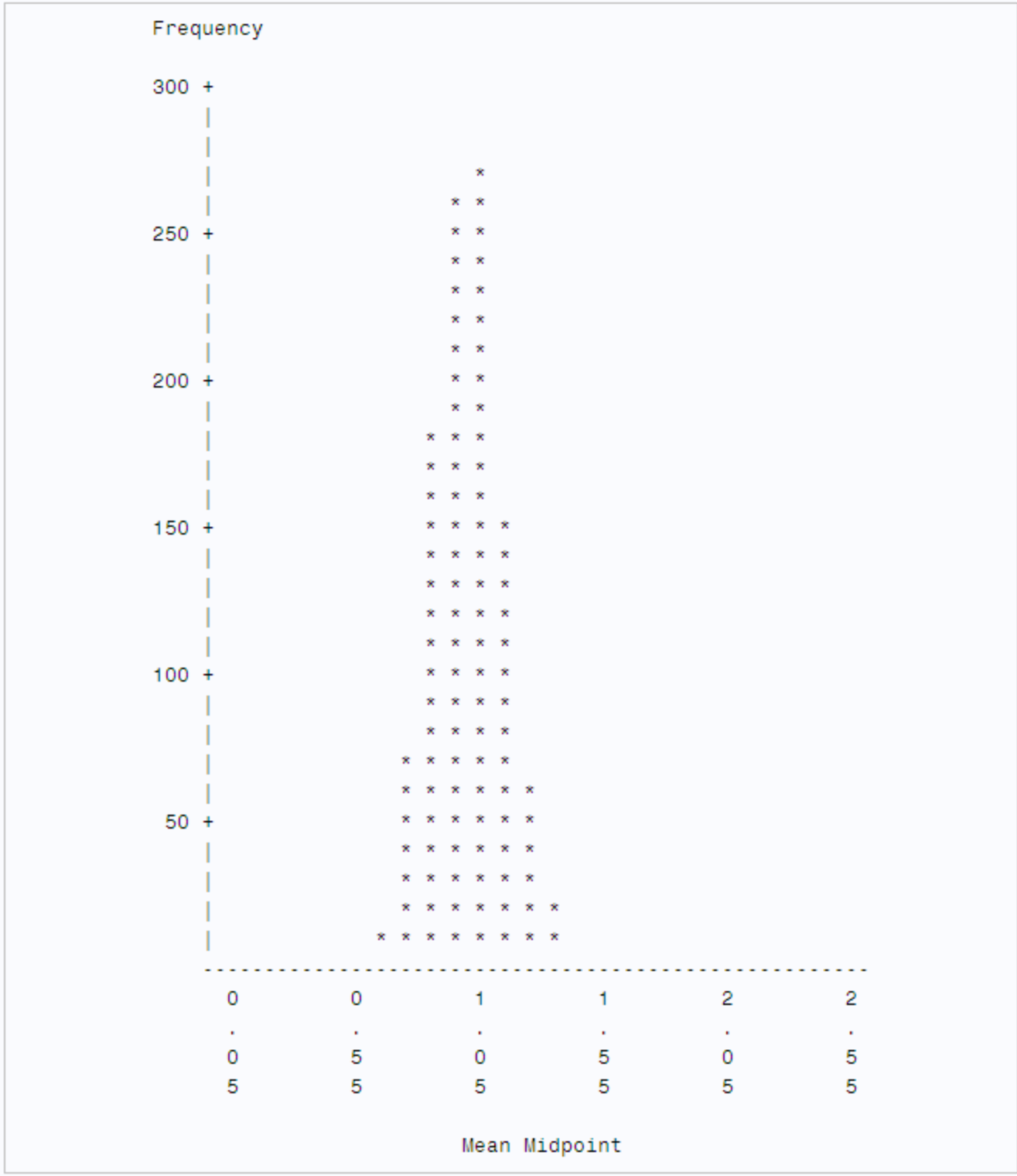
proc format;
   value axisfmt
       .05='0.05'
       .55='0.55'
      1.05='1.05'
      1.55='1.55'
      2.05='2.05'
```

```
      2.55='2.55'
      other=' ';
run;

proc chart data=mean50;
   vbar mean / axis=300
               midpoints=0.05 to 2.55 by .1;
   format mean axisfmt.;
run;

options pagesize=64;

proc univariate data=mean50 nextrobs=0 normal
                mu0=1;
   var mean;
run;
```


1000 Sample Means with 50 Obs per Sample
Drawn from an Exponential Distribution
Frequency
300
250
200
150
100
50
0
0
1
1
2
2
0
5
0
5
0
5
5
5
5
5
5
5
Mean Midpoint

1000 Sample Means with 50 Obs per Sample Drawn from an Exponential Distribution

The UNIVARIATE Procedure
Variable: Mean

Moments			
N	1000	Sum Weights	1000
Mean	0.99679697	Sum Observations	996.796973
Std Deviation	0.13815404	Variance	0.01908654
Skewness	0.19062633	Kurtosis	-0.1438604
Uncorrected SS	1012.67166	Corrected SS	19.067451
Coeff Variation	13.8597969	Std Error Mean	0.00436881

Basic Statistical Measures			
Location		Variability	
Mean	0.996797	Std Deviation	0.13815
Median	0.996023	Variance	0.01909
Mode	.	Range	0.87040
		Interquartile Range	0.18956

Tests for Location: Mu0=1				
Test	Statistic		p Value	
Student's t	t	-0.73316	Pr > |t|	0.4636
Sign	M	-13	Pr >= |M|	0.4292
Signed Rank	S	-10767	Pr >= |S|	0.2388

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.996493	Pr < W	0.0247
Kolmogorov-Smirnov	D	0.023687	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.084468	Pr > W-Sq	0.1882
Anderson-Darling	A-Sq	0.66039	Pr > A-Sq	0.0877

Quantiles (Definition 5)	
Quantile	Estimate
100% Max	1.454957
99%	1.337016
95%	1.231508
90%	1.179223
75% Q3	1.086515
50% Median	0.996023
25% Q1	0.896953
10%	0.814906
5%	0.780783
1%	0.706588
0% Min	0.584558

Testing Hypotheses

Defining a Hypothesis

The purpose of the statistical methods that have been discussed so far is to estimate a population parameter by means of a sample statistic. Another class of statistical methods is used for testing hypotheses about population parameters or for measuring the amount of evidence against a hypothesis.

Consider the universe of students in a college. Let the variable X be the number of pounds by which a student's weight deviates from the ideal weight for a person of the same sex, height, and build. You want to find out whether the population of students is, on the average, underweight or overweight. To this end, you have taken a random sample of X values from nine students, with results as given in the following DATA step:

```
title 'Deviations from Normal Weight';

data x;
   input X @@;
   datalines;
-7 -2 1 3 6 10 15 21 30
;
```

You can define several hypotheses of interest. One hypothesis is that, on the average, the students are of exactly ideal weight. If μ represents the population

mean of the X values, then you can write this hypothesis, called the *null* hypothesis, as $H_0: \mu = 0$. The other two hypotheses, called *alternative* hypotheses, are that the students are underweight on the average, $H_1: \mu < 0$, and that the students are overweight on the average, $H_2: \mu > 0$.

The null hypothesis is so called because it corresponds in many situations to the assumption of "no effect" or "no difference." However, this interpretation is not appropriate for all testing problems. The null hypothesis is like a straw man that can be toppled by statistical evidence. You decide between the alternative hypotheses according to which way the straw man falls.

A naive way to approach this problem would be to look at the sample mean $\bar{x}$ and decide among the three hypotheses according to the following rule:

- If $\bar{x} < 0$, then decide on $H_1: \mu < 0$.
- If $\bar{x} = 0$, then decide on $H_0: \mu = 0$.
- If $\bar{x} > 0$, then decide on $H_2: \mu > 0$.

The trouble with this approach is that there might be a high probability of making an incorrect decision. If H_0 is true, then you are nearly certain to make a wrong decision because the chances of $\bar{x}$ being exactly zero are almost nil. If μ is slightly less than zero, so that H_1 is true, then there might be nearly a 50% chance that $\bar{x}$ will be greater than zero in repeated sampling, so the chances of incorrectly choosing H_2 would also be nearly 50%. Thus, you have a high probability of making an error if $\bar{x}$ is near zero. In such cases, there is not enough evidence to make a confident decision, so the best response might be to reserve judgment until you can obtain more evidence.

The question is, how far from zero must $\bar{x}$ be for you to be able to make a confident decision? The answer can be obtained by considering the sampling distribution of $\bar{x}$. If X has an approximately normal distribution, then $\bar{x}$ has an approximately normal sampling distribution. The mean of the sampling distribution of $\bar{x}$ is μ. Assume temporarily that σ, the standard deviation of X, is known to be 12. Then the standard error of $\bar{x}$ for samples of nine observations is $\sigma/\sqrt{n} = 12/\sqrt{9} = 4$.

You know that about 95% of the values from a normal distribution are within two standard deviations of the mean, so about 95% of the possible samples of nine X values have a sample mean $\bar{x}$ between $0 - 2(4)$ and $0 + 2(4)$, or between −8 and 8. Consider the chances of making an error with the following decision rule:

- If $\bar{x} < -8$, then decide on $H_1: \mu < 0$.
- If $-8 \le \bar{x} \le 8$, then reserve judgment.
- If $\bar{x} > 8$, then decide on $H_2: \mu > 0$.

If H_0 is true, then in about 95% of the possible samples $\bar{x}$ will be between the *critical values* -8 and 8, so you will reserve judgment. In these cases the statistical evidence is not strong enough to fell the straw man. In the other 5% of the samples, you will make an error. In 2.5% of the samples, you will incorrectly choose H_1; in 2.5%, you will incorrectly choose H_2.

The price that you pay for controlling the chances of making an error is the necessity of reserving judgment when there is not sufficient statistical evidence to reject the null hypothesis.

Significance and Power

The probability of rejecting the null hypothesis, if it is true, is called the *Type I error rate* of the statistical test and is typically denoted as α. In this example, an $\overline{x}$ value less than -8 or greater than 8 is said to be *statistically significant* at the 5% level. You can adjust the type I error rate according to your needs by choosing different critical values. For example, critical values of −4 and 4 would produce a significance level of about 32%, and −12 and 12 would give a type I error rate of about 0.3%.

The decision rule is a *two-tailed test* because the alternative hypotheses allow for population means either smaller or larger than the value specified in the null hypothesis. If you were interested only in the possibility of the students being overweight on the average, then you could use a one-tailed test:

- If $\overline{x} \leq 8$, then reserve judgment.
- If $\overline{x} > 8$, then decide on $\mathrm{H}_2\colon\ \mu > 0$.

For this one-tailed test, the type I error rate is 2.5%, half that of the two-tailed test.

The probability of rejecting the null hypothesis, if it is false, is called the *power* of the statistical test and is typically denoted as $1 - \beta$. β is called the *Type II error rate*, which is the probability of not rejecting a false null hypothesis. The power depends on the true value of the parameter. In the example, assume that the population mean is 4. The power for detecting H_2 is the probability of getting a sample mean greater than 8. The critical value 8 is one standard error higher than the population mean 4. The chance of getting a value at least one standard deviation greater than the mean from a normal distribution is about 16%, so the power for detecting the alternative hypothesis H_2 is about 16%. If the population mean were 8, then the power for H_2 would be 50%, whereas a population mean of 12 would yield a power of about 84%.

The smaller the type I error rate is, the less the chance of making an incorrect decision, but the higher the chance of having to reserve judgment. In choosing a type I error rate, you should consider the resulting power for various alternatives of interest.

Student's t Distribution

In practice, you usually cannot use any decision rule that uses a critical value based on σ because you do not usually know the value of σ. However, you can use *s* as an estimate of σ. Consider the following statistic:

$$t = \frac{\overline{x} - \mu_0}{s/\sqrt{n}}$$

This *t* statistic is the difference between the sample mean and the hypothesized mean μ_0 divided by the estimated standard error of the mean.

If the null hypothesis is true and the population is normally distributed, then the *t* statistic has what is called a *Student's t distribution* with $n - 1$ degrees of freedom. This distribution looks very similar to a normal distribution, but the tails of the Student's *t* distribution are heavier. As the sample size gets larger, the sample standard deviation becomes a better estimator of the population standard deviation, and the *t* distribution gets closer to a normal distribution.

You can base a decision rule on the *t* statistic:

- If $t < -2.3$, then decide on $\mathrm{H}_1\colon \mu < 0$.
- If $-2.3 \leq t \leq 2.3$, then reserve judgment.
- If $t > 2.3$, then decide on $\mathrm{H}_0\colon \mu > 0$.

The value 2.3 was obtained from a table of Student's *t* distribution to give a type I error rate of 5% for 8 (that is, $9 - 1 = 8$) degrees of freedom. Most common statistics texts contain a table of Student's *t* distribution. If you do not have a statistics text handy, then you can use the DATA step and the TINV function to print any values from the *t* distribution.

By default, PROC UNIVARIATE computes a *t* statistic for the null hypothesis that $\mu_0 = 0$, along with related statistics. Use the MU0= option in the PROC statement to specify another value for the null hypothesis.

This example uses the data on deviations from normal weight, which consist of nine observations. First, PROC MEANS computes the *t* statistic for the null hypothesis that $\mu = 0$. Then, the TINV function in a DATA step computes the value of Student's *t* distribution for a two-tailed test at the 5% level of significance and eight degrees of freedom.

```
data devnorm;
   title 'Deviations from Normal Weight';
   input X @@;
   datalines;
-7 -2 1 3 6 10 15 21 30
;

proc means data=devnorm maxdec=3 n mean
           std stderr t probt;
run;

title 'Student''s t Critical Value';

data _null_;
   file print;
   t=tinv(.975,8);
   put t 5.3;
run;
```

Deviations from Normal Weight

The MEANS Procedure

Analysis Variable : X					
N	Mean	Std Dev	Std Error	t Value	Pr > |t|
9	8.556	11.759	3.920	2.18	0.0606

Student's t Critical Value

2.306

```
          Deviations from Normal Weight                1
                      The MEANS Procedure

                    Analysis Variable : X

 N           Mean        Std Dev      Std Error   t Value   Pr > |t|
 ------------------------------------------------------------------
 9          8.556         11.759          3.920      2.18     0.0606
 ------------------------------------------------------------------
```

```
                   Student's t Critical Value                  2
2.306
```

In the current example, the value of the *t* statistic is 2.18, which is less than the critical *t* value of 2.3 (for a 5% significance level and eight degrees of freedom). Thus, at a 5% significance level, you must reserve judgment. If you had chosen to use a 10% significance level, then the critical value of the *t* distribution would have been 1.86 and you could have rejected the null hypothesis. The sample size is so small, however, that the validity of your conclusion depends strongly on how close the distribution of the population is to a normal distribution.

Probability Values

Another way to report the results of a statistical test is to compute a *probability value* or *p-value*. A *p*-value gives the probability in repeated sampling of obtaining a statistic as far in the directions specified by the alternative hypothesis as is the value actually observed. A two-tailed *p*-value for a *t* statistic is the probability of obtaining an absolute *t* value that is greater than the observed absolute *t* value. A one-tailed *p*-value for a *t* statistic for the alternative hypothesis $\mu > \mu_0$ is the probability of obtaining a *t* value greater than the observed *t* value. Once the *p*-value is computed, you can perform a hypothesis test by comparing the *p*-value

with the desired significance level. If the *p*-value is less than or equal to the type I error rate of the test, then the null hypothesis can be rejected. The two-tailed *p*-value, labeled `Pr > |t|` in the PROC MEANS output, is .0606, so the null hypothesis could be rejected at the 10% significance level but not at the 5% level.

A *p*-value is a measure of the strength of the evidence against the null hypothesis. The smaller the *p*-value, the stronger the evidence for rejecting the null hypothesis.

Note: For a more thorough discussion, consult an introductory statistics textbook such as Mendenhall and Beaver (1998); Ott and Mendenhall (1994); or Snedecor and Cochran (1989).

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Appendix 2

Operating Environment-Specific Procedures

Descriptions of Operating Environment-Specific Procedures

The following table gives a brief description and the relevant releases for some common operating environment-specific procedures. All of these procedures are described in more detail in operating environment-companion documentation.

Table A67.1 *Host-Specific Procedures*

Procedure	Description	Releases
CONVERT	Converts BMDP, OSIRIS, and SPSS system files to SAS data sets.	All
C16PORT	Converts a 16-bit SAS library or catalog that was created in Release 6.08 to a transport file. You can then convert to a 32-bit format for use in the current release of SAS by using the CIMPORT procedure.	6.10 - 6.12
FSDEVICE	Creates, copies, modifies, deletes, or renames device descriptions in a catalog.	All

Procedure	Description	Releases
PDS	Lists, deletes, or renames the members of a partitioned data set.	6.09E
PDSCOPY	Copies partitioned data sets from disk to disk, disk to tape, tape to tape, or tape to disk.	6.09E
RELEASE	Releases unused space at the end of a disk data set.	6.09E
SOURCE	Provides an easy way to back up and process source library data sets.	6.09E
TAPECOPY	Copies an entire tape volume, or files from one or more tape volumes, to one output tape volume.	6.09E
TAPELABEL	Writes the label information of an IBM standard-labeled tape volume to the SAS procedure output file.	6.09E

Appendix 3

Raw Data and DATA Steps for Base SAS Procedures

Overview of Raw Data and DATA Steps for Base SAS Procedures

The following raw data examples and DATA step examples are for use with the Base SAS Procedures.

The programs for examples in this document generally show you how to create the data sets that are used. Some examples show only partial data. For these examples, the complete data is shown in this appendix.

CARSURVEY

```
data carsurvey;
   input Rater Age Progressa Remark Jupiter Dynamo;
   datalines;
1   38  94  98  84  80
2   49  96  84  80  77
3   16  64  78  76  73
4   27  89  73  90  92
5   50  93  79  84  34
6   57  92  89  75  89
7   21  88  90  89  91
8   39  88  87  76  64
9   26  77  94  93  47
10  17  68  72  85  79
11  38  94  93  84  70
12  29  78  97  74  33
13  41  89  83  75  82
14  37  54  98  70  83
15  52  92  85  88  78
16  23  85  89  89  95
17  61  92  88  77  85
18  24  87  88  88  87
19  18  54  50  62  74
20  62  90  91  90  86
21  49  94  98  84  80
22  16  96  84  80  77
23  27  64  78  76  73
24  50  89  73  90  92
25  57  93  79  84  34
26  21  92  86  75  93
27  39  88  97  89  91
28  26  88  87  76  64
29  17  77  94  93  47
30  38  68  72  85  79
31  29  94  93  84  70
32  41  78  97  74  33
33  37  89  83  75  82
34  52  54  98  70  83
35  23  92  85  88  78
36  61  85  93  89  66
37  24  92  88  77  85
38  18  87  88  88  87
39  62  54  50  62  74
40  38  90  91  90  86
41  57  94  98  84  80
42  16  96  84  80  77
43  19  64  78  76  73
```

```
44  59  89  73  90  92
45  57  93  79  84  34
46  21  92  86  75  90
47  39  88  97  89  91
48  26  88  87  76  64
49  17  77  94  93  47
50  56  68  72  85  79
51  29  94  93  84  70
52  41  78  97  74  33
53  37  89  83  75  82
54  52  54  98  70  83
55  17  92  85  88  78
56  61  85  93  89  66
57  24  92  85  77  85
58  18  87  88  88  87
59  62  54  50  62  74
60  38  90  91  90  86
61  38  94  98  84  80
62  49  96  84  80  77
63  16  64  78  76  73
64  27  89  73  90  92
65  50  93  79  84  34
66  57  92  89  75  89
67  21  88  93  89  91
68  39  88  87  76  64
69  26  77  94  93  47
70  17  68  72  85  79
71  38  94  93  84  70
72  29  78  97  74  33
73  41  89  83  75  82
74  37  54  98  70  83
75  52  92  85  88  78
76  23  85  93  89  88
77  61  92  88  77  85
78  24  87  88  88  91
79  18  54  50  62  74
80  62  90  91  90  86
;
```

CENSUS

```
data census;
   input Density CrimeRate State $ 14-27 PostalCode $ 29-30;
   datalines;
263.3 4575.3 Ohio           OH
62.1 7017.1  Washington     WA
103.4 5161.9 South Carolina SC
53.4 3438.6  Mississippi    MS
180.0 8503.2 Florida        FL
80.8 2190.7  West Virginia  WV
428.7 5477.6 Maryland       MD
```

```
71.2 4707.5  Missouri       MO
43.9 4245.2  Arkansas       AR
7.3 6371.4   Nevada         NV
264.3 3163.2 Pennsylvania   PA
11.5 4156.3  Idaho          ID
44.1 6025.6  Oklahoma       OK
51.2 4615.8  Minnesota      MN
55.2 4271.2  Vermont        VT
27.4 6969.9  Oregon         OR
205.3 5416.5 Illinois       IL
94.1 5792.0  Georgia        GA
9.1 2678.0   South Dakota   SD
9.4 2833.0   North Dakota   ND
102.4 3371.7 New Hampshire  NH
54.3 7722.4  Texas          TX
76.6 4451.4  Alabama        AL
307.6 4938.8 Delaware       DE
151.4 6506.4 California     CA
111.6 4665.6 Tennessee      TN
120.4 4649.9 North Carolina NC
;
```

CHARITY

```
data Charity;
   input School $ 1-7 Year 9-12 Name $ 14-20 MoneyRaised 22-26
         HoursVolunteered 28-29;
   datalines;
Monroe  2016 Allison 31.65 19
Monroe  2016 Barry   23.76 16
Monroe  2016 Candace 21.11  5
Monroe  2016 Danny    6.89 23
Monroe  2016 Edward  53.76 31
Monroe  2016 Fiona   48.55 13
Monroe  2016 Gert    24.00 16
Monroe  2016 Harold  27.55 17
Monroe  2016 Ima     15.98  9
Monroe  2016 Jack    20.00 23
Monroe  2016 Katie   22.11  2
Monroe  2016 Lisa    18.34 17
Monroe  2016 Tonya   55.16 40
Monroe  2016 Max     26.77 34
Monroe  2016 Ned     28.43 22
Monroe  2016 Opal    32.66 14
Monroe  2017 Patsy   18.33 18
Monroe  2017 Quentin 16.89 15
Monroe  2017 Randall 12.98 17
Monroe  2017 Sam     15.88  5
Monroe  2017 Tyra    21.88 23
Monroe  2017 Myrtle  47.33 26
Monroe  2017 Frank   41.11 22
```

```
Monroe  2017 Cameron 65.44 14
Monroe  2017 Vern    17.89 11
Monroe  2017 Wendell 23.00 10
Monroe  2017 Bob     26.88  6
Monroe  2017 Leah    28.99 23
Monroe  2018 Becky   30.33 26
Monroe  2018 Sally   35.75 27
Monroe  2018 Edgar   27.11 12
Monroe  2018 Dawson  17.24 16
Monroe  2018 Lou      5.12 16
Monroe  2018 Damien  18.74 17
Monroe  2018 Mona    27.43  7
Monroe  2018 Della   56.78 15
Monroe  2018 Monique 29.88 19
Monroe  2018 Carl    31.12 25
Monroe  2018 Reba    35.16 22
Monroe  2018 Dax     27.65 23
Monroe  2018 Gary    23.11 15
Monroe  2018 Suzie   26.65 11
Monroe  2018 Benito  47.44 18
Monroe  2018 Thomas  21.99 23
Monroe  2018 Annie   24.99 27
Monroe  2018 Paul    27.98 22
Monroe  2018 Alex    24.00 16
Monroe  2018 Lauren  15.00 17
Monroe  2018 Julia   12.98 15
Monroe  2018 Keith   11.89 19
Monroe  2018 Jackie  26.88 22
Monroe  2018 Pablo   13.98 28
Monroe  2018 L.T.    56.87 33
Monroe  2018 Willard 78.65 24
Monroe  2018 Kathy   32.88 11
Monroe  2018 Abby    35.88 10
Kennedy 2016 Arturo  34.98 14
Kennedy 2016 Grace   27.55 25
Kennedy 2016 Winston 23.88 22
Kennedy 2016 Vince   12.88 21
Kennedy 2016 Claude  15.62  5
Kennedy 2016 Mary    28.99 34
Kennedy 2016 Abner   25.89 22
Kennedy 2016 Jay     35.89 35
Kennedy 2016 Alicia  28.77 26
Kennedy 2016 Freddy  29.00 27
Kennedy 2016 Eloise  31.67 25
Kennedy 2016 Jenny   43.89 22
Kennedy 2016 Thelma  52.63 21
Kennedy 2016 Tina    19.67 21
Kennedy 2016 Eric    24.89 12
Kennedy 2016 Bubba   37.88 12
Kennedy 2016 G.L.    25.89 21
Kennedy 2016 Bert    28.89 21
Kennedy 2017 Clay    26.44 21
Kennedy 2017 Leeann  27.17 17
Kennedy 2017 Georgia 38.90 11
Kennedy 2017 Bill    42.23 25
Kennedy 2017 Holly   18.67 27
```

```
Kennedy 2017 Benny   19.09 25
Kennedy 2017 Cammie  28.77 28
Kennedy 2017 Amy     27.08 31
Kennedy 2017 Doris   22.22 24
Kennedy 2017 Robbie  19.80 24
Kennedy 2017 Ted     27.07 25
Kennedy 2017 Sarah   24.44 12
Kennedy 2017 Megan   28.89 11
Kennedy 2017 Jeff    31.11 12
Kennedy 2017 Taz     30.55 11
Kennedy 2017 George  27.56 11
Kennedy 2017 Heather 38.67 15
Kennedy 2018 Nancy   29.90 26
Kennedy 2018 Rusty   30.55 28
Kennedy 2018 Mimi    37.67 22
Kennedy 2018 J.C.    23.33 27
Kennedy 2018 Clark   27.90 25
Kennedy 2018 Rudy    27.78 23
Kennedy 2018 Samuel  34.44 18
Kennedy 2018 Forrest 28.89 26
Kennedy 2018 Luther  72.22 24
Kennedy 2018 Trey     6.78 18
Kennedy 2018 Albert  23.33 19
Kennedy 2018 Che-Min 26.66 33
Kennedy 2018 Preston 32.22 23
Kennedy 2018 Larry   40.00 26
Kennedy 2018 Anton   35.99 28
Kennedy 2018 Sid     27.45 25
Kennedy 2018 Will    28.88 21
Kennedy 2018 Morty   34.44 25
;
```

CONTROL Library

Contents of the CONTROL Library

Here are the contents of the CONTROL library that is used in the DATASETS procedure section.

```
                                Directory

Libref         CONTROL
Engine         V9
Physical Name  \myfiles\control
File Name      \myfiles\control


       Member   Obs, Entries                          File
```

```
 #  Name      Type      or Indexes   Vars  Label               Size  Last Modified

 1  A1        CATALOG       23                              62464 04Jan18:14:20:12
 2  A2        CATALOG        1                              17408 04Jan18:14:20:12
 3  ALL       DATA          23        17                    13312 04Jan18:14:20:12
 4  BODYFAT   DATA           1         2                     5120 04Jan18:14:20:12
 5  CONFOUND  DATA           8         4                     5120 04Jan18:14:20:12
 6  CORONARY  DATA          39         4                     5120 04Jan18:14:20:12
 7  DRUG1     DATA           6         2  JAN18 Data         5120 04Jan18:14:20:12
 8  DRUG2     DATA          13         2  MAY18 Data         5120 04Jan18:14:20:12
 9  DRUG3     DATA          11         2  JUL17 Data         5120 04Jan18:14:20:12
10  DRUG4     DATA           7         2  JAN17 Data         5120 04Jan18:14:20:12
11  DRUG5     DATA           1         2  JUL17 Data         5120 04Jan18:14:20:12
12  ETEST1    CATALOG        1                              17408 04Jan18:14:20:16
13  ETEST2    CATALOG        1                              17408 04Jan18:14:20:16
14  ETEST3    CATALOG        1                              17408 04Jan18:14:20:16
15  ETEST4    CATALOG        1                              17408 04Jan18:14:20:16
16  ETEST5    CATALOG        1                              17408 04Jan18:14:20:16
17  ETESTS    CATALOG        1                              17408 04Jan18:14:20:16
18  FORMATS   CATALOG        6                              17408 04Jan18:14:20:16
19  GROUP     DATA         148        11                    25600 04Jan18:14:20:16
20  MLSCL     DATA          32         4  Multiple            5120 04Jan18:14:20:16
                                          Sclerosis Data
21  NAMES     DATA           7         4                     5120 04Jan11:14:20:16
22  OXYGEN    DATA          31         7                     9216 04Jan18:14:20:16
23  PERSONL   DATA         148        11                    25600 04Jan18:14:20:16
24  PHARM     DATA           6         3  Sugar Study        5120 04Jan18:14:20:16
25  POINTS    DATA           6         6                     5120 04Jan18:14:20:16
26  PRENAT    DATA         149         6                    17408 04Jan18:14:20:16
27  RESULTS   DATA          10         5                     5120 04Jan18:14:20:16
28  SLEEP     DATA         108         6                     9216 04Jan18:14:20:16
29  SYNDROME  DATA          46         8                     9216 04Jan18:14:20:16
30  TENSION   DATA           4         3                     5120 04Jan18:14:20:16
31  TEST2     DATA          15         5                     5120 04Jan18:14:20:16
32  TRAIN     DATA           7         2                     5120 04Jan18:14:20:16
33  VISION    DATA          16         3                     5120 04Jan18:14:20:16
34  WEIGHT    DATA          83        13  California         13312 04Jan18:14:20:16
                                          Results
35  WGHT      DATA          83        13  California         13312 04Jan18:14:20:16
                                          Results
16
```

CONTROL.ALL

Here are the raw data and DATA steps for all the data files in the CONTROL library.

```
data control.all;
    input FMTNAME $8. START $9. END $8. LABEL $20. MIN best4. MAX best4.
         DEFAULT best4. LENGTH best4. FUZZ best8. PREFIX $2. MULT best8.
         FILL $1. NOEDIT best4.  TYPE $2. SEXCL $2. EEXCL $2. HLO $7. ;
    label FMTNAME='Format name'
          START='Starting value for format'
          END='Ending value for format'
```

```
          LABEL='Format value label'
          MIN='Minimum length'
          MAX='Maximum length'
          DEFAULT='Default length'
          LENGTH='Format length'
          FUZZ='Fuzz value'
          PREFIX='Prefix characters'
          MULT='Multiplier'
          FILL='Fill character'
          NOEDIT='Is picture string noedit?'
          TYPE='Type of format'
          SEXCL='Start exclusion'
          EEXCL='End exclusion'
          HLO='Additional information';
    datalines;
BENEFIT       LOW    7304         WORDDATE20.   1 40  20  20   1E-12      0.00   0 N N
N     LF
BENEFIT      7305    HIGH  ** Not Eligible **   1 40  20  20   1E-12      0.00   0 N N N
DOLLARS       LOW    HIGH             000,000   1 40   7   7   1E-12 $    1.96   0 P N
N     LH
NOZEROS       LOW    0.01                 999   1 40   5   5   1E-12 .  1000.00   0 P N
Y     L
NOZEROS      0.01     0.1                  99   1 40   5   5   1E-12 .   100.00   0 P N Y
NOZEROS       0.1       1               0.000   1 40   5   5   1E-12 .  1000.00   0 P N Y
NOZEROS         1    HIGH               0.000   1 40   5   5   1E-12    1000.00   0 P N
N     H
BRIT          BR1     BR1          Birmingham   1 40  14  14       0      0.00   0 C N N
BRIT          BR2     BR2            Plymouth   1 40  14  14       0      0.00   0 C N N
BRIT          BR3     BR3                York   1 40  14  14       0      0.00   0 C N N
BRIT     *OTHER****OTHER*      INCORRECT CODE   1 40  14  14       0      0.00   0 C N
N     0
SKILL           A      D~              Test A   1 40   6   6       0      0.00   0 C N N
SKILL           E      M~              Test B   1 40   6   6       0      0.00   0 C N N
SKILL           N      Z~              Test C   1 40   6   6       0      0.00   0 C N N
SKILL           a      d~              Test A   1 40   6   6       0      0.00   0 C N N
SKILL           e      m~              Test B   1 40   6   6       0      0.00   0 C N N
SKILL           n      z~              Test C   1 40   6   6       0      0.00   0 C N N
EVAL            0       4              _SAME_   1 40   1   1       0      0.00   0 I N
N     I
EVAL            C       C                   1   1 40   1   1       0      0.00   0 I N N
EVAL            E       E                   2   1 40   1   1       0      0.00   0 I N N
EVAL            N       N                   0   1 40   1   1       0      0.00   0 I N N
EVAL            O       O                   4   1 40   1   1       0      0.00   0 I N N
EVAL            S       S                   3   1 40   1   1       0      0.00   0 I N N
;
run;
```

CONTROL.BODYFAT

```
data control.bodyfat;
    input NAME $  AGE $;
    datalines;
jeff    44
```

```
;
run;
```

CONTROL.CONFOUND

```
data control.confound;
    input SMOKING $8.  STATUS $8.  CANCER $8.  WT;
    datalines;
Yes     Single  Yes     34
Yes     Single  No      120
Yes     Married Yes     7
Yes     Married No      30
Yes     Single  Yes     2
Yes     Single  No      30
Yes     Married Yes     6
Yes     Married No      145
;
run;
```

CONTROL.CORONARY

```
data control.coronary;
    input SEX  ECG AGE CA;
    datalines;
0       0       28      0
0       0       34      0
0       0       38      0
0       0       41      0
0       0       44      0
0       0       45      1
0       0       46      0
0       0       47      0
0       0       50      0
0       0       51      0
0       0       51      0
0       0       53      0
0       0       55      1
0       0       59      0
0       0       60      1
0       0       32      1
0       0       33      0
0       0       35      0
0       0       39      0
0       0       40      0
0       0       46      0
0       0       48      1
0       0       49      0
0       0       49      0
0       0       52      0
```

```
0       0       53      1
0       0       54      1
0       0       55      0
0       0       57      1
0       0       46      1
0       0       48      0
0       0       57      1
0       0       60      1
0       0       30      0
0       0       34      0
0       0       36      1
0       0       38      1
0       0       39      0
0       0       42      0
;
run;
```

CONTROL.DRUG1

```
data control.drug1 (label='JAN2018 DATA');
    input CHAR $8.  NUM;
    datalines;
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
;
run;
```

CONTROL.DRUG2

```
 data control.drug2 (label='MAY2018 DATA');
    input CHAR $8.  NUM;
    datalines;
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
;
```

```
run;
```

CONTROL.DRUG3

```
data control.drug3 (label='JUL2017 DATA');
    input CHAR $8.  NUM;
    datalines;
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
;
run;
```

CONTROL.DRUG4

```
data control.drug4 (label='JAN2017 DATA');
    input CHAR $8.  NUM;
    datalines;
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
junk    0
;
run;
```

CONTROL.DRUG5

```
data control.drug5 (label='JUL2017 DATA');
    input CHAR $8.  NUM;
    datalines;
junk    0
;
run;
```

CONTROL.GROUP

```
data control.group;
    input IDNUM $ 1-4 LNAME $ 5-18 FNAME $ 19-32 CITY $ 33-47 STATE $
          48-50 SEX $ 52-53 JOBCODE $ 54-57 SALARY comma8. BIRTH
          HIRED date9. HPHONE $ 86-97;
    format salary comma8.;
    format hired date9.;
    informat hired date9.;
    datalines;
1919 ADAMS         GERALD        STAMFORD       CT M TA2   34,377    11212 04JUN2007
203/781-1255
1653 AHMAD         AZEEM         BRIDGEPORT     CT F ME2   35,109     9054 09AUG2010
203/675-7715
1400 ALVAREZ       GLORIA        NEW YORK       NY M ME1   29,770    10170 16OCT2010
212/586-0808
1350 ARTHUR        BARBARA       NEW YORK       NY F FA3   32,887     9374 29JUL2010
718/383-1549
1401 AVERY         JERRY         PATERSON       NJ M TA3   38,823     3999 17NOV2005
201/732-8787
1499 BAREFOOT      JOSEPH        PRINCETON      NJ M ME3   43,026     5229 07JUN2010
201/812-5665
1101 BASQUEZ       RICHARDO      NEW YORK       NY M SCP   18,724     8192 01OCT2010
212/586-8060
1333 BEAULIEU      ARMANDO       NEW YORK       NY M TA2   32,616     7759 10FEB2011
718/384-2849
1402 BLALOCK       RALPH         NEW YORK       NY M TA2   32,615     8417 02DEC2010
718/384-2849
1479 BOSTIC        MARIE         NEW YORK       NY F TA3   38,786    10583 05OCT2007
718/384-8816
1403 BOWDEN        EARL          BRIDGEPORT     CT M ME1   28,073    10620 21DEC2016
203/675-3434
1739 BOYCE         JONATHAN      NEW YORK       NY M PT1   66,518     9125 27JAN2011
212/587-1247
1658 BRADLEY       JEREMY        NEW YORK       NY M SCP   17,944     9959 29FEB2012
212/587-3622
1428 BRADY         CHRISTINE     STAMFORD       CT F PT1   68,768     7399 16NOV2011
203/781-1212
1782 BROWN         JASON         STAMFORD       CT M ME2   35,346     7643 22FEB2012
203/781-0019
1244 BRYANT        LEONARD       NEW YORK       NY M ME2   36,926     8643 17JAN2008
718/383-3334
1383 BURNETTE      THOMAS        NEW YORK       NY M BCK   25,824    10251 20OCT2009
718/384-3569
1574 CAHILL        MARSHALL      NEW YORK       NY M FA2   28,573     7422 20DEC2012
718/383-2338
1789 CANALES       VIVIANA       NEW YORK       NY M SCP   18,327     6232 11APR2008
212/587-9000
1404 CARTER        DONALD        NEW YORK       NY M PT2   91,377     4803 01JAN2010
718/384-2946
1437 CARTER        DOROTHY       BRIDGEPORT     CT F FA3   33,105     7568 31AUG2004
203/675-4117
```

```
1639 CARTER        KAREN         STAMFORD       CT F TA3   40,261     6386 28JAN2014
203/781-8839
1269 CASTON        FRANKLIN      STAMFORD       CT M NA1   41,691     4506 28NOV2012
203/781-3335
1065 CHAPMAN       NEIL          NEW YORK       NY M ME2   35,091     1486 07JAN2007
718/384-5618
1876 CHIN          JACK          NEW YORK       NY M TA3   39,676     6714 27APR2015
212/588-5634
1037 CHOW          JANE          STAMFORD       CT F TA1   28,559     8866 13SEP2012
203/781-8868
1129 COOK          BRENDA        NEW YORK       NY F ME2   34,930     8012 17AUG2011
718/383-2313
1988 COOPER        ANTHONY       NEW YORK       NY M FA3   32,218     7273 18SEP2004
212/587-1228
1405 DAVIDSON      JASON         PATERSON       NJ M SCP   18,057     9560 26JAN2012
201/732-2323
1430 DEAN          SANDRA        BRIDGEPORT     CT F TA2   32,926     8094 27APR2017
203/675-1647
1983 DEAN          SHARON        NEW YORK       NY F FA3   33,420      789 30APR2005
718/384-1647
1134 DELGADO       MARIA         STAMFORD       CT F TA2   33,463    10656 21DEC2016
203/781-1528
1118 DENNIS        ROGER         NEW YORK       NY M PT3  111,380     1476 18DEC2000
718/383-1122
1438 DESAI         AAKASH        STAMFORD       CT F TA3   39,224     9205 18NOV2007
203/781-2229
1125 DUNLAP        DONNA         NEW YORK       NY F FA2   28,889    10539 11DEC2007
718/383-2094
1475 EATON         ALICIA        NEW YORK       NY F FA2   27,788     8019 13JUL2010
718/383-2828
1117 EDGERTON      JOSHUA        NEW YORK       NY M TA3   39,772     8556 13AUG2012
212/588-1239
1935 FERNANDEZ     KATRINA       BRIDGEPORT     CT F NA2   51,082     5200 16OCT2011
203/675-2962
1124 FIELDS        DIANA         WHITE PLAINS   NY F FA1   23,178     6765 01OCT2010
914/455-2998
1422 FLETCHER      MARIE         PRINCETON      NJ F FA1   22,455     8921 06APR2011
201/812-0902
1616 FLOWERS       ANNETTE       NEW YORK       NY F TA2   34,138    11017 04JUN2013
718/384-3329
1406 FOSTER        GERALD        BRIDGEPORT     CT M ME2   35,186     7737 17FEB2007
203/675-6363
1120 GARCIA        JACK          NEW YORK       NY M ME1   28,620    11942 07OCT2013
718/384-4930
1094 GOMEZ         ALAN          BRIDGEPORT     CT M FA1   22,269    11049 17APR2011
203/675-7181
1389 GORDON        LEVI          NEW YORK       NY M BCK   25,029     7135 18AUG2010
718/384-9326
1905 GRAHAM        ALVIN         NEW YORK       NY M PT1   65,112    11794 29MAY2012
212/586-8815
1407 GRANT         DANIEL        MT. VERNON     NY M PT1   68,097    10674 18MAR2010
914/468-1616
1114 GREEN         JANICE        NEW YORK       NY F TA2   32,929    10853 27JUN2007
212/588-1092
1410 HARRIS        CHARLES       STAMFORD       CT M PT2   84,686     9984 07NOV2006
203/781-0937
```

```
1439 HARRISON      FELICIA       BRIDGEPORT     CT F PT1   70,737     8831 10SEP2010
203/675-4987
1409 HARTFORD      RAYMOND       STAMFORD       CT M ME3   41,552     3761 22OCT2001
203/781-9697
1408 HENDERSON     WILLIAM       PRINCETON      NJ M TA2   34,139     7393 14OCT2007
201/812-4789
1121 HERNANDEZ     MICHAEL       NEW YORK       NY M ME1   29,113     7939 07DEC2011
718/384-3313
1991 HOLMES        GABRIEL       BRIDGEPORT     CT F TA1   27,646     8162 12DEC2012
203/675-0007
1102 HOLMES        SHANE         WHITE PLAINS   NY M TA2   34,543     7213 15APR2011
914/455-0976
1356 HOLMES        SHAWN         NEW YORK       NY M ME2   36,870     6478 22FEB2003
212/586-8411
1545 HUNTER        CLYDE         STAMFORD       CT M PT1   66,131     7163 29MAY2010
203/781-1119
1292 HUNTER        HELEN         BRIDGEPORT     CT F ME2   36,692     9067 02JUL2009
203/675-4830
1440 JACKSON       LAURA         STAMFORD       CT F ME2   35,758     8305 09APR2011
203/781-0088
1368 JEPSEN        RONALD        STAMFORD       CT M FA2   27,809     7832 03NOV2014
203/781-8413
1369 JOHNSON       ANTHONY       NEW YORK       NY M TA2   33,706     8032 13MAR2017
212/587-5385
1411 JOHNSON       JACKSON       PATERSON       NJ M FA2   27,266     7817 01DEC2017
201/732-3678
1113 JONES         LESLIE        NEW YORK       NY F FA1   22,368    10241 17OCT2011
718/383-3003
1704 JOSHI         ABHAY         NEW YORK       NY M BCK   25,466     9738 28JUN2007
718/384-0049
1900 KING          WILLIAM       NEW YORK       NY M ME2   35,106     8180 27OCT2007
718/383-3698
1126 KOSTECKA      NICHOLAS      NEW YORK       NY F TA3   40,900     8548 21NOV2010
212/586-1229
1677 KRAMER        JACKSON       BRIDGEPORT     CT M BCK   26,008     8709 27MAR2009
203/675-7432
1441 LAWRENCE      KATHY         PRINCETON      NJ F FA2   27,159    10915 23MAR2011
201/812-3337
1421 LEE           RUSSELL       MT. VERNON     NY M TA2   33,156     6947 28FEB2010
914/468-9143
1119 LI            JEFF          NEW YORK       NY M TA1   26,925     8206 06SEP2008
212/586-2344
1834 LONG          RUSSELL       NEW YORK       NY M BCK   26,897     8074 02JUL2012
718/384-0040
1777 LUFKIN        ROY           NEW YORK       NY M PT3  109,631     4283 21JUN2001
718/383-4413
1663 MAHANNAHS     SHANTHA       NEW YORK       NY M BCK   26,453     9872 11AUG2011
212/587-7742
1106 MARSHBURN     JASPER        STAMFORD       CT M PT2   89,633     6519 16AUG2004
203/781-1457
1103 MCDANIEL      RONDA         NEW YORK       NY F FA1   23,739    10273 23JUL2012
212/586-0013
1477 MEYERS        PRESTON       BRIDGEPORT     CT M FA2   28,567     8846 07MAR2008
203/675-8125
1476 MONROE        JOYCE         STAMFORD       CT F TA2   34,804     7890 17MAR2017
203/781-2837
```

```
1379 MORGAN          ALFRED         STAMFORD        CT M ME3   42,265     8515 10JUN2004
203/781-2216
1104 MORGAN          CHRISTOPHER    NEW YORK        NY M SCP   17,947     8515 10JUN2011
718/383-9740
1009 MORGAN          GEORGE         NEW YORK        NY M TA1   28,881     7000 26MAR2012
212/586-7753
1412 MURPHEY         JOHN           PRINCETON       NJ M ME1   27,800     6013 05DEC2011
201/812-4414
1115 MURPHY          ALICE          NEW YORK        NY F FA3   32,700     7539 28FEB2010
718/384-1982
1128 NELSON          FELICIA        BRIDGEPORT      CT F TA2   32,778     9274 20OCT2010
203/675-1166
1442 NEWKIRK         SANDRA         PRINCETON       NJ F PT2   84,537     9744 12APR2008
201/812-3331
1417 NEWKIRK         WILLIAM        PATERSON        NJ M NA2   52,271     8944 07MAR2009
201/732-6611
1478 NEWTON          JAMES          NEW YORK        NY M PT2   84,204     7160 24OCT2010
212/587-5549
1673 NICHOLLS        HENRY          STAMFORD        CT M BCK   25,478     7362 15JUL2011
203/781-7770
1839 NORRIS          DIANE          NEW YORK        NY F NA1   43,434     7638 03JUL2013
718/384-1767
1347 O'NEAL          BRYAN          NEW YORK        NY M TA3   40,080    10125 06SEP2014
718/384-0230
1423 OSWALD          LESLIE         MT. VERNON      NY F ME2   35,774    10361 19AUG2010
914/468-9171
1200 OVERMAN         MICHELLE       STAMFORD        CT F ME1   27,817     7680 14AUG2012
203/781-1835
1970 PAPI            PAOLO          NEW YORK        NY F FA1   22,616     9034 12MAR2011
718/383-3895
1521 PAPIA           ISMAEL         NEW YORK        NY M ME3   41,527     8502 13JUL2008
212/587-7603
1354 PAPIA           FRANCISCO      WHITE PLAINS    NY F SCP   18,336     7819 16JUN2012
914/455-2337
1424 PATTERSON       RENEE          NEW YORK        NY F FA2   28,979     7155 11DEC2009
212/587-8991
1132 PEARCE          CAROL          NEW YORK        NY F FA1   22,414     4533 22OCT2003
718/384-1986
1845 PEARSON         JAMES          NEW YORK        NY M BCK   25,997     7263 22MAR2000
718/384-2311
1556 PENNINGTON      MICHAEL        NEW YORK        NY M PT1   71,350     8939 11DEC2011
718/383-5681
1413 PETERS          RANDALL        PRINCETON       NJ M FA2   27,436     5737 02JAN2010
201/812-2478
1123 PETERSON        SUZANNE        NEW YORK        NY F TA1   28,407     8339 05DEC2012
718/383-0077
1907 PHELPS          WILLIAM        STAMFORD        CT M TA2   33,330     7624 06JUL2007
203/781-1118
1436 PORTER          SUSAN          NEW YORK        NY F TA2   34,476     8928 12MAR2007
718/383-5777
1385 RAYNOR          MILTON         BRIDGEPORT      CT M ME3   43,901     8051 01APR2016
203/675-2846
1432 REED            MARILYN        MT. VERNON      NY F ME2   35,328     7977 10FEB2015
914/468-5454
1111 RHODES          JEREMY         PRINCETON       NJ M NA1   40,587     7977 31OCT2012
201/812-1837
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1116 RICHARDS      CASEY         NEW YORK       NY F FA1   22,863     7210 21MAR2011
212/587-1224
1352 RIVERS        SIMON         NEW YORK       NY M NA2   53,799     7641 16OCT2006
718/383-3345
1555 RODRIGUEZ     JULIA         BRIDGEPORT     CT F FA2   27,500     6649 04JUL2012
203/675-2401
1038 RODRIGUEZ     MARIA         BRIDGEPORT     CT F TA1   26,534    10905 23NOV2011
203/675-2048
1420 ROUSE         JEREMY        PATERSON       NJ M ME3   43,072     9181 22JUL2017
201/732-9834
1561 SANDERS       RAYMOND       NEW YORK       NY M TA2   34,515     8734 07OCT2007
212/588-6615
1434 SANDERSON     EDITH         STAMFORD       CT F FA2   28,623     8227 28OCT2010
203/781-1333
1414 SARKAR        ABHEEK        BRIDGEPORT     CT M FA1   23,645     8118 12APR2012
203/675-1715
1112 SAYERS        RANDY         NEW YORK       NY M TA1   26,906     9099 07DEC2012
718/384-4895
1390 SMART         JONATHAN      NEW YORK       NY M FA2   27,762     9181 23JUN2011
718/383-1141
1332 STEPHENSON    ADAM          BRIDGEPORT     CT M NA1   42,179     7565 04JUN2011
203/675-1497
1890 STEPHENSON    ROBERT        NEW YORK       NY M PT2   85,897     7871 25NOV2017
718/384-9874
1429 THOMPSON      ALICE         STAMFORD       CT F TA1   27,940     7363 07AUG2012
203/781-3857
1107 THOMPSON      WAYNE         NEW YORK       NY M PT2   89,978     5273 10FEB2009
718/384-3785
1908 TRENTON       MELISSA       NEW YORK       NY F TA2   32,996     7283 23APR2010
212/586-6262
1830 TRIPP         KATHY         BRIDGEPORT     CT F PT2   84,472     6356 29JAN2013
203/675-2479
1882 TUCKER        ALAN          NEW YORK       NY M ME3   41,539     6400 21NOV2008
718/384-0216
1050 TUTTLE        THOMAS        WHITE PLAINS   NY M ME2   35,168     8595 24AUG2016
914/455-2119
1425 UNDERWOOD     JENNY         STAMFORD       CT F FA1   23,980     8032 28FEB2013
203/781-0978
1928 UPCHURCH      LARRY         WHITE PLAINS   NY M PT2   89,859     5372 13JUL2010
914/455-5009
1480 UPDIKE        THERESA       NEW YORK       NY F TA3   39,584     6455 25MAR2001
212/587-8729
1100 VANDEUSEN     RICHARD       NEW YORK       NY M BCK   25,005     7640 07MAY2008
212/586-2531
1995 VARNER        ELIZABETH     NEW YORK       NY F ME1   28,811     8636 19SEP2013
718/384-7113
1135 VEGA          ANNA          NEW YORK       NY F FA2   27,322     7568 31MAR2010
718/384-5913
1415 VEGA          FRANKLIN      NEW YORK       NY M FA2   28,279     6642 12FEB2008
718/384-2823
1076 VENTER        RANDALL       NEW YORK       NY M PT1   66,559     5765 03OCT2011
718/383-2321
1426 VICK          THERESA       PRINCETON      NJ F TA2   32,992     9835 25JUN2010
201/812-2424
1564 WALTERS       ANNE          NEW YORK       NY F SCP   18,834     8137 01JUL2012
212/587-3257
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1221 WALTERS       DIANE         NEW YORK       NY F FA2   27,897     10126 04OCT2011
718/384-1918
1133 WANG          CHIN          NEW YORK       NY M TA1   27,702      9690 12FEB2012
212/587-1956
1435 WARD          ELAINE        NEW YORK       NY F TA3   38,809      7071 08FEB2010
718/383-4987
1418 WATSON        BERNARD       NEW YORK       NY M ME1   28,006      6297 06JAN2012
718/383-1298
1017 WELCH         DARIUS        NEW YORK       NY M TA3   40,859      6571 16OCT2011
212/586-5535
1443 WELLS         AGNES         STAMFORD       CT F NA1   42,275     10548 29AUG2011
203/781-5546
1131 WELLS         NADINE        NEW YORK       NY F TA2   32,576      8030 19APR2011
718/383-1045
1427 WHALEY        CAROLYN       MT. VERNON     NY F TA2   34,047     11261 30JAN2010
914/468-4528
1036 WONG          LESLIE        NEW YORK       NY F TA3   39,393      9270 23OCT2004
212/587-2570
1130 WOOD          DEBORAH       NEW YORK       NY F FA1   23,917      7806 05JUN2012
212/587-0013
1127 WOOD          SANDRA        NEW YORK       NY F TA2   33,012      9079 07DEC2006
212/587-2881
1433 YANCEY        ROBIN         PRINCETON      NJ F FA3   32,983      9685 17JAN2007
201/812-1874
1431 YOUNG         DEBORAH       STAMFORD       CT F FA3   33,231      8926 05APR2008
203/781-2987
1122 YOUNG         JOANN         NEW YORK       NY F FA2   27,957      8521 27NOV2008
718/384-2021
1105 YOUNG         LAWRENCE      NEW YORK       NY M ME2   34,806      8095 13AUG2010
718/384-0008
;
run;
```

CONTROL.MLSCL

```
data control.mlscl (label='Multiple Sclerosis Data');
    input GROUP OBS1 OBS2 WT;
    datalines;
      1        4       4     10
      1        4       1      3
      1        4       2      7
      1        4       3      3
      1        1       4      1
      1        1       1     38
      1        1       2      5
      1        1       3      0
      1        2       4      0
      1        2       1     33
      1        2       2     11
      1        2       3      3
      1        3       4      6
      1        3       1     10
      1        3       2     14
```

```
      1        3       3      5
      2        4       1      1
      2        4       2      2
      2        4       3      4
      2        4       4     14
      2        3       1      2
      2        3       2     13
      2        3       3      3
      2        3       4      4
      2        2       1      3
      2        2       2     11
      2        2       3      4
      2        2       4      0
      2        1       1      5
      2        1       2      3
      2        1       3      0
      2        1       4      0
;
run;
```

CONTROL.NAMES

```
data control.names;
    input LABEL $ 1-16 START $ 17-24 FMTNAME $ 31-35 TYPE $ 41-41;
    datalines;
Capalleti, Jimmy    2355      bonus     C
Chen, Len           5889      bonus     C
Davis, Brad         3878      bonus     C
Leung, Brenda       4409      bonus     C
Patel, Mary         2398      bonus     C
Smith, Robert       5862      bonus     C
Zook, Carla         7385      bonus     C
;
run;
```

CONTROL.OXYGEN

```
data control.oxygen;
    input AGE WEIGHT RUNTIME RSTPULSE RUNPULSE MAXPULSE OXYGEN;
    datalines;
44     89.47     11.37        62          178         182      44.609
40     75.07     10.07        62          185         185      45.313
44     85.84      8.65        45          156         168      54.297
42     68.15      8.17        40          166         172      59.571
38     89.02      9.22        55          178         180      49.874
47     77.45     11.63        58          176         176      44.811
40     75.98     11.95        70          176         180      45.681
43     81.19     10.85        64          162         170      49.091
44     81.42     13.08        63          174         176      39.442
```

```
38      81.87       8.63        48          170         186       60.055
44      73.03      10.13        45          168         168       50.541
45      87.66      14.03        56          186         192       37.388
45      66.45      11.12        51          176         176       44.754
47      79.15      10.60        47          162         164       47.273
54      83.12      10.33        50          166         170       51.855
49      81.42       8.95        44          180         185       49.156
51      69.63      10.95        57          168         172       40.836
51      77.91      10.00        48          162         168       46.672
48      91.63      10.25        48          162         164       46.774
49      73.37      10.08        76          168         168       50.388
57      73.37      12.63        58          174         176       39.407
54      79.38      11.17        62          156         165       46.080
52      76.32       9.63        48          164         166       45.441
50      70.87       8.92        48          146         155       54.625
51      67.25      11.08        48          172         172       45.118
54      91.63      12.88        44          168         172       39.203
51      73.71      10.47        59          186         188       45.790
57      59.08       9.93        49          148         155       50.545
49      76.32       9.40        56          186         188       48.673
48      61.24      11.50        52          170         176       47.920
52      82.78      10.50        53          170         172       47.467
;
run;
```

CONTROL.PERSONL

```
data control.personl;
    input IDNUM $ 1-4 LNAME $ 4-18 FNAME $ 19-33 CITY $ 32-46 STATE $ 47-48
          SEX $ 50-50 JOBCODE $ 52-54 SALARY BIRTH date. @63
          HIRED date9. @73 HPHONE $ 84-99;
    format birth date9.;
    informat birth date.;
    format hired date9.;
    informat hired date.;
    datalines;
1919 ADAMS          GERALD         STAMFORD       CT M TA2  34376 12SEP1990 04JUN2007
203/781-1255
1653 AHMAD          AZEEM          BRIDGEPORT     CT F ME2  35108 15OCT1984 09AUG2010
203/675-7715
1400 ALVAREZ        GLORIA         NEW YORK       NY M ME1  29769 05NOV1987 16OCT2010
212/586-0808
1350 ARTHUR         BARBARA        NEW YORK       NY F FA3  32886 31AUG1985 29JUL2010
718/383-1549
1401 AVERY          JERRY          PATERSON       NJ M TA3  38822 13DEC1970 17NOV2005
201/732-8787
1499 BAREFOOT       JOSEPH         PRINCETON      NJ M ME3  43025 26APR1974 07JUN2010
201/812-5665
1101 BASQUEZ        RICHARDO       NEW YORK       NY M SCP  18723 06JUN1982 01OCT2010
212/586-8060
1333 BEAULIEU       ARMANDO        STAMFORD       CT M PT2  88606 30MAR1981 10FEB2011
203/781-1777
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1402 BLALOCK       RALPH          NEW YORK       NY M TA2  32615 17JAN1983 02DEC2010
718/384-2849
1479 BOSTIC        MARIE          NEW YORK       NY F TA3  38785 22DEC1988 05OCT2007
718/384-8816
1403 BOWDEN        EARL           BRIDGEPORT     CT M ME1  28072 28JAN1989 21DEC2016
203/675-3434
1739 BOYCE         JONATHAN       NEW YORK       NY M PT1  66517 25DEC1984 27JAN2011
212/587-1247
1658 BRADLEY       JEREMY         NEW YORK       NY M SCP  17943 08APR1987 29FEB2012
212/587-3622
1428 BRADY         CHRISTINE      STAMFORD       CT F PT1  68767 04APR1980 16NOV2011
203/781-1212
1782 BROWN         JASON          STAMFORD       CT M ME2  35345 04DEC1980 22FEB2012
203/781-0019
1244 BRYANT        LEONARD        NEW YORK       NY M ME2  36925 31AUG1983 17JAN2008
718/383-3334
1383 BURNETTE      THOMAS         NEW YORK       NY M BCK  25824 25JAN1985 20OCT2009
718/384-3569
1574 CAHILL        MARSHALL       NEW YORK       NY M FA2  28572 27APR1980 20DEC2012
718/383-2338
1789 CANALES       VIVIANA        NEW YORK       NY M SCP  18326 23JAN1977 11APR2008
212/587-9000
1404 CARTER        DONALD         NEW YORK       NY M PT2  91376 24FEB1973 01JAN2010
718/384-2946
1437 CARTER        DOROTHY        BRIDGEPORT     CT F FA3  33104 20SEP1980 31AUG2004
203/675-4117
1639 CARTER        KAREN          STAMFORD       CT F TA3  40260 26JUN1977 28JAN2014
203/781-8839
1269 CASTON        FRANKLIN       STAMFORD       CT M NA1  41690 03MAY1972 28NOV2012
203/781-3335
1065 CHAPMAN       NEIL           NEW YORK       NY M ME2  35090 26JAN1977 07JAN2007
718/384-5618
1876 CHIN          JACK           NEW YORK       NY M TA3  39675 20MAY1978 27APR2015
212/588-5634
1037 CHOW          JANE           STAMFORD       CT F TA1  28558 10APR1984 13SEP2012
203/781-8868
1129 COOK          BRENDA         NEW YORK       NY F ME2  34929 08DEC1981 17AUG2011
718/383-2313
1988 COOPER        ANTHONY        NEW YORK       NY M FA3  32217 30NOV1979 18SEP2004
212/587-1228
1405 DAVIDSON      JASON          PATERSON       NJ M SCP  18056 05MAR1986 26JAN2012
201/732-2323
1430 DEAN          SANDRA         BRIDGEPORT     CT F TA2  32925 28FEB1982 27APR2017
203/675-1647
1983 DEAN          SHARON         NEW YORK       NY F FA3  33419 28FEB1962 30APR2005
718/384-1647
1134 DELGADO       MARIA          STAMFORD       CT F TA2  33462 05MAR1989 21DEC2016
203/781-1528
1118 DENNIS        ROGER          NEW YORK       NY M PT3 111379 16JAN1964 18DEC2000
718/383-1122
1438 DESAI         AAKASH         STAMFORD       CT F TA3  39223 15MAR1985 18NOV2007
203/781-2229
1125 DUNLAP        DONNA          NEW YORK       NY F FA2  28888 08NOV1988 11DEC2007
718/383-2094
1475 EATON         ALICIA         NEW YORK       NY F FA2  27787 15DEC1981 13JUL2010
718/383-2828
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1117 EDGERTON      JOSHUA         NEW YORK       NY M TA3  39771 05JUN1983 13AUG2012
212/588-1239
1935 FERNANDEZ     KATRINA        BRIDGEPORT     CT F NA2  51081 28MAR1974 16OCT2011
203/675-2962
1124 FIELDS        DIANA          WHITE PLAINS   NY F FA1  23177 10JUL1978 01OCT2010
914/455-2998
1422 FLETCHER      MARIE          PRINCETON      NJ F FA1  22454 04JUN1984 06APR2011
201/812-0902
1616 FLOWERS       ANNETTE        NEW YORK       NY F TA2  34137 01MAR1990 04JUN2013
718/384-3329
1406 FOSTER        GERALD         BRIDGEPORT     CT M ME2  35185 08MAR1981 17FEB2007
203/675-6363
1120 GARCIA        JACK           NEW YORK       NY M ME1  28619 11SEP1992 07OCT2013
718/384-4930
1094 GOMEZ         ALAN           BRIDGEPORT     CT M FA1  22268 02APR1990 17APR2011
203/675-7181
1389 GORDON        LEVI           NEW YORK       NY M BCK  25028 15JUL1979 18AUG2010
718/384-9326
1905 GRAHAM        ALVIN          NEW YORK       NY M PT1  65111 16APR1992 29MAY2012
212/586-8815
1407 GRANT         DANIEL         MT. VERNON     NY M PT1  68096 23MAR1989 18MAR2010
914/468-1616
1114 GREEN         JANICE         NEW YORK       NY F TA2  32928 18SEP1989 27JUN2007
212/588-1092
1410 HARRIS        CHARLES        STAMFORD       CT M PT2  84685 03MAY1987 07NOV2006
203/781-0937
1439 HARRISON      FELICIA        BRIDGEPORT     CT F PT1  70736 06MAR1984 10SEP2010
203/675-4987
1409 HARTFORD      RAYMOND        STAMFORD       CT M ME3  41551 19APR1970 22OCT2001
203/781-9697
1408 HENDERSON     WILLIAM        PRINCETON      NJ M TA2  34138 29MAR1980 14OCT2007
201/812-4789
1121 HERNANDEZ     MICHAEL        NEW YORK       NY M ME1  29112 26SEP1981 07DEC2011
718/384-3313
1991 HOLMES        GABRIEL        BRIDGEPORT     CT F TA1  27645 07MAY1982 12DEC2012
203/675-0007
1102 HOLMES        SHANE          WHITE PLAINS   NY M TA2  34542 01OCT1979 15APR2011
914/455-0976
1356 HOLMES        SHAWN          NEW YORK       NY M ME2  36869 26SEP1977 22FEB2003
212/586-8411
1545 HUNTER        CLYDE          STAMFORD       CT M PT1  66130 12AUG1979 29MAY2010
203/781-1119
1292 HUNTER        HELEN          BRIDGEPORT     CT F ME2  36691 28OCT1984 02JUL2009
203/675-4830
1440 JACKSON       LAURA          STAMFORD       CT F ME2  35757 27SEP1982 09APR2011
203/781-0088
1368 JEPSEN        RONALD         STAMFORD       CT M FA2  27808 11JUN1981 03NOV2014
203/781-8413
1369 JOHNSON       ANTHONY        NEW YORK       NY M TA2  33705 28DEC1981 13MAR2017
212/587-5385
1411 JOHNSON       JACKSON        PATERSON       NJ M FA2  27265 27MAY1981 01DEC2017
201/732-3678
1113 JONES         LESLIE         NEW YORK       NY F FA1  22367 15JAN1988 17OCT2011
718/383-3003
1704 JOSHI         ABHAY          NEW YORK       NY M BCK  25465 30AUG1986 28JUN2007
718/384-0049
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1900 KING          WILLIAM        NEW YORK       NY M ME2  35105 25MAY1982 27OCT2007
718/383-3698
1126 KOSTECKA      NICHOLAS       NEW YORK       NY F TA3  40899 28MAY1983 21NOV2010
212/586-1229
1677 KRAMER        JACKSON        BRIDGEPORT     CT M BCK  26007 05NOV1983 27MAR2009
203/675-7432
1441 LAWRENCE      KATHY          PRINCETON      NJ F FA2  27158 19NOV1989 23MAR2011
201/812-3337
1421 LEE           RUSSELL        MT. VERNON     NY M TA2  33155 08JAN1979 28FEB2010
914/468-9143
1119 LI            JEFF           NEW YORK       NY M TA1  26924 20JUN1982 06SEP2008
212/586-2344
1834 LONG          RUSSELL        NEW YORK       NY M BCK  26896 08FEB1982 02JUL2012
718/384-0040
1777 LUFKIN        ROY            NEW YORK       NY M PT3 109630 23SEP1971 21JUN2001
718/383-4413
1663 MAHANNAHS     SHANTHA        NEW YORK       NY M BCK  26452 11JAN1987 11AUG2011
212/587-7742
1106 MARSHBURN     JASPER         STAMFORD       CT M PT2  89632 06NOV1977 16AUG2004
203/781-1457
1103 MCDANIEL      RONDA          NEW YORK       NY F FA1  23738 16FEB1988 23JUL2012
212/586-0013
1477 MEYERS        PRESTON        BRIDGEPORT     CT M FA2  28566 21MAR1984 07MAR2008
203/675-8125
1476 MONROE        JOYCE          STAMFORD       CT F TA2  34803 30MAY1986 17MAR2017
203/781-2837
1379 MORGAN        ALFRED         STAMFORD       CT M ME3  42264 08AUG1981 10JUN2004
203/781-2216
1104 MORGAN        CHRISTOPHER    NEW YORK       NY M SCP  17946 25APR1983 10JUN2011
718/383-9740
1009 MORGAN        GEORGE         NEW YORK       NY M TA1  28880 02MAR1979 26MAR2012
212/586-7753
1412 MURPHEY       JOHN           PRINCETON      NJ M ME1  27799 18JUN1976 05DEC2011
201/812-4414
1115 MURPHY        ALICE          NEW YORK       NY F FA3  32699 22AUG1980 28FEB2010
718/384-1982
1128 NELSON        FELICIA        BRIDGEPORT     CT F TA2  32777 23MAY1985 20OCT2010
203/675-1166
1442 NEWKIRK       SANDRA         PRINCETON      NJ F PT2  84536 05SEP1986 12APR2008
201/812-3331
1417 NEWKIRK       WILLIAM        PATERSON       NJ M NA2  52270 27JUN1984 07MAR2009
201/732-6611
1478 NEWTON        JAMES          NEW YORK       NY M PT2  84203 09AUG1979 24OCT2010
212/587-5549
1673 NICHOLLS      HENRY          STAMFORD       CT M BCK  25477 27FEB1980 15JUL2011
203/781-7770
1839 NORRIS        DIANE          NEW YORK       NY F NA1  44433 29NOV1980 03JUL2013
718/384-1767
1347 O'NEAL        BRYAN          NEW YORK       NY M TA3  40079 21SEP1987 06SEP2014
718/384-0230
1423 OSWALD        LESLIE         MT. VERNON     NY F ME2  35773 14MAY1988 19AUG2010
914/468-9171
1200 OVERMAN       MICHELLE       STAMFORD       CT F ME1  27816 10JAN1981 14AUG2012
203/781-1835
1970 PAPI          PAOLO          NEW YORK       NY F FA1  22615 25SEP1984 12MAR2011
718/383-3895
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1521 PAPIA          ISMAEL          NEW YORK        NY M ME3  41526 12APR1983 13JUL2008
212/587-7603
1354 PAPIA          FRANCISCO       WHITE PLAINS    NY F SCP  18335 29MAY1981 16JUN2012
914/455-2337
1424 PATTERSON      RENEE           NEW YORK        NY F FA2  28978 04AUG1979 11DEC2009
212/587-8991
1132 PEARCE         CAROL           NEW YORK        NY F FA1  22413 30MAY1972 22OCT2003
718/384-1986
1845 PEARSON        JAMES           NEW YORK        NY M BCK  25996 20NOV1979 22MAR2000
718/384-2311
1556 PENNINGTON     MICHAEL         NEW YORK        NY M PT1  71349 22JUN1984 11DEC2011
718/383-5681
1413 PETERS         RANDALL         PRINCETON       NJ M FA2  27435 16SEP1975 02JAN2010
201/812-2478
1123 PETERSON       SUZANNE         NEW YORK        NY F TA1  28407 31OCT1982 05DEC2012
718/383-0077
1907 PHELPS         WILLIAM         STAMFORD        CT M TA2  33329 15NOV1980 06JUL2007
203/781-1118
1436 PORTER         SUSAN           NEW YORK        NY F TA2  34475 11JUN1984 12MAR2007
718/383-5777
1385 RAYNOR         MILTON          BRIDGEPORT      CT M ME3  43900 16JAN1982 01APR2016
203/675-2846
1432 REED           MARILYN         MT. VERNON      NY F ME2  35327 03NOV1981 10FEB2015
914/468-5454
1111 RHODES         JEREMY          PRINCETON       NJ M NA1  40586 14JUL1983 31OCT2012
201/812-1837
1116 RICHARDS       CASEY           NEW YORK        NY F FA1  22862 28SEP1979 21MAR2011
212/587-1224
1352 RIVERS         SIMON           NEW YORK        NY M NA2  53798 02DEC1980 16OCT2006
718/383-3345
1555 RODRIGUEZ      JULIA           BRIDGEPORT      CT F FA2  27499 16MAR1978 04JUL2012
203/675-2401
1038 RODRIGUEZ      MARIA           BRIDGEPORT      CT F TA1  26533 09NOV1989 23NOV2011
203/675-2048
1420 ROUSE          JEREMY          PATERSON        NJ M ME3  43071 19FEB1985 22JUL2017
201/732-9834
1561 SANDERS        RAYMOND         NEW YORK        NY M TA2  34514 30NOV1983 07OCT2007
212/588-6615
1434 SANDERSON      EDITH           STAMFORD        CT F FA2  28622 11JUL1982 28OCT2010
203/781-1333
1414 SARKAR         ABHEEK          BRIDGEPORT      CT M FA1  23644 24MAR1982 12APR2012
203/675-1715
1112 SAYERS         RANDY           NEW YORK        NY M TA1  26905 29NOV1984 07DEC2012
718/384-4895
1390 SMART          JONATHAN        NEW YORK        NY M FA2  27761 19FEB1985 23JUN2011
718/383-1141
1332 STEPHENSON     ADAM            BRIDGEPORT      CT M NA1  42178 17SEP1980 04JUN2011
203/675-1497
1890 STEPHENSON     ROBERT          NEW YORK        NY M PT2  85896 20JUL1981 25NOV2017
718/384-9874
1429 THOMPSON       ALICE           STAMFORD        CT F TA1  27939 28FEB1980 07AUG2012
203/781-3857
1107 THOMPSON       WAYNE           NEW YORK        NY M PT2  89977 09JUN1974 10FEB2009
718/384-3785
1908 TRENTON        MELISSA         NEW YORK        NY F TA2  32995 10DEC1979 23APR2010
212/586-6262
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1830 TRIPP          KATHY          BRIDGEPORT     CT F PT2  84471 27MAY1977 29JAN2013
203/675-2479
1882 TUCKER         ALAN           NEW YORK       NY M ME3  41538 10JUL1977 21NOV2008
718/384-0216
1050 TUTTLE         THOMAS         WHITE PLAINS   NY M ME2  35167 14JUL1983 24AUG2016
914/455-2119
1425 UNDERWOOD      JENNY          STAMFORD       CT F FA1  23979 28DEC1981 28FEB2013
203/781-0978
1928 UPCHURCH       LARRY          WHITE PLAINS   NY M PT2  89858 16SEP1974 13JUL2010
914/455-5009
1480 UPDIKE         THERESA        NEW YORK       NY F TA3  39583 03SEP1977 25MAR2001
212/587-8729
1100 VANDEUSEN      RICHARD        NEW YORK       NY M BCK  25004 01DEC1980 07MAY2008
212/586-2531
1995 VARNER         ELIZABETH      NEW YORK       NY F ME1  28810 24AUG1983 19SEP2013
718/384-7113
1135 VEGA           ANNA           NEW YORK       NY F FA2  27321 20SEP1980 31MAR2010
718/384-5913
1415 VEGA           FRANKLIN       NEW YORK       NY M FA2  28278 09MAR1978 12FEB2008
718/384-2823
1076 VENTER         RANDALL        NEW YORK       NY M PT1  66558 14OCT1975 03OCT2011
718/383-2321
1426 VICK           THERESA        PRINCETON      NJ F TA2  32991 05DEC1986 25JUN2010
201/812-2424
1564 WALTERS        ANNE           NEW YORK       NY F SCP  18833 12APR1982 01JUL2012
212/587-3257
1221 WALTERS        DIANE          NEW YORK       NY F FA2  27896 22SEP1987 04OCT2011
718/384-1918
1133 WANG           CHIN           NEW YORK       NY M TA1  27701 13JUL1986 12FEB2012
212/587-1956
1435 WARD           ELAINE         NEW YORK       NY F TA3  38808 12MAY1979 08FEB2010
718/383-4987
1418 WATSON         BERNARD        NEW YORK       NY M ME1  28005 29MAR1977 06JAN2012
718/383-1298
1017 WELCH          DARIUS         NEW YORK       NY M TA3  40858 28DEC1977 16OCT2011
212/586-5535
1443 WELLS          AGNES          STAMFORD       CT F NA1  42274 17NOV1988 29AUG2011
203/781-5546
1131 WELLS          NADINE         NEW YORK       NY F TA2  32575 26DEC1981 19APR2011
718/383-1045
1427 WHALEY         CAROLYN        MT. VERNON     NY F TA2  34046 31OCT1990 30JAN2010
914/468-4528
1036 WONG           LESLIE         NEW YORK       NY F TA3  39392 19MAY1985 23OCT2004
212/587-2570
1130 WOOD           DEBORAH        NEW YORK       NY F FA1  23916 16MAY1981 05JUN2012
212/587-0013
1127 WOOD           SANDRA         NEW YORK       NY F TA2  33011 09NOV1984 07DEC2006
212/587-2881
1433 YANCEY         ROBIN          PRINCETON      NJ F FA3  32982 08JUL1986 17JAN2007
201/812-1874
1431 YOUNG          DEBORAH        STAMFORD       CT F FA3  33230 09JUN1984 05APR2008
203/781-2987
1122 YOUNG          JOANN          NEW YORK       NY F FA2  27956 01MAY1983 27NOV2008
718/384-2021
1105 YOUNG          LAWRENCE       NEW YORK       NY M ME2  34805 01MAR1982 13AUG2010
718/384-0008
```

```
;
run;
```

CONTROL.PHARM

```
data control.pharm (label='Sugar Study');
    input DRUG $8. RESPONSE $8. WT ;
    datalines;
      A cured   14
      A uncured 22
      B cured   24
      B uncured 19
      C cured   17
      C uncured 13
;
run;
```

CONTROL.POINTS

```
data control.points;
    input EMPID $8. Q1 Q2 Q3 Q4 TOTPTS;
    datalines;
2355           3       4       4       3       14
5889           2       2       2       2       8
3878           1       2       2       2       7
4409           0       1       1       1       3
2398           2       2       1       1       6
5862           1       1       1       2       5
;
run;
```

CONTROL.PRENAT

```
data control.prenat;
    input IDNUM $ 1-4 LNAME $ 6-20  FNAME $ 22-36 CITY $ 39-53
          STATE $ 55-56 HPHONE $ 58-69;
    datalines;
1919 ADAMS           GERALD          STAMFORD        CT 203/781-1255
1653 ALIBRANDI       MARIA           BRIDGEPORT      CT 203/675-7715
1400 ALHERTANI       ABDULLAH        NEW YORK        NY 212/586-0808
1350 ALVAREZ         MERCEDES        NEW YORK        NY 718/383-1549
1401 ALVAREZ         CARLOS          PATERSON        NJ 201/732-8787
1499 BAREFOOT        JOSEPH          PRINCETON       NJ 201/812-5665
1101 BAUCOM          WALTER          NEW YORK        NY 212/586-8060
1333 BANADYGA        JUSTIN          STAMFORD        CT 203/781-1777
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1402	BLALOCK	RALPH	NEW YORK	NY	718/384-2849
1479	BALLETTI	MARIE	NEW YORK	NY	718/384-8816
1403	BOWDEN	EARL	BRIDGEPORT	CT	203/675-3434
1739	BRANCACCIO	JOSEPH	NEW YORK	NY	212/587-1247
1658	BREUHAUS	JEREMY	NEW YORK	NY	212/587-3622
1428	BRADY	CHRISTINE	STAMFORD	CT	203/781-1212
1782	BREWCZAK	JAKOB	STAMFORD	CT	203/781-0019
1244	BUCCI	ANTHONY	NEW YORK	NY	718/383-3334
1383	BURNETTE	THOMAS	NEW YORK	NY	718/384-3569
1574	CAHILL	MARSHALL	NEW YORK	NY	718/383-2338
1789	CARAWAY	DAVIS	NEW YORK	NY	212/587-9000
1404	COHEN	LEE	NEW YORK	NY	718/384-2946
1437	CARTER	DOROTHY	BRIDGEPORT	CT	203/675-4117
1639	CARTER-COHEN	KAREN	STAMFORD	CT	203/781-8839
1269	CASTON	FRANKLIN	STAMFORD	CT	203/781-3335
1065	COPAS	FREDERICO	NEW YORK	NY	718/384-5618
1876	CHIN	JACK	NEW YORK	NY	212/588-5634
1037	CHOW	JANE	STAMFORD	CT	203/781-8868
1129	COUNIHAN	BRENDA	NEW YORK	NY	718/383-2313
1988	COOPER	ANTHONY	NEW YORK	NY	212/587-1228
1405	DACKO	JASON	PATERSON	NJ	201/732-2323
1430	DABROWSKI	SANDRA	BRIDGEPORT	CT	203/675-1647
1983	DEAN	SHARON	NEW YORK	NY	718/384-1647
1134	DELGADO	MARIA	STAMFORD	CT	203/781-1528
1118	DENNIS	ROGER	NEW YORK	NY	718/383-1122
1438	DABBOUSSI	KAMILLA	STAMFORD	CT	203/781-2229
1125	DUNLAP	DONNA	NEW YORK	NY	718/383-2094
1475	ELGES	MARGARETE	NEW YORK	NY	718/383-2828
1117	EDGERTON	JOSHUA	NEW YORK	NY	212/588-1239
1935	FERNANDEZ	KATRINA	BRIDGEPORT	CT	203/675-2962
1124	FIELDS	DIANA	WHITE PLAINS	NY	914/455-2998
1422	FUJIHARA	KYOKO	PRINCETON	NJ	201/812-0902
1616	FUENTAS	CARLA	NEW YORK	NY	718/384-3329
1406	FOSTER	GERALD	BRIDGEPORT	CT	203/675-6363
1120	GARCIA	JACK	NEW YORK	NY	718/384-4930
1094	GOMEZ	ALAN	BRIDGEPORT	CT	203/675-7181
1389	GOLDSTEIN	LEVI	NEW YORK	NY	718/384-9326
1905	GRAHAM	ALVIN	NEW YORK	NY	212/586-8815
1407	GREGORSKI	DANIEL	MT. VERNON	NY	914/468-1616
1114	GREENWALD	JANICE	NEW YORK	NY	212/588-1092
1410	HARRIS	CHARLES	STAMFORD	CT	203/781-0937
1439	HASENHAUER	CHRISTINA	BRIDGEPORT	CT	203/675-4987
1409	HAVELKA	RAYMOND	STAMFORD	CT	203/781-9697
1408	HENDERSON	WILLIAM	PRINCETON	NJ	201/812-4789
1121	HERNANDEZ	ROBERTO	NEW YORK	NY	718/384-3313
1991	HOWARD	GRETCHEN	BRIDGEPORT	CT	203/675-0007
1102	HERMANN	JOACHIM	WHITE PLAINS	NY	914/455-0976
1356	HOWARD	MICHAEL	NEW YORK	NY	212/586-8411
1545	HERRERO	CLYDE	STAMFORD	CT	203/781-1119
1292	HUNTER	HELEN	BRIDGEPORT	CT	203/675-4830
1440	JACKSON	LAURA	STAMFORD	CT	203/781-0088
1368	JEPSEN	RONALD	STAMFORD	CT	203/781-8413
1369	JONSON	ANTHONY	NEW YORK	NY	212/587-5385
1411	JOHNSEN	JACK	PATERSON	NJ	201/732-3678
1113	JOHNSON	LESLIE	NEW YORK	NY	718/383-3003
1704	JONES	NATHAN	NEW YORK	NY	718/384-0049

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1900 KING            WILLIAM          NEW YORK        NY 718/383-3698
1126 KIMANI          ANNE             NEW YORK        NY 212/586-1229
1677 KRAMER          JACKSON          BRIDGEPORT      CT 203/675-7432
1441 LAWRENCE        KATHY            PRINCETON       NJ 201/812-3337
1421 LEE             RUSSELL          MT. VERNON      NY 914/468-9143
1119 LI              JEFF             NEW YORK        NY 212/586-2344
1834 LEBLANC         RUSSELL          NEW YORK        NY 718/384-0040
1777 LUFKIN          ROY              NEW YORK        NY 718/383-4413
1663 MARKS           JOHN             NEW YORK        NY 212/587-7742
1106 MARSHBURN       JASPER           STAMFORD        CT 203/781-1457
1103 MCDANIEL        RONDA            NEW YORK        NY 212/586-0013
1477 MEYERS          PRESTON          BRIDGEPORT      CT 203/675-8125
1476 MONROE          JOYCE            STAMFORD        CT 203/781-2837
1379 MORGAN          ALFRED           STAMFORD        CT 203/781-2216
1104 MORGAN          CHRISTOPHER      NEW YORK        NY 718/383-9740
1009 MORGAN          GEORGE           NEW YORK        NY 212/586-7753
1412 MURPHEY         JOHN             PRINCETON       NJ 201/812-4414
1115 MURPHY          ALICE            NEW YORK        NY 718/384-1982
1128 NELSON          FELICIA          BRIDGEPORT      CT 203/675-1166
1442 NEWKIRK         SANDRA           PRINCETON       NJ 201/812-3331
1417 NEWKIRK         WILLIAM          PATERSON        NJ 201/732-6611
1478 NEWTON          JAMES            NEW YORK        NY 212/587-5549
1673 NICHOLLS        HENRY            STAMFORD        CT 203/781-7770
1839 NORRIS          DIANE            NEW YORK        NY 718/384-1767
1347 O'NEAL          BRYAN            NEW YORK        NY 718/384-0230
1423 OSWALD          LESLIE           MT. VERNON      NY 914/468-9171
1200 OVERMAN         MICHELLE         STAMFORD        CT 203/781-1835
1970 PARKER          ANNE             NEW YORK        NY 718/383-3895
1521 PARKER          JAY              NEW YORK        NY 212/587-7603
1354 PARKER          MARY             WHITE PLAINS    NY 914/455-2337
1424 PATTERSON       RENEE            NEW YORK        NY 212/587-8991
1132 PEARCE          CAROL            NEW YORK        NY 718/384-1986
1845 PEARSON         JAMES            NEW YORK        NY 718/384-2311
1556 PENNINGTON      MICHAEL          NEW YORK        NY 718/383-5681
1413 PETERS          RANDALL          PRINCETON       NJ 201/812-2478
1123 PETERSON        SUZANNE          NEW YORK        NY 718/383-0077
1907 PHELPS          WILLIAM          STAMFORD        CT 203/781-1118
1436 PORTER          SUSAN            NEW YORK        NY 718/383-5777
1385 RAYNOR          MILTON           BRIDGEPORT      CT 203/675-2846
1432 REED            MARILYN          MT. VERNON      NY 914/468-5454
1111 RHODES          JEREMY           PRINCETON       NJ 201/812-1837
1116 RICHARDS        CASEY            NEW YORK        NY 212/587-1224
1352 RIVERS          SIMON            NEW YORK        NY 718/383-3345
1555 RODRIGUEZ       JULIA            BRIDGEPORT      CT 203/675-2401
1038 RODRIGUEZ       MARIA            BRIDGEPORT      CT 203/675-2048
1420 ROUSE           JEREMY           PATERSON        NJ 201/732-9834
1561 SANDERS         RAYMOND          NEW YORK        NY 212/588-6615
1434 SANDERSON       EDITH            STAMFORD        CT 203/781-1333
1414 SANDERSON       NATHAN           BRIDGEPORT      CT 203/675-1715
1112 SANYERS         RANDY            NEW YORK        NY 718/384-4895
1390 SMART           JONATHAN         NEW YORK        NY 718/383-1141
1332 STEPHENSON      ADAM             BRIDGEPORT      CT 203/675-1497
1890 STEPHENSON      ROBERT           NEW YORK        NY 718/384-9874
1429 THOMPSON        ALICE            STAMFORD        CT 203/781-3857
1107 THOMPSON        WAYNE            NEW YORK        NY 718/384-3785
1908 TRENTON         MELISSA          NEW YORK        NY 212/586-6262
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1830 TRIPP           KATHY           BRIDGEPORT      CT 203/675-2479
1882 TUCKER          ALAN            NEW YORK        NY 718/384-0216
1050 TUTTLE          THOMAS          WHITE PLAINS    NY 914/455-2119
1425 UNDERWOOD       JENNY           STAMFORD        CT 203/781-0978
1928 UPCHURCH        LARRY           WHITE PLAINS    NY 914/455-5009
1480 UPDIKE          THERESA         NEW YORK        NY 212/587-8729
1100 VANDEUSEN       RICHARD         NEW YORK        NY 212/586-2531
1995 VARNER          ELIZABETH       NEW YORK        NY 718/384-7113
1135 VEGA            ANNA            NEW YORK        NY 718/384-5913
1415 VEGA            FRANKLIN        NEW YORK        NY 718/384-2823
1076 VENTER          RANDALL         NEW YORK        NY 718/383-2321
1426 VICK            THERESA         PRINCETON       NJ 201/812-2424
1564 WALTERS         ANNE            NEW YORK        NY 212/587-3257
1221 WALTERS         DIANE           NEW YORK        NY 718/384-1918
1133 WANG            CHIN            NEW YORK        NY 212/587-1956
1435 WARD            ELAINE          NEW YORK        NY 718/383-4987
1418 WATSON          BERNARD         NEW YORK        NY 718/383-1298
1017 WELCH           DARIUS          NEW YORK        NY 212/586-5535
1443 WELLS           AGNES           STAMFORD        CT 203/781-5546
1131 WELLS           NADINE          NEW YORK        NY 718/383-1045
1427 WHALEY          CAROLYN         MT. VERNON      NY 914/468-4528
1036 WONG            LESLIE          NEW YORK        NY 212/587-2570
1130 WOOD            DEBORAH         NEW YORK        NY 212/587-0013
1127 WOOD            SANDRA          NEW YORK        NY 212/587-2881
1433 YANCEY          ROBIN           PRINCETON       NJ 201/812-1874
1431 YOUNG           DEBORAH         STAMFORD        CT 203/781-2987
1122 YOUNG           JOANN           NEW YORK        NY 718/384-2021
1105 YOUNG           LAWRENCE        NEW YORK        NY 718/384-0008

;
run;
```

CONTROL.RESULTS

```
data control.results;
    input ID    TREAT $8.   INITWT    WT3MOS    AGE;
    datalines;
       1   Other  166.28  146.98     35
       2   Other  214.42  210.22     54
       3   Other  172.46  159.42     33
       5   Other  175.41  160.66     37
       6   Other  173.13  169.40     20
       7   Other  181.25  170.94     30
      10   Other  239.83  214.48     48
      11   Other  175.32  162.66     51
      12   Other  227.01  211.06     29
      13   Other  274.82  251.82     31
;
run;
```

CONTROL.SLEEP

```
data control.sleep;
    input  GROUP TIME  SOL  WASO FNA TST;
    datalines;
    1.00    1.00   38.69   48.43     0      0
    2.36  424.50    0.00    0.00     0      0
    1.00    2.00   15.83    9.67     0      0
    2.16  500.30    0.00    0.00     0      0
    1.00    1.00   93.04   87.10     0      0
    1.86  302.40    0.00    0.00     0      0
    1.00    2.00   65.00   16.67     0      0
    1.50  305.00    0.00    0.00     0      0
    1.00    1.00   19.82   74.38     0      0
    2.00  359.20    0.00    0.00     0      0
    1.00    2.00   13.75   13.90     0      0
    1.40  378.13    0.00    0.00     0      0
    1.00    1.00   47.35   60.52     0      0
    2.89  248.10    0.00    0.00     0      0
    1.00    2.00   72.14   86.07     0      0
    4.14  308.50    0.00    0.00     0      0
    1.00    1.00   99.65  151.79     0      0
    3.86  263.93    0.00    0.00     0      0
    1.00    2.00   65.35  118.33     0      0
    2.71  374.17    0.00    0.00     0      0
    1.00    1.00   47.15  105.36     0      0
    2.50  254.60    0.00    0.00     0      0
    1.00    2.00   66.00   92.60     0      0
    2.20  297.40    0.00    0.00     0      0
    1.00    1.00   30.84   84.97     0      0
    3.24  242.90    0.00    0.00     0      0
    1.00    2.00    7.86   23.86     0      0
    1.28  340.70    0.00    0.00     0      0
    1.00    1.00  117.41   36.93     0      0
    1.00  204.20    0.00    0.00     0      0
    1.00    2.00   50.42   24.86     0      0
    1.85  231.00    0.00    0.00     0      0
    1.00    1.00    6.50   41.15     0      0
    2.67  308.00    0.00    0.00     0      0
    1.00    2.00    2.00    0.00     0      0
    0.00  454.40    0.00    0.00     0      0
    2.00    1.00   54.29   84.93     0      0
    3.43  394.70    0.00    0.00     0      0
    2.00    2.00   13.57   48.00     0      0
    1.00  405.00    0.00    0.00     0      0
    2.00    1.00    4.43   58.43     0      0
    2.89  375.70    0.00    0.00     0      0
    2.00    2.00    5.00   49.28     0      0
    3.57  423.60    0.00    0.00     0      0
    2.00    1.00   32.50   38.43     0      0
    4.57  357.20    0.00    0.00     0      0
    2.00    2.00   17.14   33.14     0      0
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3.57  315.70    0.00    0.00      0       0
2.00    1.00   33.57   83.43      0       0
4.36  282.50    0.00    0.00      0       0
2.00    2.00   22.85   37.86      0       0
2.42  288.57    0.00    0.00      0       0
2.00    1.00   53.21  120.00      0       0
3.50  366.80    0.00    0.00      0       0
2.00    2.00   29.00   97.40      0       0
2.80  388.00    0.00    0.00      0       0
2.00    1.00   56.79   67.73      0       0
3.19  326.00    0.00    0.00      0       0
2.00    2.00   52.50   64.16      0       0
4.00   45.80    0.00    0.00      0       0
2.00    1.00   23.50   35.19      0       0
6.60  416.80    0.00    0.00      0       0
2.00    2.00   25.71   38.43      0       0
8.50  446.30    0.00    0.00      0       0
2.00    1.00   43.00   95.59      0       0
1.75  288.90    0.00    0.00      0       0
2.00    2.00   45.00   85.71      0       0
1.43  272.10    0.00    0.00      0       0
3.00    1.00   24.70   67.17      0       0
3.90  399.90    0.00    0.00      0       0
3.00    2.00    3.86   22.50      0       0
3.00  425.14    0.00    0.00      0       0
3.00    1.00   70.72   80.43      0       0
3.00  286.30    0.00    0.00      0       0
3.00    2.00   22.50  139.33      0       0
3.50  283.50    0.00    0.00      0       0
3.00    1.00   48.23   40.57      0       0
1.65  407.20    0.00    0.00      0       0
3.00    2.00   30.00   38.00      0       0
1.57  372.90    0.00    0.00      0       0
3.00    1.00   43.93   34.57      0       0
1.29  393.40    0.00    0.00      0       0
3.00    2.00   30.71   58.43      0       0
2.28  348.60    0.00    0.00      0       0
3.00    1.00   95.00   35.22      0       0
2.06  409.90    0.00    0.00      0       0
3.00    2.00   66.43   68.57      0       0
2.14  345.60    0.00    0.00      0       0
3.00    1.00   18.93   86.43      0       0
5.36  349.50    0.00    0.00      0       0
3.00    2.00   17.50  116.50      0       0
5.00  337.70    0.00    0.00      0       0
3.00    1.00  125.00   69.15      0       0
2.00  242.50    0.00    0.00      0       0
3.00    2.00   60.00   81.43      0       0
1.57  304.30    0.00    0.00      0       0
3.00    1.00   38.57   68.61      0       0
3.64  394.50    0.00    0.00      0       0
3.00    2.00   18.33   19.83      0       0
2.00  448.83    0.00    0.00      0       0
3.00    1.00   43.00  121.72      0       0
2.63  247.80    0.00    0.00      0       0
3.00    2.00   40.00   98.83      0       0
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    1.86  199.67    0.00    0.00      0       0
    3.00    1.00   11.61   70.36      0       0
    2.86  348.40    0.00    0.00      0       0
    3.00    2.00   20.43   70.57      0       0
    3.14  335.40    0.00    0.00      0       0
 ;
run;
```

CONTROL.SYNDROME

```
data control.syndrome;
    input FLIGHT $ 1-3 @10 DATE DATE7.  @22 DEPART TIME5. ORIG $ 31-33
          DEST $ 39-41 MILES  BOARDED  CAPACITY;
    format date DATE7.;
    format depart TIME5.;
    informat date DATE7.;
    informat depart TIME5.;
    datalines;
114       01MAR18     7:10     LGA     LAX      2475      172         210
202       01MAR18    10:43     LGA     ORD       740      151         210
219       01MAR18     9:31     LGA     LON      3442      198         250
622       01MAR18    12:19     LGA     FRA      3857      207         250
132       01MAR18    15:35     LGA     YYZ       366      115         178
271       01MAR18    13:17     LGA     PAR      3635      138         250
302       01MAR18    20:22     LGA     WAS       229      105         180
114       02MAR18     7:10     LGA     LAX      2475      119         210
202       02MAR18    10:43     LGA     ORD       740      120         210
219       02MAR18     9:31     LGA     LON      3442      147         250
622       02MAR18    12:19     LGA     FRA      3857      176         250
132       02MAR18    15:35     LGA     YYZ       366      106         178
302       02MAR18    20:22     LGA     WAS       229       78         180
271       02MAR18    13:17     LGA     PAR      3635      104         250
114       03MAR18     7:10     LGA     LAX      2475      197         210
202       03MAR18    10:43     LGA     ORD       740      118         210
219       03MAR18     9:31     LGA     LON      3442      197         250
622       03MAR18    12:19     LGA     FRA      3857      180         250
132       03MAR18    15:35     LGA     YYZ       366       75         178
271       03MAR18    13:17     LGA     PAR      3635      147         250
302       03MAR18    20:22     LGA     WAS       229      123         180
114       04MAR18     7:10     LGA     LAX      2475      178         210
202       04MAR18    10:43     LGA     ORD       740      148         210
219       04MAR18     9:31     LGA     LON      3442      232         250
622       04MAR18    12:19     LGA     FRA      3857      137         250
132       04MAR18    15:35     LGA     YYZ       366      117         178
271       04MAR18    13:17     LGA     PAR      3635      146         250
302       04MAR18    20:22     LGA     WAS       229      115         180
114       05MAR18     7:10     LGA     LAX      2475      117         210
202       05MAR18    10:43     LGA     ORD       740      104         210
219       05MAR18     9:31     LGA     LON      3442      160         250
622       05MAR18    12:19     LGA     FRA      3857      185         250
132       05MAR18    15:35     LGA     YYZ       366      157         178
271       05MAR18    13:17     LGA     PAR      3635      177         250
114       06MAR18     7:10     LGA     LAX      2475      128         210
```

```
202       06MAR18     10:43      LGA      ORD        740       115          210
219       06MAR18      9:31      LGA      LON       3442       163          250
132       06MAR18     15:35      LGA      YYZ        366       150          178
302       06MAR18     20:22      LGA      WAS        229        66          180
114       07MAR18      7:10      LGA      LAX       2475       160          210
202       07MAR18     10:43      LGA      ORD        740       175          210
219       07MAR18      9:31      LGA      LON       3442       241          250
622       07MAR18     12:19      LGA      FRA       3857       210          250
132       07MAR18     15:35      LGA      YYZ        366       164          178
271       07MAR18     13:17      LGA      PAR       3635       155          250
302       07MAR18     20:22      LGA      WAS        229       135          180
;
run;
```

CONTROL.TENSION

```
data control.tension;
    input TENSION $8.  CHD $8.  COUNT ;
    datalines;
yes       yes        97
yes       no        307
no        yes       200
no        no       1409
;
run;
```

CONTROL.TEST2

```
data control.test2;
    input STD1 $ TEST1 $  STD2 $   TEST2 $    WT;
    datalines ;
neg       neg      neg       neg      509
neg       neg      neg       pos        4
neg       neg      pos       neg       17
neg       neg      pos       pos        3
neg       pos      neg       neg       13
neg       pos      neg       pos        8
neg       pos      pos       pos        8
pos       neg      neg       neg       14
pos       neg      neg       pos        1
pos       neg      pos       neg       17
pos       neg      pos       pos        9
pos       pos      neg       neg        7
pos       pos      neg       pos        4
pos       pos      pos       neg        9
pos       pos      pos       pos      170
;
run;
```

CONTROL.TRAIN

```
data control.train;
    input NAME $ 1-16 IDNUM $ 17-24;
    datalines;
Capalleti, Jimmy    2355
Chen, Len           5889
Davis, Brad         3878
Leung, Brenda       4409
Patel, Mary         2398
Smith, Robert       5862
Zook, Carla         7385
;
run;
```

CONTROL.VISION

```
data control.vision;
    input RIGHT LEFT COUNT;
    datalines;
      1        1    1520
      1        2     266
      1        3     124
      1        4      66
      2        1     234
      2        2    1512
      2        3     432
      2        4      78
      3        1     117
      3        2     362
      3        3    1772
      3        4     205
      4        1      36
      4        2      82
      4        3     179
      4        4     492
;
run;
```

CONTROL.WEIGHT

```
data control.weight (label='California Results');
    input ID TREAT $8.  IBW INITWT WT3MOS WT6MOS WT9MOS AGE MMPI1 MMPI2
```

```
        MMPI3 MMPI4 MMPI5;
   datalines;
 1  Other    149  166.28  146.98  138.26     .       35    62     68     67     55     67
 2  Other    137  214.42  210.22     .    213.87     54    57     56     59     57     47
 3  Other    138  172.46  159.42  146.01  143.84     33    54     69     63     87     34
 5  Other    122  175.41  160.66  154.30     .       37    56     67     64     71     32
 6  Other    134  173.13  169.40  176.12     .       20    42     51     63     71     45
 7  Other    160  181.25  170.94     .       .       30    72     58     70     71     80
 9  Other    152  212.83  179.93  169.74  164.47  49100    65     87     71     74      4
10  Other    145  239.83  214.48  208.28     .       48    56     51     56     53     53
11  Other    158  175.32  162.66  161.39     .       51    66     60     71     62     84
12  Other    174  227.01  211.06  202.87  205.17     29    77     70     69     65     64
13  Other    137  274.82  251.82  248.18     .       31    66     82     66     69     55
15  Other    152  168.75  156.58  154.61  156.58     42    52     58     65     67     51
16  Other    162  187.81  172.07     .       .       40    57     68     67     67     74
17  Other    123  226.63     .    219.72     .       21    58     49     59     74     70
18  Other    146  176.03  160.27  160.27     .       41    48     55     49     68     43
19  Other    166  190.96  159.04     .       .       32    53     52     51     62     71
21  Other    148  165.54     .    166.22     .       48    57     60     65     74     55
22  Other    125  193.60  184.00     .       .       28    64     67     70     69     54
24  Other    152  267.43  230.26  206.09     .       30    48     45     55     50     41
25  Other    151  193.38  185.43     .       .       33    54     99     67     75     74
26  Other    134  252.61  227.61  217.72  223.88     31    62     51     70     57     39
27  Other    140  193.93  191.43  196.43     .       25    54     65     66     55     55
29  Other    119  182.77     .       .       .       38    66     63     64     60     41
30  Other    134  189.93  172.39  175.37     .       35    70     92     73     98     39
31  Other    138  190.22  181.88  178.99  181.16     36    56     69     61     62     34
32  Other    134  182.09  169.40  163.81  163.81     34    42     65     54     55     41
34  Other    133  200.00  189.47     .       .       24    52     61     64     62     39
35  Other    149  221.81  216.11     .       .       46    66     52     69     71     61
36  Other    133  241.35  247.37     .       .       34    50     65     57     74     47
37  Other    134  223.13  217.91     .       .       33    64     63     63     60     41
38  Other    140  235.36  228.57  210.71     .       50    56     61     70     74     39
39  Other    125  178.60  178.40     .       .       39    50     73     58     58     32
40  Other    143  243.01  226.57  210.49     .       38    64     66     70     54     46
41  Other    134  282.65  239.55     .       .       26    66     65     75     74     53
44  Other    139  282.37  258.99  238.13  241.01     43    66     69     68     65     39
45  Other    134  216.04  182.09     .       .       39    50     55     59     67     43
46  Other    115  190.00  171.30     .       .       36    64     59     58     58     44
47  Other    134  175.19  167.16     .       .       43    57     48     52     71     47
48  Other    118  179.87     .       .       .       37    52     57     45     50     30
50  Other    137  173.54  166.97  164.60     .       32    54     76     63     69     25
51  Other    125  180.60  162.40  152.00  157.60     32    50     56     64     53     53
52  Other    155  235.32  225.16  210.32  208.39     35    62     64     55     60     51
53  Other    143  183.39  169.23     .       .       38    64     57     72     81     61
54  Other    131  212.60  208.40  211.45     .       27    50     67     53     74     47
63  Surgery  146  219.18  167.12  139.73  119.18     35    58     53     67     48     55
65  Surgery  123  192.68  155.28  127.64  115.45     31    52     74     54     64     32
66  Surgery  134  199.25  173.88  161.19  144.03     38    68     64     70     77     30
71  Surgery  139  209.35  172.66  156.83  138.13     39    66     56     66     71     42
77  Surgery  137  179.56  150.36  132.12  123.36     29    46     49     42     47     49
80  Surgery  170  138.24  121.76  100.00     .       31    56     57     64     64     39
81  Surgery  129  206.98  173.64  132.56  121.71     28    42     78     52     62     41
84  Surgery  143  220.28  178.32     .       .       29    58     67     54     46     59
85  Surgery  152  189.47  156.58  140.79  140.79     34    75     73     62     74     51
86  Surgery  210  157.14  138.57  121.90  109.05     30    88     75     73     69     65
```

```
 92  Surgery  139  203.60  169.78  143.88     .       38    62     59     68     60     49
 93  Surgery  151  171.52  150.33  123.18  109.27     42    72     69     59     53     47
 95  Surgery  134  207.46  155.22     .       .       41    51     52     56     63     57
 96  Surgery  138  201.45  172.46  172.46  155.07     55    57     49     57     67     37
 97  Surgery  128  209.38  182.81  162.50  153.91     34    68     88     73     74      .
101  Surgery  166  185.54  146.39  139.76  132.53     42    82     80     89     79     51
102  Surgery  127  218.11  173.23  152.76  137.80     39    76     80     70     74     45
107  Surgery  128  227.34  192.97  184.38  170.31     49    50     51     59     50     55
110  Surgery  143  251.75  207.69  183.22  165.03     42    48     84     52     76     38
111  Surgery  152  197.37  164.47  148.68  132.89     56    90     70     86     76     70
112  Surgery  140  202.14  156.43  137.86     .       31    48     51     50     41     41
116  Surgery  139  273.38  235.25  194.24     .       31    58     55     66     81     45
117  Surgery  125  192.00  156.80  140.00  127.20     42    58     44     63     53     51
120  Surgery  119  277.31  231.93  208.40  192.44     31    60     69     59     95     34
122  Surgery  138  165.22  130.43  119.57     .       44    66     67     70     62     34
125  Surgery  152  257.89  200.00  182.89  134.21     39    47     84     53     88     74
126  Surgery  138  170.29  142.75     .       .       39    64     64     66     65     46
132  Surgery  149  208.05  173.83     .    126.85     34    82     57     75     65     45
133  Surgery  136  230.15  205.15  190.44  180.88     39    52     71     52     65     30
134  Surgery  168  177.98  140.48  119.64     .       45    70     77     62     67     69
137  Surgery  138  188.41  164.49  152.90  135.51     39    58     61     57     60     46
138  Surgery  141  268.09  220.57  185.82     .       32    52     59     66     74     53
158  Surgery  130  220.00  190.77  173.85     .       27    68     73     66     58     43
223  Surgery  157  220.38  185.35  152.23  138.85     43    78     76     70     57     53
266  Surgery  135  184.44  148.15  123.70     .       41    56     55     59     64     49
269  Surgery  155  201.29  151.61  140.65     .       57    82     84     86     77     73
293  Surgery  160  163.75  130.63     .       .       47    52     67     47     64     76
295  Surgery  128  211.72  172.66  151.56  137.50     45    93     65     80     60     41
298  Surgery  140  243.57  195.00     .    166.43     40    63     62     62     76     52
;
run;
```

CONTROL.WGHT

```
data control.wght (label='California Results');
    input ID TREAT $8.  IBW INITWT WT3MOS WT6MOS WT9MOS AGE MMPI1 MMPI2
          MMPI3 MMPI4 MMPI5;
    datalines;
  1  Other    149  166.28  146.98  138.26     .       35    62     68     67     55     67
  2  Other    137  214.42  210.22     .    213.87     54    57     56     59     57     47
  3  Other    138  172.46  159.42  146.01  143.84     33    54     69     63     87     34
  5  Other    122  175.41  160.66  154.30     .       37    56     67     64     71     32
  6  Other    134  173.13  169.40  176.12     .       20    42     51     63     71     45
  7  Other    160  181.25  170.94     .       .       30    72     58     70     71     80
  9  Other    152  212.83  179.93  169.74  164.47  49100    65     87     71     74      4
 10  Other    145  239.83  214.48  208.28     .       48    56     51     56     53     53
 11  Other    158  175.32  162.66  161.39     .       51    66     60     71     62     84
 12  Other    174  227.01  211.06  202.87  205.17     29    77     70     69     65     64
 13  Other    137  274.82  251.82  248.18     .       31    66     82     66     69     55
 15  Other    152  168.75  156.58  154.61  156.58     42    52     58     65     67     51
 16  Other    162  187.81  172.07     .       .       40    57     68     67     67     74
 17  Other    123  226.63     .    219.72     .       21    58     49     59     74     70
 18  Other    146  176.03  160.27  160.27     .       41    48     55     49     68     43
```

19	Other	166	190.96	159.04	.	.	32	53	52	51	62	71
21	Other	148	165.54	.	166.22	.	48	57	60	65	74	55
22	Other	125	193.60	184.00	.	.	28	64	67	70	69	54
24	Other	152	267.43	230.26	206.09	.	30	48	45	55	50	41
25	Other	151	193.38	185.43	.	.	33	54	99	67	75	74
26	Other	134	252.61	227.61	217.72	223.88	31	62	51	70	57	39
27	Other	140	193.93	191.43	196.43	.	25	54	65	66	55	55
29	Other	119	182.77	.	.	.	38	66	63	64	60	41
30	Other	134	189.93	172.39	175.37	.	35	70	92	73	98	39
31	Other	138	190.22	181.88	178.99	181.16	36	56	69	61	62	34
32	Other	134	182.09	169.40	163.81	163.81	34	42	65	54	55	41
34	Other	133	200.00	189.47	.	.	24	52	61	64	62	39
35	Other	149	221.81	216.11	.	.	46	66	52	69	71	61
36	Other	133	241.35	247.37	.	.	34	50	65	57	74	47
37	Other	134	223.13	217.91	.	.	33	64	63	63	60	41
38	Other	140	235.36	228.57	210.71	.	50	56	61	70	74	39
39	Other	125	178.60	178.40	.	.	39	50	73	58	58	32
40	Other	143	243.01	226.57	210.49	.	38	64	66	70	54	46
41	Other	134	282.65	239.55	.	.	26	66	65	75	74	53
44	Other	139	282.37	258.99	238.13	241.01	43	66	69	68	65	39
45	Other	134	216.04	182.09	.	.	39	50	55	59	67	43
46	Other	115	190.00	171.30	.	.	36	64	59	58	58	44
47	Other	134	175.19	167.16	.	.	43	57	48	52	71	47
48	Other	118	179.87	.	.	.	37	52	57	45	50	30
50	Other	137	173.54	166.97	164.60	.	32	54	76	63	69	25
51	Other	125	180.60	162.40	152.00	157.60	32	50	56	64	53	53
52	Other	155	235.32	225.16	210.32	208.39	35	62	64	55	60	51
53	Other	143	183.39	169.23	.	.	38	64	57	72	81	61
54	Other	131	212.60	208.40	211.45	.	27	50	67	53	74	47
63	Surgery	146	219.18	167.12	139.73	119.18	35	58	53	67	48	55
65	Surgery	123	192.68	155.28	127.64	115.45	31	52	74	54	64	32
66	Surgery	134	199.25	173.88	161.19	144.03	38	68	64	70	77	30
71	Surgery	139	209.35	172.66	156.83	138.13	39	66	56	66	71	42
77	Surgery	137	179.56	150.36	132.12	123.36	29	46	49	42	47	49
80	Surgery	170	138.24	121.76	100.00	.	31	56	57	64	64	39
81	Surgery	129	206.98	173.64	132.56	121.71	28	42	78	52	62	41
84	Surgery	143	220.28	178.32	.	.	29	58	67	54	46	59
85	Surgery	152	189.47	156.58	140.79	140.79	34	75	73	62	74	51
86	Surgery	210	157.14	138.57	121.90	109.05	30	88	75	73	69	65
92	Surgery	139	203.60	169.78	143.88	.	38	62	59	68	60	49
93	Surgery	151	171.52	150.33	123.18	109.27	42	72	69	59	53	47
95	Surgery	134	207.46	155.22	.	.	41	51	52	56	63	57
96	Surgery	138	201.45	172.46	172.46	155.07	55	57	49	57	67	37
97	Surgery	128	209.38	182.81	162.50	153.91	34	68	88	73	74	.
101	Surgery	166	185.54	146.39	139.76	132.53	42	82	80	89	79	51
102	Surgery	127	218.11	173.23	152.76	137.80	39	76	80	70	74	45
107	Surgery	128	227.34	192.97	184.38	170.31	49	50	51	59	50	55
110	Surgery	143	251.75	207.69	183.22	165.03	42	48	84	52	76	38
111	Surgery	152	197.37	164.47	148.68	132.89	56	90	70	86	76	70
112	Surgery	140	202.14	156.43	137.86	.	31	48	51	50	41	41
116	Surgery	139	273.38	235.25	194.24	.	31	58	55	66	81	45
117	Surgery	125	192.00	156.80	140.00	127.20	42	58	44	63	53	51
120	Surgery	119	277.31	231.93	208.40	192.44	31	60	69	59	95	34
122	Surgery	138	165.22	130.43	119.57	.	44	66	67	70	62	34
125	Surgery	152	257.89	200.00	182.89	134.21	39	47	84	53	88	74
126	Surgery	138	170.29	142.75	.	.	39	64	64	66	65	46

```
132  Surgery  149  208.05  173.83     .    126.85     34    82     57     75     65     45
133  Surgery  136  230.15  205.15  190.44  180.88     39    52     71     52     65     30
134  Surgery  168  177.98  140.48  119.64     .       45    70     77     62     67     69
137  Surgery  138  188.41  164.49  152.90  135.51     39    58     61     57     60     46
138  Surgery  141  268.09  220.57  185.82     .       32    52     59     66     74     53
158  Surgery  130  220.00  190.77  173.85     .       27    68     73     66     58     43
223  Surgery  157  220.38  185.35  152.23  138.85     43    78     76     70     57     53
266  Surgery  135  184.44  148.15  123.70     .       41    56     55     59     64     49
269  Surgery  155  201.29  151.61  140.65     .       57    82     84     86     77     73
293  Surgery  160  163.75  130.63     .       .       47    52     67     47     64     76
295  Surgery  128  211.72  172.66  151.56  137.50     45    93     65     80     60     41
298  Surgery  140  243.57  195.00     .    166.43     40    63     62     62     76     52
;
run;
```

CUSTOMER_RESPONSE

```
data customer_response;
   input Customer Factor1-Factor4 Source1-Source3
        Quality1-Quality3;
   datalines;
1 . . 1 1 1 1 . 1 . .
2 1 1 . 1 1 1 . 1 1 .
3 . . 1 1 1 1 . . . .
4 1 1 . 1 . 1 . . . 1
5 . 1 . 1 1 . . . . 1
6 . 1 . 1 1 . . . . .
7 . 1 . 1 1 . . 1 . .
8 1 . . 1 1 1 . 1 1 .
9 1 1 . 1 1 . . . . 1
10 1 . . 1 1 1 . 1 1 .
11 1 1 1 1 . 1 . 1 1 1
12 1 1 . 1 1 1 . . . .
13 1 1 . 1 . 1 . 1 1 .
14 1 1 . 1 1 1 . . . .
15 1 1 . 1 . 1 . 1 1 1
16 1 . . 1 1 . . 1 . .
17 1 1 . 1 1 1 . . 1 .
18 1 1 . 1 1 1 1 . . 1
19 . 1 . 1 1 1 1 . 1 .
20 1 . . 1 1 1 . 1 1 1
21 . . . 1 1 1 . 1 . .
22 . . . 1 1 1 . 1 1 .
23 1 . . 1 . . . . . 1
24 . 1 . 1 1 . . 1 . 1
25 1 1 . 1 1 . . . 1 1
26 1 1 . 1 1 . . 1 . .
27 1 . . 1 1 . . . 1 .
28 1 1 . 1 . . . 1 1 1
29 1 . . 1 1 1 . 1 . 1
30 1 . 1 1 1 . . 1 1 .
```

```
31 . . . 1 1 . . 1 1 .
32 1 1 1 1 1 . . 1 1 1
33 1 . . 1 1 . . 1 . 1
34 . . 1 1 . . . 1 1 .
35 1 1 1 1 1 . 1 1 . .
36 1 1 1 1 . 1 . 1 . .
37 1 1 . 1 . . . 1 . .
38 . . . 1 1 1 . 1 . .
39 1 1 . 1 1 . . 1 . 1
40 1 . . 1 . . 1 1 . 1
41 1 . . 1 1 1 1 1 . 1
42 1 1 1 1 . . 1 1 . .
43 1 . . 1 1 1 . 1 . .
44 1 . 1 1 . 1 . 1 . 1
45 . . . 1 . . 1 . . 1
46 . . . 1 1 . . . 1 .
47 1 1 . 1 . . 1 1 . .
48 1 . 1 1 1 . 1 1 . .
49 . . 1 1 1 1 . 1 . 1
50 . 1 . 1 1 . . 1 1 .
51 1 . 1 1 1 1 . . . .
52 1 1 1 1 1 1 . 1 . .
53 . 1 1 1 . 1 . 1 1 1
54 1 . . 1 1 . . 1 1 .
55 1 1 . 1 1 1 . 1 . .
56 1 . . 1 1 . . 1 1 .
57 1 1 . 1 1 . 1 . . 1
58 . 1 . 1 . 1 . . 1 1
59 1 1 1 1 . . 1 1 1 .
60 . 1 1 1 1 1 . . 1 1
61 1 1 1 1 1 1 . 1 . .
62 1 1 . 1 1 . . 1 1 .
63 . . . 1 . . . 1 1 1
64 1 . . 1 1 1 . 1 . .
65 1 . . 1 1 1 . 1 . .
66 1 . . 1 1 1 1 1 1 .
67 1 1 . 1 1 1 . 1 1 .
68 1 1 . 1 1 1 . 1 1 .
69 1 1 . 1 1 . 1 . . .
70 . . . 1 1 1 . 1 . .
71 1 . . 1 1 . 1 . . 1
72 1 . 1 1 1 1 . . 1 .
73 1 1 . 1 . 1 . 1 1 .
74 1 1 1 1 1 1 . 1 . .
75 . 1 . 1 1 1 . . 1 .
76 1 1 . 1 1 1 . 1 1 1
77 . . . 1 1 1 . . . .
78 1 1 1 1 1 1 . 1 1 .
79 1 . . 1 1 1 . 1 1 .
80 1 1 1 1 1 . 1 1 . 1
81 1 1 . 1 1 1 1 1 1 .
82 . . . 1 1 1 1 . . .
83 1 1 . 1 1 1 . 1 1 .
84 1 . . 1 1 . . 1 1 .
85 . . . 1 . 1 . 1 . .
86 1 . . 1 1 1 . 1 1 1
```

```
87 1 1 . 1 1 1 . 1 . .
88 . . . 1 . 1 . . . .
89 1 . . 1 . 1 . . 1 1
90 1 1 . 1 1 1 . 1 . 1
91 . . . 1 1 . . . 1 .
92 1 . . 1 1 1 . 1 1 .
93 1 . . 1 1 . . 1 1 .
94 1 . . 1 1 1 1 1 . .
95 1 . . 1 . 1 1 1 1 .
96 1 . 1 1 1 1 . . 1 .
97 1 1 . 1 1 . . . 1 .
98 1 . 1 1 1 1 1 1 . .
99 1 1 . 1 1 1 1 1 1 .
100 1 . 1 1 1 . . . 1 1
101 1 . 1 1 1 1 . . . .
102 1 . . 1 1 . 1 1 . .
103 1 1 . 1 1 1 . 1 . .
104 . . . 1 1 1 . 1 1 1
105 1 . 1 1 1 . . 1 . 1
106 1 1 1 1 1 1 1 1 1 1
107 1 1 1 1 . . . 1 . 1
108 1 . . 1 . 1 1 1 . .
109 . 1 . 1 1 . . 1 1 .
110 1 . . 1 . . . . . .
111 1 . . 1 1 1 . 1 1 .
112 1 1 . 1 1 1 . . . 1
113 1 1 . 1 1 . 1 1 1 .
114 1 1 . 1 1 . . . . .
115 1 1 . 1 1 . . 1 . .
116 . 1 . 1 1 1 1 1 . .
117 . 1 . 1 1 1 . . . .
118 . 1 1 1 1 . . 1 1 .
119 . . . 1 . . . 1 . .
120 1 1 . 1 . . . . 1 .
;
```

DJIA

```
data djia;
      input Year HighDate date9. High LowDate date9. Low;
      format highdate lowdate date9.;
      datalines;
1968 03DEC1968   985.21 21MAR1968   825.13
1969 14MAY1969   968.85 17DEC1969   769.93
1970 29DEC1970   842.00 06MAY1970   631.16
1971 28APR1971   950.82 23NOV1971   797.97
1972 11DEC1972  1036.27 26JAN1972   889.15
1973 11JAN1973  1051.70 05DEC1973   788.31
1974 13MAR1974   891.66 06DEC1974   577.60
1975 15JUL1975   881.81 02JAN1975   632.04
1976 21SEP1976  1014.79 02JAN1976   858.71
```

```
1977 03JAN1977   999.75 02NOV1977   800.85
1978 08SEP1978   907.74 28FEB1978   742.12
1979 05OCT1979   897.61 07NOV1979   796.67
1980 20NOV1980  1000.17 21APR1980   759.13
1981 27APR1981  1024.05 25SEP1981   824.01
1982 27DEC1982  1070.55 12AUG1982   776.92
1983 29NOV1983  1287.20 03JAN1983  1027.04
1984 06JAN1984  1286.64 24JUL1984  1086.57
1985 16DEC1985  1553.10 04JAN1985  1184.96
1986 02DEC1986  1955.57 22JAN1986  1502.29
1987 25AUG1987  2722.42 19OCT1987  1738.74
1988 21OCT1988  2183.50 20JAN1988  1879.14
1989 09OCT1989  2791.41 03JAN1989  2144.64
1990 16JUL1990  2999.75 11OCT1990  2365.10
1991 31DEC1991  3168.83 09JAN1991  2470.30
1992 01JUN1992  3413.21 09OCT1992  3136.58
1993 29DEC1993  3794.33 20JAN1993  3241.95
1994 31JAN1994  3978.36 04APR1994  3593.35
1995 13DEC1995  5216.47 30JAN1995  3832.08
1996 27DEC1996  6560.90 10JAN1996  5032.94
1997 06AUG1997  8259.30 11APR1997  6391.69
1998 23NOV1998  9374.27 31AUG1998  7539.06
1999 31DEC1999 11497.12 22JAN1999  9120.67
2000 14JAN2000 11722.98 07MAR2000  9796.04
2001 21MAY2001 11337.92 21SEP2001  8235.81
2002 19MAR2002 10635.25 09OCT2002  7286.27
2003 31DEC2003 10453.92 11MAR2003  7524.06
2004 28DEC2004 10854.54 25OCT2004  9749.99
2005 04MAR2005 10940.55 20APR2005 10012.36
2006 27DEC2006 12510.57 20JAN2006 10667.39
2007 09OCT2007 14164.53 05MAR2007 12050.41
2008 02MAY2008 13058.20 10OCT2008  8451.19
2009 24DEC2009 10520.10 09MAR2009  6507.O4
2010 31DEC2010 11577.51 02JUL2010  9686.48
2011 29APR2011 12810.54 23SEP2011 10771.48
2012 05OCT2012 13610.15 01JUN2012 12118.57
2013 31DEC2013 16576.66 04JAN2013 13435.21
2014 05DEC2014 17958.79 11APR2014 16026.75
2015 15MAY2015 18272.56 04SEP2015 16102.38
2016 23DEC2016 19993.81 12FEB2015 15973.84
2017 22DEC2017 24754.06 06JAN2017 19963.80
;
```

EDUCATION

```
data education;
   input State $14. +1 Code $ DropoutRate Expenditures MathScore Region $;
   label dropoutrate='Dropout Percentage - 2017'
         expenditures='Expenditure Per Pupil - 2017'
           mathscore='8th Grade Math Exam - 2018';
   datalines;
```

```
Alabama        AL 22.3 3197 252 SE
Alaska         AK 35.8 7716 .   W
Arizona        AZ 31.2 3902 259 W
Arkansas       AR 11.5 3273 256 SE
California     CA 32.7 4121 256 W
Colorado       CO 24.7 4408 267 W
Connecticut    CT 16.8 6857 270 NE
Delaware       DE 28.5 5422 261 NE
Florida        FL 38.5 4563 255 SE
Georgia        GA 27.9 3852 258 SE
Hawaii         HI 18.3 4121 251 W
Idaho          ID 21.8 2838 272 W
Illinois       IL 21.5 4906 260 MW
Indiana        IN 13.8 4284 267 MW
Iowa           IA 13.6 4285 278 MW
Kansas         KS 17.9 4443 .   MW
Kentucky       KY 32.7 3347 256 SE
Louisiana      LA 43.1 3317 246 SE
Maine          ME 22.5 4744 .   NE
Maryland       MD 26.0 5758 260 NE
Massachusetts  MA 28.0 5979 .   NE
Michigan       MI 29.3 5116 264 MW
Minnesota      MN 11.4 4755 276 MW
Mississippi    MS 39.9 2874 .   SE
Missouri       MO 26.5 4263 .   MW
Montana        MT 15.0 4293 280 W
Nebraska       NE 13.9 4360 276 MW
Nevada         NV 28.1 3791 .   W
New Hampshire  NH 25.9 4807 273 NE
New Jersey     NE 20.4 7549 269 NE
New Mexico     NM 28.5 3473 256 W
New York       NY 35.0 .    261 NE
North Carolina NC 31.2 3874 250 SE
North Dakota   ND 12.1 3952 281 MW
Ohio           OH 24.4 4649 264 MW
;
```

EMPDATA

```
data empdata;
input IdNumber $ 1-4 LastName $ 8-18 FirstName $ 19-28
      City $ 29-41 State $ 42-43
      Gender $ 45 JobCode $ 49-51 Salary 55-60 @63 Birth date9.
      @73 Hired date9. HomePhone $ 85-98;
format birth hired date9.;
datalines;
1919   Adams      Gerald    Stamford     CT M   TA2   34376   12SEP1990   04JUN2007
203/781-1255
1653   Ahmad      Azeem     Bridgeport   CT F   ME2   35108   15OCT1984   09AUG2010
203/675-7715
```

```
1400   Alvarez    Gloria     New York     NY M   ME1   29769   05NOV1987   16OCT2010
212/586-0808
1350   Arthur     Barbara    New York     NY F   FA3   32886   31AUG1985   29JUL2010
718/383-1549
1401   Avery      Jerry      Paterson     NJ M   TA3   38822   13DEC1970   17NOV2005
201/732-8787
1499   Barefoot   Joseph     Princeton    NJ M   ME3   43025   26APR1974   07JUN2010
201/812-5665
1101   Basquez    Richardo   New York     NY M   SCP   18723   06JUN1982   01OCT2010
212/586-8060
1333   Beaulieu   Armando    Stamford     CT M   PT2   88606   30MAR1983   10FEB2011
203/781-1777
1402   Blalock    Ralph      New York     NY M   TA2   32615   17JAN1983   02DEC2010
718/384-2849
1479   Bostic     Marie      New York     NY F   TA3   38785   22DEC1988   05OCT2007
718/384-8816
1403   Bowden     Earl       Bridgeport   CT M   ME1   28072   28JAN1989   21DEC2016
203/675-3434
1739   Boyce      Jonathan   New York     NY M   PT1   66517   25DEC1984   27JAN2011
212/587-1247
1658   Bradley    Jeremy     New York     NY M   SCP   17943   08APR1987   29FEB2012
212/587-3622
1428   Brady      Christine  Stamford     CT F   PT1   68767   04APR1980   16NOV2011
203/781-1212
1782   Brown      Jason      Stamford     CT M   ME2   35345   04DEC1980   22FEB2012
203/781-0019
1244   Bryant     Leonard    New York     NY M   ME2   36925   31AUG1983   17JAN2008
718/383-3334
1383   Burnette   Thomas     New York     NY M   BCK   25823   25JAN1985   20OCT2009
718/384-3569
1574   Cahill     Marshall   New York     NY M   FA2   28572   27APR1980   20DEC2012
718/383-2338
1789   Canales    Viviana    New York     NY M   SCP   18326   23JAN1977   11APR2008
212/587-9000
1404   Carter     Donald     New York     NY M   PT2   91376   24FEB1973   01JAN2010
718/384-2946
1437   Carter     Dorothy    Bridgeport   CT F   A3    33104   20SEP1980   31AUG2004
203/675-4117
1639   Carter     Karen      Stamford     CT F   A3    40260   26JUN1977   28JAN2014
203/781-8839
1269   Caston     Franklin   Stamford     CT M   NA1   41690   03MAY1972   28NOV2012
203/781-3335
1065   Chapman    Neil       New York     NY M   ME2   35090   26JAN1977   07JAN2007
718/384-5618
1876   Chin       Jack       New York     NY M   TA3   39675   20MAY1978   27APR2015
212/588-5634
1037   Chow       Jane       Stamford     CT F   TA1   28558   10APR1984   13SEP2012
203/781-8868
1129   Cook       Brenda     New York     NY F   ME2   34929   08DEC1981   17AUG2011
718/383-2313
1988   Cooper     Anthony    New York     NY M   FA3   32217   30NOV1979   18SEP2004
212/587-1228
1405   Davidson   Jason      Paterson     NJ M   SCP   18056   05MAR1986   26JAN2012
201/732-2323
1430   Dean       Sandra     Bridgeport   CT F   TA2   32925   28FEB1982   27APR2017
203/675-1647
```

```
1983   Dean       Sharon    New York     NY F   FA3   33419   28FEB1962   30APR2005
718/384-1647
1134   Delgado    Maria     Stamford     CT F   TA2   33462   05MAR1989   21DEC2016
203/781-1528
1118   Dennis     Roger     New York     NY M   PT3   111379  16JAN1964   18DEC2000
718/383-1122
1438   Desai      Aakash    Stamford     CT F   TA3   39223   15MAR1985   18NOV2007
203/781-2229
1125   Dunlap     Donna     New York     NY F   FA2   28888   08NOV1988   11DEC2007
718/383-2094
1475   Eaton      Alicia    New York     NY F   FA2   27787   15DEC1981   13JUL2010
718/383-2828
1117   Edgerton   Joshua    New York     NY M   TA3   39771   05JUN1983   13AUG2012
212/588-1239
1935   Fernandez  Katrina   Bridgeport   CT F   NA2   51081   28MAR1974   16OCT2011
203/675-2962
1124   Fields     Diana     White Plains NY F   FA1   23177   10JUL1978   01OCT2010
914/455-2998
1422   Fletcher   Marie     Princeton    NJ F   FA1   22454   04JUN1984   06APR2011
201/812-0902
1616   Flowers    Annette   New York     NY F   TA2   34137   01MAR1990   04JUN2013
718/384-3329
1406   Foster     Gerald    Bridgeport   CT M   ME2   35185   08MAR1981   17FEB2007
203/675-6363
1120   Garcia     Jack      New York     NY M   ME1   28619   11SEP1992   07OCT2013
718/384-4930
1094   Gomez      Alan      Bridgeport   CT M   FA1   22268   02APR1990   17APR2011
203/675-7181
1389   Gordon     Levi      New York     NY M   BCK   25028   15JUL1979   18AUG2010
718/384-9326
1905   Graham     Alvin     New York     NY M   PT1   65111   16APR1992   29MAY2012
212/586-8815
1407   Grant      Daniel    Mt. Vernon   NY M   PT1   68096   23MAR1989   18MAR2010
914/468-1616
1114   Green      Janice    New York     NY F   TA2   32928   18SEP1989   27JUN2007
212/588-1092
;
```

ENERGY

```
data energy;
   length State $2;
   input Region Division state $ Type Expenditures;
   datalines;
1 1 ME 1 708
1 1 ME 2 379
1 1 NH 1 597
1 1 NH 2 301
1 1 VT 1 353
1 1 VT 2 188
1 1 MA 1 3264
```

```
1 1 MA 2 2498
1 1 RI 1 531
1 1 RI 2 358
1 1 CT 1 2024
1 1 CT 2 1405
1 2 NY 1 8786
1 2 NY 2 7825
1 2 NJ 1 4115
1 2 NJ 2 3558
1 2 PA 1 6478
1 2 PA 2 3695
4 3 MT 1 322
4 3 MT 2 232
4 3 ID 1 392
4 3 ID 2 298
4 3 WY 1 194
4 3 WY 2 184
4 3 CO 1 1215
4 3 CO 2 1173
4 3 NM 1 545
4 3 NM 2 578
4 3 AZ 1 1694
4 3 AZ 2 1448
4 3 UT 1 621
4 3 UT 2 438
4 3 NV 1 493
4 3 NV 2 378
4 4 WA 1 1680
4 4 WA 2 1122
4 4 OR 1 1014
4 4 OR 2 756
4 4 CA 1 10643
4 4 CA 2 10114
4 4 AK 1 349
4 4 AK 2 329
4 4 HI 1 273
4 4 HI 2 298
;
```

EXP Library

EXP.RESULTS

The following sections are the raw data and DATA steps for the EXP library.

```
options ps=40 ls=64 nodate pageno=1;
```

```
LIBNAME exp 'library-name';

data exp.results;
   set exp.wght(firstobs=1 obs=11 keep=id treat initwt wt3mos
       age);
   if age>100 then delete;
run;
proc print data=exp.results noobs;
    title 'The RESULTS Data Set';
run;
proc datasets library=exp;

data exp.results;
    input id  treat $  initwt  wt3mos age;
    datalines;
 1    Other      166.28    146.98     35
 2    Other      214.42    210.22     54
 3    Other      172.46    159.42     33
 5    Other      175.41    160.66     37
 6    Other      173.13    169.40     20
 7    Other      181.25    170.94     30
10    Other      239.83    214.48     48
11    Other      175.32    162.66     51
12    Other      227.01    211.06     29
13    Other      274.82    251.82     31
;
run;
```

EXP.SUR

```
data exp.sur;
    input id  treat $  initwt  wt3mos  wt6mos  age;
    datalines;
14    surgery    203.60    169.78    143.88     38
17    surgery    171.52    150.33    123.18     42
18    surgery    207.46    155.22         .     41
;
run;
```

EXPREV

```
ods html close;
data exprev;
input Country $ 1-24 Emp_ID $ 25-32 Order_Date $  Ship_Date $  Sale_Type $ 67-75
Quantity Price Cost;

datalines;
```

```
Antarctica              99999999    1/1/18     1/7/18          Internet    2
92.60     20.70
Puerto Rico             99999999    1/1/18     1/5/18          Catalog    14
51.20     12.10
Virgin Islands (U.S.)   99999999    1/1/18     1/4/18          In Store   25
31.10     15.65
Aruba                   99999999    1/1/18     1/4/18          Catalog    30
123.70    59.00
Bahamas                 99999999    1/1/18     1/4/18          Catalog     8
113.40    28.45
Bermuda                 99999999    1/1/18     1/4/18          Catalog     7
41.00     9.25
Belize                  120458      1/2/18     1/2/18          In Store    2
146.40    36.70
British Virgin Islands  99999999    1/2/18     1/5/18          Catalog    11
40.20     20.20
Canada                  99999999    1/2/18     1/5/18          Catalog    100
11.80     5.00
Cayman Islands          120454      1/2/18     1/2/18          In Store   20
71.00     32.30
Costa Rica              99999999    1/2/18     1/6/18          Internet   31
53.00     26.60
Cuba                    121044      1/2/18     1/2/18          Internet   12
42.40     19.35
Dominican Republic      121040      1/2/18     1/2/18          Internet   13
48.00     23.95
El Salvador             99999999    1/2/18     1/6/18          Catalog    21
266.40    66.70
Guatemala               120931      1/2/18     1/2/18          In Store   13
144.40    65.70
Haiti                   121059      1/2/18     1/2/18          Internet    5
47.90     23.45
Honduras                120455      1/2/18     1/2/18          Internet   20
66.40     30.25
Jamaica                 99999999    1/2/18     1/4/18          In Store   23
169.80    38.70
Mexico                  120127      1/2/18     1/2/18          In Store   30
211.80    33.65
Montserrat              120127      1/2/18     1/2/18          In Store   19
184.20    36.90
Nicaragua               120932      1/2/18     1/2/18          Internet   16
122.00    28.75
Panama                  99999999    1/2/18     1/6/18          Internet   20
88.20     38.40
Saint Kitts/Nevis       99999999    1/2/18     1/6/18          Internet   20
41.40     18.00
St. Helena              120360      1/2/18     1/2/18          Internet   19
94.70     47.45
St. Pierre/Miquelon     120842      1/2/18     1/6/18          Internet   16
103.80    47.25
Turks/Caicos Islands    120372      1/2/18     1/2/18          Internet   10
57.70     28.95
United States           120372      1/2/18     1/2/18          Internet   20
88.20     38.40
Anguilla                99999999    1/2/18     1/6/18          In Store   15
233.50    22.25
```

```
Antigua/Barbuda          120458       1/2/18       1/2/18            In Store    31
99.60       45.35
Argentina                99999999     1/2/18       1/6/18            In Store    42
408.80      87.15
Barbados                 99999999     1/2/18       1/6/18            In Store    26
94.80       42.60
Bolivia                  120127       1/2/18       1/2/18            In Store    26
66.00       16.60
Brazil                   120127       1/2/18       1/2/18            Catalog     12
73.40       18.45
Chile                    120447       1/2/18       1/2/18            In Store    20
19.10       8.75
Colombia                 121059       1/2/18       1/2/18            Internet    28
361.40      90.45
Dominica                 121043       1/2/18       1/2/18            Internet    35
121.30      57.80
Ecuador                  121042       1/2/18       1/2/18            In Store    11
100.90      50.55
Falkland Islands         120932       1/2/18       1/2/18            In Store    15
61.40       30.80
French Guiana            120935       1/2/18       1/2/18            Catalog     15
96.40       43.85
Grenada                  120931       1/2/18       1/2/18            Catalog     19
56.30       25.05
Guadeloupe               120445       1/2/18       1/2/18            Internet    21
231.60      48.70
Guyana                   120455       1/2/18       1/2/18            In Store    25
132.80      30.25
Martinique               120841       1/2/18       1/3/18            In Store    16
56.30       31.05
Netherlands Antilles     99999999     1/2/18       1/6/18            In Store    31
41.80       19.45
Paraguay                 120603       1/2/18       1/2/18            Catalog     17
117.60      58.90
Peru                     120845       1/2/18       1/2/18            Catalog     12
93.80       41.75
St. Lucia                120845       1/2/18       1/2/18            Internet    19
64.30       28.65
Suriname                 120538       1/3/18       1/3/18            Internet    22
110.80      29.35
;
run;
```

GROC

```
data groc;
   input Region $9. Manager $ Department $ Sales;
   datalines;
Southeast    Hayes       Paper       250
Southeast    Hayes       Produce     100
Southeast    Hayes       Canned      120
```

```
Southeast    Hayes       Meat          80
Southeast    Michaels    Paper         40
Southeast    Michaels    Produce      300
Southeast    Michaels    Canned       220
Southeast    Michaels    Meat          70
Northwest    Jeffreys    Paper         60
Northwest    Jeffreys    Produce      600
Northwest    Jeffreys    Canned       420
Northwest    Jeffreys    Meat          30
Northwest    Duncan      Paper         45
Northwest    Duncan      Produce      250
Northwest    Duncan      Canned       230
Northwest    Duncan      Meat          73
Northwest    Aikmann     Paper         45
Northwest    Aikmann     Produce      205
Northwest    Aikmann     Canned       420
Northwest    Aikmann     Meat          76
Southwest    Royster     Paper         53
Southwest    Royster     Produce      130
Southwest    Royster     Canned       120
Southwest    Royster     Meat          50
Southwest    Patel       Paper         40
Southwest    Patel       Produce      350
Southwest    Patel       Canned       225
Southwest    Patel       Meat          80
Northeast    Rice        Paper         90
Northeast    Rice        Produce       90
Northeast    Rice        Canned       420
Northeast    Rice        Meat          86
Northeast    Fuller      Paper        200
Northeast    Fuller      Produce      300
Northeast    Fuller      Canned       420
Northeast    Fuller      Meat         125
;
```

MATCH_11

```
data match_11;
   input Pair Low Age Lwt Race Smoke Ptd Ht UI @@;
   select(race);
      when (1) do;
         race1=0;
         race2=0;
      end;
      when (2) do;
         race1=1;
         race2=0;
      end;
      when (3) do;
         race1=0;
         race2=1;
```

```
      end;
   end;
   datalines;
1  0 14 135 1 0 0 0 0     1  1 14 101 3 1 1 0 0
2  0 15  98 2 0 0 0 0     2  1 15 115 3 0 0 0 1
3  0 16  95 3 0 0 0 0     3  1 16 130 3 0 0 0 0
4  0 17 103 3 0 0 0 0     4  1 17 130 3 1 1 0 1
5  0 17 122 1 1 0 0 0     5  1 17 110 1 1 0 0 0
6  0 17 113 2 0 0 0 0     6  1 17 120 1 1 0 0 0
7  0 17 113 2 0 0 0 0     7  1 17 120 2 0 0 0 0
8  0 17 119 3 0 0 0 0     8  1 17 142 2 0 0 1 0
9  0 18 100 1 1 0 0 0     9  1 18 148 3 0 0 0 0
10 0 18  90 1 1 0 0 1     10 1 18 110 2 1 1 0 0
11 0 19 150 3 0 0 0 0     11 1 19  91 1 1 1 0 1
12 0 19 115 3 0 0 0 0     12 1 19 102 1 0 0 0 0
13 0 19 235 1 1 0 1 0     13 1 19 112 1 1 0 0 1
14 0 20 120 3 0 0 0 1     14 1 20 150 1 1 0 0 0
15 0 20 103 3 0 0 0 0     15 1 20 125 3 0 0 0 1
16 0 20 169 3 0 1 0 1     16 1 20 120 2 1 0 0 0
17 0 20 141 1 0 1 0 1     17 1 20  80 3 1 0 0 1
18 0 20 121 2 1 0 0 0     18 1 20 109 3 0 0 0 0
19 0 20 127 3 0 0 0 0     19 1 20 121 1 1 1 0 1
20 0 20 120 3 0 0 0 0     20 1 20 122 2 1 0 0 0
21 0 20 158 1 0 0 0 0     21 1 20 105 3 0 0 0 0
22 0 21 108 1 1 0 0 1     22 1 21 165 1 1 0 1 0
23 0 21 124 3 0 0 0 0     23 1 21 200 2 0 0 0 0
24 0 21 185 2 1 0 0 0     24 1 21 103 3 0 0 0 0
25 0 21 160 1 0 0 0 0     25 1 21 100 3 0 1 0 0
26 0 21 115 1 0 0 0 0     26 1 21 130 1 1 0 1 0
27 0 22  95 3 0 0 1 0     27 1 22 130 1 1 0 0 0
28 0 22 158 2 0 1 0 0     28 1 22 130 1 1 1 0 1
29 0 23 130 2 0 0 0 0     29 1 23  97 3 0 0 0 1
30 0 23 128 3 0 0 0 0     30 1 23 187 2 1 0 0 0
31 0 23 119 3 0 0 0 0     31 1 23 120 3 0 0 0 0
32 0 23 115 3 1 0 0 0     32 1 23 110 1 1 1 0 0
33 0 23 190 1 0 0 0 0     33 1 23  94 3 1 0 0 0
34 0 24  90 1 1 1 0 0     34 1 24 128 2 0 1 0 0
35 0 24 115 1 0 0 0 0     35 1 24 132 3 0 0 1 0
36 0 24 110 3 0 0 0 0     36 1 24 155 1 1 1 0 0
37 0 24 115 3 0 0 0 0     37 1 24 138 1 0 0 0 0
38 0 24 110 3 0 1 0 0     38 1 24 105 2 1 0 0 0
39 0 25 118 1 1 0 0 0     39 1 25 105 3 0 1 1 0
40 0 25 120 3 0 0 0 1     40 1 25  85 3 0 0 0 1
41 0 25 155 1 0 0 0 0     41 1 25 115 3 0 0 0 0
42 0 25 125 2 0 0 0 0     42 1 25  92 1 1 0 0 0
43 0 25 140 1 0 0 0 0     43 1 25  89 3 0 1 0 0
44 0 25 241 2 0 0 1 0     44 1 25 105 3 0 1 0 0
45 0 26 113 1 1 0 0 0     45 1 26 117 1 1 1 0 0
46 0 26 168 2 1 0 0 0     46 1 26  96 3 0 0 0 0
47 0 26 133 3 1 1 0 0     47 1 26 154 3 0 1 1 0
48 0 26 160 3 0 0 0 0     48 1 26 190 1 1 0 0 0
49 0 27 124 1 1 0 0 0     49 1 27 130 2 0 0 0 1
50 0 28 120 3 0 0 0 0     50 1 28 120 3 1 1 0 1
51 0 28 130 3 0 0 0 0     51 1 28  95 1 1 0 0 0
52 0 29 135 1 0 0 0 0     52 1 29 130 1 0 0 0 1
53 0 30  95 1 1 0 0 0     53 1 30 142 1 1 1 0 0
```

```
54 0 31 215 1 1 0 0 0     54 1 31 102 1 1 1 0 0
55 0 32 121 3 0 0 0 0     55 1 32 105 1 1 0 0 0
56 0 34 170 1 0 1 0 0     56 1 34 187 2 1 0 1 0
;
```

PROCLIB.DELAY

```
data proclib.delay;
   input flight $3. +5 date date7. +2 orig $3. +3 dest $3. +3
         delaycat $15. +2 destype $15. +8 delay;
   informat date date7.;
   format date date7.;
   datalines;
114     01MAR18  LGA   LAX   1-10 Minutes     Domestic               8
202     01MAR18  LGA   ORD   No Delay         Domestic              -5
219     01MAR18  LGA   LON   11+ Minutes      International         18
622     01MAR18  LGA   FRA   No Delay         International         -5
132     01MAR18  LGA   YYZ   11+ Minutes      International         14
271     01MAR18  LGA   PAR   1-10 Minutes     International          5
302     01MAR18  LGA   WAS   No Delay         Domestic              -2
114     02MAR18  LGA   LAX   No Delay         Domestic               0
202     02MAR18  LGA   ORD   1-10 Minutes     Domestic               5
219     02MAR18  LGA   LON   11+ Minutes      International         18
622     02MAR18  LGA   FRA   No Delay         International          0
132     02MAR18  LGA   YYZ   1-10 Minutes     International          5
271     02MAR18  LGA   PAR   1-10 Minutes     International          4
302     02MAR18  LGA   WAS   No Delay         Domestic               0
114     03MAR18  LGA   LAX   No Delay         Domestic              -1
202     03MAR18  LGA   ORD   No Delay         Domestic              -1
219     03MAR18  LGA   LON   1-10 Minutes     International          4
622     03MAR18  LGA   FRA   No Delay         International         -2
132     03MAR18  LGA   YYZ   1-10 Minutes     International          6
271     03MAR18  LGA   PAR   1-10 Minutes     International          2
302     03MAR18  LGA   WAS   1-10 Minutes     Domestic               5
114     04MAR18  LGA   LAX   11+ Minutes      Domestic              15
202     04MAR18  LGA   ORD   No Delay         Domestic              -5
219     04MAR18  LGA   LON   1-10 Minutes     International          3
622     04MAR18  LGA   FRA   11+ Minutes      International         30
132     04MAR18  LGA   YYZ   No Delay         International         -5
271     04MAR18  LGA   PAR   1-10 Minutes     International          5
302     04MAR18  LGA   WAS   1-10 Minutes     Domestic               7
114     05MAR18  LGA   LAX   No Delay         Domestic              -2
202     05MAR18  LGA   ORD   1-10 Minutes     Domestic               2
219     05MAR18  LGA   LON   1-10 Minutes     International          3
622     05MAR18  LGA   FRA   No Delay         International         -6
132     05MAR18  LGA   YYZ   1-10 Minutes     International          3
271     05MAR18  LGA   PAR   1-10 Minutes     International          5
114     06MAR18  LGA   LAX   No Delay         Domestic              -1
202     06MAR18  LGA   ORD   No Delay         Domestic              -3
219     06MAR18  LGA   LON   11+ Minutes      International         27
132     06MAR18  LGA   YYZ   1-10 Minutes     International          7
```

```
302     06MAR18  LGA   WAS   1-10 Minutes     Domestic              1
114     07MAR18  LGA   LAX   No Delay         Domestic             -1
202     07MAR18  LGA   ORD   No Delay         Domestic             -2
219     07MAR18  LGA   LON   11+ Minutes      International        15
622     07MAR18  LGA   FRA   11+ Minutes      International        21
132     07MAR18  LGA   YYZ   No Delay         International        -2
271     07MAR18  LGA   PAR   1-10 Minutes     International         4
302     07MAR18  LGA   WAS   No Delay         Domestic              0
;
```

PROCLIB.EMP95

```
data proclib.emp95;
   input #1 idnum $4. @6 name $15.
         #2 address $42.
         #3 salary 6.;
   datalines;
2388 James Schmidt
100 Apt. C Blount St. SW Raleigh NC 27693
92100
2457 Fred Williams
99 West Lane  Garner NC 27509
33190
2776 Robert Jones
12988 Wellington Farms Ave. Cary NC 27512
29025
8699 Jerry Capalleti
222 West L St. Oxford NC 27587
39985
2100 Lanny Engles
293 Manning Pl. Raleigh NC 27606
30998
9857 Kathy Krupski
1000 Taft Ave. Morrisville NC 27508
38756
0987 Dolly Lunford
2344 Persimmons Branch  Apex NC 27505
44010
3286 Hoa Nguyen
2818 Long St. Cary NC 27513
87734
6579 Bryan Samosky
3887 Charles Ave. Garner NC 27508
50234
3888 Kim Siu
5662 Magnolia Blvd Southeast Cary NC 27513
77558
;
```

PROCLIB.EMP96

```
data proclib.emp96;
   input #1 idnum $4. @6 name $15.
         #2 address $42.
         #3 salary 6.;
   datalines;
2388 James Schmidt
100 Apt. C Blount St. SW Raleigh NC 27693
92100
2457 Fred Williams
99 West Lane  Garner NC 27509
33190
2776 Robert Jones
12988 Wellington Farms Ave. Cary NC 27511
29025
8699 Jerry Capalleti
222 West L St. Oxford NC 27587
39985
3278 Mary Cravens
211 N. Cypress St. Cary NC 27512
35362
2100 Lanny Engles
293 Manning Pl. Raleigh NC 27606
30998
9857 Kathy Krupski
100 Taft Ave. Morrisville NC 27508
40456
0987 Dolly Lunford
2344 Persimmons Branch Trail Apex NC 27505
45110
3286 Hoa Nguyen
2818 Long St. Cary NC 27513
89834
6579 Bryan Samosky
3887 Charles Ave. Garner NC 27508
50234
3888 Kim Siu
5662 Magnolia Blvd Southwest Cary NC 27513
79958
6544 Roger Monday
3004 Crepe Myrtle Court Raleigh NC 27604
47007
;
```

PROCLIB.INTERNAT

```
data proclib.internat;
   input flight $3.  +5 date date7. +2 dest $3. +8 boarded;
   informat date date7.;
   format date date7.;
   datalines;
219     01MAR18  LON        198
622     01MAR18  FRA        207
132     01MAR18  YYZ        115
271     01MAR18  PAR        138
219     02MAR18  LON        147
622     02MAR18  FRA        176
132     02MAR18  YYZ        106
271     02MAR18  PAR        172
219     03MAR18  LON        197
622     03MAR18  FRA        180
132     03MAR18  YYZ         75
271     03MAR18  PAR        147
219     04MAR18  LON        232
622     04MAR18  FRA        137
132     04MAR18  YYZ        117
271     04MAR18  PAR        146
219     05MAR18  LON        160
622     05MAR18  FRA        185
132     05MAR18  YYZ        157
271     05MAR18  PAR        177
219     06MAR18  LON        163
132     06MAR18  YYZ        150
219     07MAR18  LON        241
622     07MAR18  FRA        210
132     07MAR18  YYZ        164
271     07MAR18  PAR        155
;
```

PROCLIB.LAKES

```
data proclib.lakes;
    input region $ 1-2 lake $ 5-13 pol_a1 pol_a2 pol_b1-pol_b4;
    datalines;
NE  Carr       0.24     0.99     0.95     0.36     0.44     0.67
NE  Duraleigh  0.34     0.01     0.48     0.58     0.12     0.56
NE  Charlie    0.40     0.48     0.29     0.56     0.52     0.95
NE  Farmer     0.60     0.65     0.25     0.20     0.30     0.64
```

```
NW  Canyon     0.63     0.44     0.20     0.98     0.19     0.01
NW  Morris     0.85     0.95     0.80     0.67     0.32     0.81
NW  Golf       0.69     0.37     0.08     0.72     0.71     0.32
NW  Falls      0.01     0.02     0.59     0.58     0.67     0.02
SE  Pleasant   0.16     0.96     0.71     0.35     0.35     0.48
SE  Juliette   0.82     0.35     0.09     0.03     0.59     0.90
SE  Massey     1.01     0.77     0.45     0.32     0.55     0.66
SE  Delta      0.84     1.05     0.90     0.09     0.64     0.03
SW  Alumni     0.45     0.32     0.45     0.44     0.55     0.12
SW  New Dam    0.80     0.70     0.31     0.98     1.00     0.22
SW  Border     0.51     0.04     0.55     0.35     0.45     0.78
SW  Red        0.22     0.09     0.02     0.10     0.32     0.01
;
```

PROCLIB.MARCH

```
data proclib.march;
   input flight $3. +5 date date7. +3 depart time5. +2 orig $3.
         +3 dest $3.  +7 miles +6 boarded +6 capacity;
   format date date7. depart time5.;
   informat date date7. depart time5.;
   datalines;
114     01MAR18    7:10  LGA   LAX       2475       172       210
202     01MAR18   10:43  LGA   ORD        740       151       210
219     01MAR18    9:31  LGA   LON       3442       198       250
622     01MAR18   12:19  LGA   FRA       3857       207       250
132     01MAR18   15:35  LGA   YYZ        366       115       178
271     01MAR18   13:17  LGA   PAR       3635       138       250
302     01MAR18   20:22  LGA   WAS        229       105       180
114     02MAR18    7:10  LGA   LAX       2475       119       210
202     02MAR18   10:43  LGA   ORD        740       120       210
219     02MAR18    9:31  LGA   LON       3442       147       250
622     02MAR18   12:19  LGA   FRA       3857       176       250
132     02MAR18   15:35  LGA   YYZ        366       106       178
302     02MAR18   20:22  LGA   WAS        229        78       180
271     02MAR18   13:17  LGA   PAR       3635       104       250
114     03MAR18    7:10  LGA   LAX       2475       197       210
202     03MAR18   10:43  LGA   ORD        740       118       210
219     03MAR18    9:31  LGA   LON       3442       197       250
622     03MAR18   12:19  LGA   FRA       3857       180       250
132     03MAR18   15:35  LGA   YYZ        366        75       178
271     03MAR18   13:17  LGA   PAR       3635       147       250
302     03MAR18   20:22  LGA   WAS        229       123       180
114     04MAR18    7:10  LGA   LAX       2475       178       210
202     04MAR18   10:43  LGA   ORD        740       148       210
219     04MAR18    9:31  LGA   LON       3442       232       250
622     04MAR18   12:19  LGA   FRA       3857       137       250
132     04MAR18   15:35  LGA   YYZ        366       117       178
271     04MAR18   13:17  LGA   PAR       3635       146       250
302     04MAR18   20:22  LGA   WAS        229       115       180
114     05MAR18    7:10  LGA   LAX       2475       117       210
```

```
202     05MAR18   10:43  LGA   ORD        740       104       210
219     05MAR18    9:31  LGA   LON       3442       160       250
622     05MAR18   12:19  LGA   FRA       3857       185       250
132     05MAR18   15:35  LGA   YYZ        366       157       178
271     05MAR18   13:17  LGA   PAR       3635       177       250
114     06MAR18    7:10  LGA   LAX       2475       128       210
202     06MAR18   10:43  LGA   ORD        740       115       210
219     06MAR18    9:31  LGA   LON       3442       163       250
132     06MAR18   15:35  LGA   YYZ        366       150       178
302     06MAR18   20:22  LGA   WAS        229        66       180
114     07MAR18    7:10  LGA   LAX       2475       160       210
202     07MAR18   10:43  LGA   ORD        740       175       210
219     07MAR18    9:31  LGA   LON       3442       241       250
622     07MAR18   12:19  LGA   FRA       3857       210       250
132     07MAR18   15:35  LGA   YYZ        366       164       178
271     07MAR18   13:17  LGA   PAR       3635       155       250
302     07MAR18   20:22  LGA   WAS        229       135       180
;
```

PROCLIB.PAYLIST2

```
proc sql;
   create table proclib.paylist2
       (IdNum char(4),
        Gender char(1),
        Jobcode char(3),
        Salary num,
        Birth num informat=date9.
                  format=date9.,
        Hired num informat=date9.
                  format=date9.);

insert into proclib.paylist2
values('1919','M','TA2',34376,'12SEP1990'd,'04JUN2007'd)
values('1653','F','ME2',31896,'15OCT1984'd,'09AUG2010'd)
values('1350','F','FA3',36886,'31AUG1985'd,'29JUL2010'd)
values('1401','M','TA3',38822,'13DEC1970'd,'17NOV2005'd)
values('1499','M','ME1',23025,'26APR1974'd,'07JUN2010'd);

title 'PROCLIB.PAYLIST2 Table';
select * from proclib.paylist2;
```

PROCLIB.PAYROLL

This data set (table) is updated in "Updating Data in a PROC SQL Table" in *SAS SQL Procedure User's Guide*, and its updated data is used in subsequent examples.

```
data proclib.payroll;
   input IdNumber $4. +3 Gender $1. +4 Jobcode $3. +8 Salary 6.
         +2 Birth date9. +2 Hired date9.;
   informat birth date9. hired date9.;
   format birth date9. hired date9.;
   datalines;
1919   M    TA2         34376  12SEP1990  04JUN2007
1653   F    ME2         35108  15OCT1984  09AUG2010
1400   M    ME1         29769  05NOV1987  16OCT2010
1350   F    FA3         32886  31AUG1985  29JUL2010
1401   M    TA3         38822  13DEC1970  17NOV2005
1499   M    ME3         43025  26APR1974  07JUN2010
1101   M    SCP         18723  06JUN1982  01OCT2010
1333   M    PT2         88606  30MAR1981  10FEB2011
1402   M    TA2         32615  17JAN1983  02DEC2010
1479   F    TA3         38785  22DEC1988  05OCT2007
1403   M    ME1         28072  28JAN1989  21DEC2016
1739   M    PT1         66517  25DEC1984  27JAN2011
1658   M    SCP         17943  08APR1987  29FEB2012
1428   F    PT1         68767  04APR1980  16NOV2011
1782   M    ME2         35345  04DEC1980  22FEB2012
1244   M    ME2         36925  31AUG1983  17JAN2008
1383   M    BCK         25823  25JAN1985  20OCT2009
1574   M    FA2         28572  27APR1980  20DEC2012
1789   M    SCP         18326  23JAN1977  11APR2008
1404   M    PT2         91376  24FEB1973  01JAN2010
1437   F    FA3         33104  20SEP1980  31AUG2004
1639   F    TA3         40260  26JUN1977  28JAN2014
1269   M    NA1         41690  03MAY1972  28NOV2012
1065   M    ME2         35090  26JAN1977  07JAN2007
1876   M    TA3         39675  20MAY1978  27APR2015
1037   F    TA1         28558  10APR1984  13SEP2012
1129   F    ME2         34929  08DEC1981  17AUG2011
1988   M    FA3         32217  30NOV1979  18SEP2004
1405   M    SCP         18056  05MAR1986  26JAN2012
1430   F    TA2         32925  28FEB1982  27APR2017
1983   F    FA3         33419  28FEB1962  30APR2005
1134   F    TA2         33462  05MAR1989  21DEC2016
1118   M    PT3        111379  16JAN1964  18DEC2000
1438   F    TA3         39223  15MAR1985  18NOV2007
1125   F    FA2         28888  08NOV1988  11DEC2007
1475   F    FA2         27787  15DEC1981  13JUL2010
1117   M    TA3         39771  05JUN1983  13AUG2012
1935   F    NA2         51081  28MAR1974  16OCT2011
1124   F    FA1         23177  10JUL1978  01OCT2010
```

```
1422   F    FA1         22454  04JUN1984  06APR2011
1616   F    TA2         34137  01MAR1990  04JUN2013
1406   M    ME2         35185  08MAR1981  17FEB2007
1120   M    ME1         28619  11SEP1992  07OCT2013
1094   M    FA1         22268  02APR1990  17APR2011
1389   M    BCK         25028  15JUL1979  18AUG2010
1905   M    PT1         65111  16APR1992  29MAY2012
1407   M    PT1         68096  23MAR1989  18MAR2010
1114   F    TA2         32928  18SEP1989  27JUN2007
1410   M    PT2         84685  03MAY1987  07NOV2006
1439   F    PT1         70736  06MAR1984  10SEP2010
1409   M    ME3         41551  19APR1970  22OCT2001
1408   M    TA2         34138  29MAR1980  14OCT2007
1121   M    ME1         29112  26SEP1981  07DEC2011
1991   F    TA1         27645  07MAY1982  12DEC2012
1102   M    TA2         34542  01OCT1979  15APR2011
1356   M    ME2         36869  26SEP1977  22FEB2003
1545   M    PT1         66130  12AUG1979  29MAY2010
1292   F    ME2         36691  28OCT1984  02JUL2009
1440   F    ME2         35757  27SEP1982  09APR2011
1368   M    FA2         27808  11JUN1981  03NOV2014
1369   M    TA2         33705  28DEC1981  13MAR2017
1411   M    FA2         27265  27MAY1981  01DEC2017
1113   F    FA1         22367  15JAN1988  17OCT2011
1704   M    BCK         25465  30AUG1986  28JUN2007
1900   M    ME2         35105  25MAY1982  27OCT2007
1126   F    TA3         40899  28MAY1983  21NOV2010
1677   M    BCK         26007  05NOV1983  27MAR2009
1441   F    FA2         27158  19NOV1989  23MAR2011
1421   M    TA2         33155  08JAN1979  28FEB2010
1119   M    TA1         26924  20JUN1982  06SEP2008
1834   M    BCK         26896  08FEB1982  02JUL2012
1777   M    PT3        109630  23SEP1971  21JUN2001
1663   M    BCK         26452  11JAN1987  11AUG2011
1106   M    PT2         89632  06NOV1977  16AUG2004
1103   F    FA1         23738  16FEB1988  23JUL2012
1477   M    FA2         28566  21MAR1984  07MAR2008
1476   F    TA2         34803  30MAY1986  17MAR2017
1379   M    ME3         42264  08AUG1981  10JUN2004
1104   M    SCP         17946  25APR1983  10JUN2011
1009   M    TA1         28880  02MAR1979  26MAR2012
1412   M    ME1         27799  18JUN1976  05DEC2011
1115   F    FA3         32699  22AUG1980  28FEB2010
1128   F    TA2         32777  23MAY1985  20OCT2010
1442   F    PT2         84536  05SEP1986  12APR2008
1417   M    NA2         52270  27JUN1984  07MAR2009
1478   M    PT2         84203  09AUG1979  24OCT2010
1673   M    BCK         25477  27FEB1980  15JUL2011
1839   F    NA1         43433  29NOV1980  03JUL2013
1347   M    TA3         40079  21SEP1987  06SEP2014
1423   F    ME2         35773  14MAY1988  19AUG2010
1200   F    ME1         27816  10JAN1981  14AUG2012
1970   F    FA1         22615  25SEP1984  12MAR2011
1521   M    ME3         41526  12APR1983  13JUL2008
1354   F    SCP         18335  29MAY1981  16JUN2012
1424   F    FA2         28978  04AUG1979  11DEC2009
```

```
1132   F    FA1         22413  30MAY1972  22OCT2003
1845   M    BCK         25996  20NOV1979  22MAR2000
1556   M    PT1         71349  22JUN1984  11DEC2011
1413   M    FA2         27435  16SEP1975  02JAN2010
1123   F    TA1         28407  31OCT1982  05DEC2012
1907   M    TA2         33329  15NOV1980  06JUL2007
1436   F    TA2         34475  11JUN1984  12MAR2007
1385   M    ME3         43900  16JAN1982  01APR2016
1432   F    ME2         35327  03NOV1981  10FEB2015
1111   M    NA1         40586  14JUL1983  31OCT2012
1116   F    FA1         22862  28SEP1979  21MAR2011
1352   M    NA2         53798  02DEC1980  16OCT2006
1555   F    FA2         27499  16MAR1978  04JUL2012
1038   F    TA1         26533  09NOV1989  23NOV2011
1420   M    ME3         43071  19FEB1985  22JUL2017
1561   M    TA2         34514  30NOV1983  07OCT2007
1434   F    FA2         28622  11JUL1982  28OCT2010
1414   M    FA1         23644  24MAR1982  12APR2012
1112   M    TA1         26905  29NOV1984  07DEC2012
1390   M    FA2         27761  19FEB1985  23JUN2011
1332   M    NA1         42178  17SEP1980  04JUN2011
1890   M    PT2         91908  20JUL1981  25NOV2017
1429   F    TA1         27939  28FEB1980  07AUG2012
1107   M    PT2         89977  09JUN1974  10FEB2009
1908   F    TA2         32995  10DEC1979  23APR2010
1830   F    PT2         84471  27MAY1977  29JAN2013
1882   M    ME3         41538  10JUL1977  21NOV2008
1050   M    ME2         35167  14JUL1983  24AUG2016
1425   F    FA1         23979  28DEC1981  28FEB2013
1928   M    PT2         89858  16SEP1974  13JUL2010
1480   F    TA3         39583  03SEP1977  25MAR2001
1100   M    BCK         25004  01DEC1980  07MAY2008
1995   F    ME1         28810  24AUG1983  19SEP2013
1135   F    FA2         27321  20SEP1980  31MAR2010
1415   M    FA2         28278  09MAR1978  12FEB2008
1076   M    PT1         66558  14OCT1975  03OCT2011
1426   F    TA2         32991  05DEC1986  25JUN2010
1564   F    SCP         18833  12APR1982  01JUL2012
1221   F    FA2         27896  22SEP1987  04OCT2011
1133   M    TA1         27701  13JUL1986  12FEB2012
1435   F    TA3         38808  12MAY1979  08FEB2010
1418   M    ME1         28005  29MAR1977  06JAN2012
1017   M    TA3         40858  28DEC1977  16OCT2011
1443   F    NA1         42274  17NOV1988  29AUG2011
1131   F    TA2         32575  26DEC1981  19APR2011
1427   F    TA2         34046  31OCT1990  30JAN2010
1036   F    TA3         39392  19MAY1985  23OCT2004
1130   F    FA1         23916  16MAY1981  05JUN2012
1127   F    TA2         33011  09NOV1984  07DEC2006
1433   F    FA3         32982  08JUL1986  17JAN2007
1431   F    FA3         33230  09JUN1984  05APR2008
1122   F    FA2         27956  01MAY1983  27NOV2008
1105   M    ME2         34805  01MAR1982  13AUG2010
;
```

PROCLIB.PAYROLL2

```
data proclib.payroll2;
   input idnum $4. +3 gender $1. +4 jobcode $3. +9 salary 5.
         +2 birth date9. +2 hired date9.;
   informat birth date9. hired date9.;
   format birth date9. hired date9.;
   datalines;
1639   F    TA3         42260  26JUN1977  28JAN2004
1065   M    ME3         38090  26JAN1964  07JAN2007
1561   M    TA3         36514  30NOV1983  07OCT2007
1221   F    FA3         29896  22SEP1987  04OCT2011
1447   F    FA1         22123  07AUG1982  29OCT2002
1998   M    SCP         23100  10SEP1970  02NOV2012
1036   F    TA3         42465  19MAY1965  23OCT2004
1106   M    PT3         94039  06NOV1957  16AUG2004
1129   F    ME3         36758  08DEC1961  17AUG2011
1350   F    FA3         36098  31AUG1985  29JUL2010
1369   M    TA3         36598  28DEC1961  13MAR2007
1076   M    PT1         69742  14OCT1955  03OCT2011
;
```

PROCLIB.SCHEDULE

```
data proclib.schedule;
   input flight $3. +5 date date7. +2 dest $3. +3 idnum $4.;
   format date date7.;
   informat date date7.;
   datalines;
132     01MAR18  YYZ   1739
132     01MAR18  YYZ   1478
132     01MAR18  YYZ   1130
132     01MAR18  YYZ   1390
132     01MAR18  YYZ   1983
132     01MAR18  YYZ   1111
219     01MAR18  LON   1407
219     01MAR18  LON   1777
219     01MAR18  LON   1103
219     01MAR18  LON   1125
219     01MAR18  LON   1350
219     01MAR18  LON   1332
271     01MAR18  PAR   1439
271     01MAR18  PAR   1442
271     01MAR18  PAR   1132
```

```
271     01MAR18  PAR   1411
271     01MAR18  PAR   1988
271     01MAR18  PAR   1443
622     01MAR18  FRA   1545
622     01MAR18  FRA   1890
622     01MAR18  FRA   1116
622     01MAR18  FRA   1221
622     01MAR18  FRA   1433
622     01MAR18  FRA   1352
132     02MAR18  YYZ   1556
132     02MAR18  YYZ   1478
132     02MAR18  YYZ   1113
132     02MAR18  YYZ   1411
132     02MAR18  YYZ   1574
132     02MAR18  YYZ   1111
219     02MAR18  LON   1407
219     02MAR18  LON   1118
219     02MAR18  LON   1132
219     02MAR18  LON   1135
219     02MAR18  LON   1441
219     02MAR18  LON   1332
271     02MAR18  PAR   1739
271     02MAR18  PAR   1442
271     02MAR18  PAR   1103
271     02MAR18  PAR   1413
271     02MAR18  PAR   1115
271     02MAR18  PAR   1443
622     02MAR18  FRA   1439
622     02MAR18  FRA   1890
622     02MAR18  FRA   1124
622     02MAR18  FRA   1368
622     02MAR18  FRA   1477
622     02MAR18  FRA   1352
132     03MAR18  YYZ   1739
132     03MAR18  YYZ   1928
132     03MAR18  YYZ   1425
132     03MAR18  YYZ   1135
132     03MAR18  YYZ   1437
132     03MAR18  YYZ   1111
219     03MAR18  LON   1428
219     03MAR18  LON   1442
219     03MAR18  LON   1130
219     03MAR18  LON   1411
219     03MAR18  LON   1115
219     03MAR18  LON   1332
271     03MAR18  PAR   1905
271     03MAR18  PAR   1118
271     03MAR18  PAR   1970
271     03MAR18  PAR   1125
271     03MAR18  PAR   1983
271     03MAR18  PAR   1443
622     03MAR18  FRA   1545
622     03MAR18  FRA   1830
622     03MAR18  FRA   1414
622     03MAR18  FRA   1368
622     03MAR18  FRA   1431
```

```
622     03MAR18  FRA   1352
132     04MAR18  YYZ   1428
132     04MAR18  YYZ   1118
132     04MAR18  YYZ   1103
132     04MAR18  YYZ   1390
132     04MAR18  YYZ   1350
132     04MAR18  YYZ   1111
219     04MAR18  LON   1739
219     04MAR18  LON   1478
219     04MAR18  LON   1130
219     04MAR18  LON   1125
219     04MAR18  LON   1983
219     04MAR18  LON   1332
271     04MAR18  PAR   1407
271     04MAR18  PAR   1410
271     04MAR18  PAR   1094
271     04MAR18  PAR   1411
271     04MAR18  PAR   1115
271     04MAR18  PAR   1443
622     04MAR18  FRA   1545
622     04MAR18  FRA   1890
622     04MAR18  FRA   1116
622     04MAR18  FRA   1221
622     04MAR18  FRA   1433
622     04MAR18  FRA   1352
132     05MAR18  YYZ   1556
132     05MAR18  YYZ   1890
132     05MAR18  YYZ   1113
132     05MAR18  YYZ   1475
132     05MAR18  YYZ   1431
132     05MAR18  YYZ   1111
219     05MAR18  LON   1428
219     05MAR18  LON   1442
219     05MAR18  LON   1422
219     05MAR18  LON   1413
219     05MAR18  LON   1574
219     05MAR18  LON   1332
271     05MAR18  PAR   1739
271     05MAR18  PAR   1928
271     05MAR18  PAR   1103
271     05MAR18  PAR   1477
271     05MAR18  PAR   1433
271     05MAR18  PAR   1443
622     05MAR18  FRA   1545
622     05MAR18  FRA   1830
622     05MAR18  FRA   1970
622     05MAR18  FRA   1441
622     05MAR18  FRA   1350
622     05MAR18  FRA   1352
132     06MAR18  YYZ   1333
132     06MAR18  YYZ   1890
132     06MAR18  YYZ   1414
132     06MAR18  YYZ   1475
132     06MAR18  YYZ   1437
132     06MAR18  YYZ   1111
219     06MAR18  LON   1106
```

```
219     06MAR18  LON   1118
219     06MAR18  LON   1425
219     06MAR18  LON   1434
219     06MAR18  LON   1555
219     06MAR18  LON   1332
132     07MAR18  YYZ   1407
132     07MAR18  YYZ   1118
132     07MAR18  YYZ   1094
132     07MAR18  YYZ   1555
132     07MAR18  YYZ   1350
132     07MAR18  YYZ   1111
219     07MAR18  LON   1905
219     07MAR18  LON   1478
219     07MAR18  LON   1124
219     07MAR18  LON   1434
219     07MAR18  LON   1983
219     07MAR18  LON   1332
271     07MAR18  PAR   1410
271     07MAR18  PAR   1777
271     07MAR18  PAR   1103
271     07MAR18  PAR   1574
271     07MAR18  PAR   1115
271     07MAR18  PAR   1443
622     07MAR18  FRA   1107
622     07MAR18  FRA   1890
622     07MAR18  FRA   1425
622     07MAR18  FRA   1475
622     07MAR18  FRA   1433
622     07MAR18  FRA   1352
;
```

PROCLIB.STAFF

```
data proclib.staff;
   input idnum $4. +3 lname $15. +2 fname $15. +2 city $15. +2
         state $2. +5 hphone $12.;
   datalines;
1919   ADAMS           GERALD          STAMFORD        CT     203/781-1255
1653   ALIBRANDI       MARIA           BRIDGEPORT      CT     203/675-7715
1400   ALHERTANI       ABDULLAH        NEW YORK        NY     212/586-0808
1350   ALVAREZ         MERCEDES        NEW YORK        NY     718/383-1549
1401   ALVAREZ         CARLOS          PATERSON        NJ     201/732-8787
1499   BAREFOOT        JOSEPH          PRINCETON       NJ     201/812-5665
1101   BAUCOM          WALTER          NEW YORK        NY     212/586-8060
1333   BANADYGA        JUSTIN          STAMFORD        CT     203/781-1777
1402   BLALOCK         RALPH           NEW YORK        NY     718/384-2849
1479   BALLETTI        MARIE           NEW YORK        NY     718/384-8816
1403   BOWDEN          EARL            BRIDGEPORT      CT     203/675-3434
1739   BRANCACCIO      JOSEPH          NEW YORK        NY     212/587-1247
1658   BREUHAUS        JEREMY          NEW YORK        NY     212/587-3622
1428   BRADY           CHRISTINE       STAMFORD        CT     203/781-1212
```

1782	BREWCZAK	JAKOB	STAMFORD	CT	203/781-0019
1244	BUCCI	ANTHONY	NEW YORK	NY	718/383-3334
1383	BURNETTE	THOMAS	NEW YORK	NY	718/384-3569
1574	CAHILL	MARSHALL	NEW YORK	NY	718/383-2338
1789	CARAWAY	DAVIS	NEW YORK	NY	212/587-9000
1404	COHEN	LEE	NEW YORK	NY	718/384-2946
1437	CARTER	DOROTHY	BRIDGEPORT	CT	203/675-4117
1639	CARTER-COHEN	KAREN	STAMFORD	CT	203/781-8839
1269	CASTON	FRANKLIN	STAMFORD	CT	203/781-3335
1065	COPAS	FREDERICO	NEW YORK	NY	718/384-5618
1876	CHIN	JACK	NEW YORK	NY	212/588-5634
1037	CHOW	JANE	STAMFORD	CT	203/781-8868
1129	COUNIHAN	BRENDA	NEW YORK	NY	718/383-2313
1988	COOPER	ANTHONY	NEW YORK	NY	212/587-1228
1405	DACKO	JASON	PATERSON	NJ	201/732-2323
1430	DABROWSKI	SANDRA	BRIDGEPORT	CT	203/675-1647
1983	DEAN	SHARON	NEW YORK	NY	718/384-1647
1134	DELGADO	MARIA	STAMFORD	CT	203/781-1528
1118	DENNIS	ROGER	NEW YORK	NY	718/383-1122
1438	DABBOUSSI	KAMILLA	STAMFORD	CT	203/781-2229
1125	DUNLAP	DONNA	NEW YORK	NY	718/383-2094
1475	ELGES	MARGARETE	NEW YORK	NY	718/383-2828
1117	EDGERTON	JOSHUA	NEW YORK	NY	212/588-1239
1935	FERNANDEZ	KATRINA	BRIDGEPORT	CT	203/675-2962
1124	FIELDS	DIANA	WHITE PLAINS	NY	914/455-2998
1422	FUJIHARA	KYOKO	PRINCETON	NJ	201/812-0902
1616	FUENTAS	CARLA	NEW YORK	NY	718/384-3329
1406	FOSTER	GERALD	BRIDGEPORT	CT	203/675-6363
1120	GARCIA	JACK	NEW YORK	NY	718/384-4930
1094	GOMEZ	ALAN	BRIDGEPORT	CT	203/675-7181
1389	GOLDSTEIN	LEVI	NEW YORK	NY	718/384-9326
1905	GRAHAM	ALVIN	NEW YORK	NY	212/586-8815
1407	GREGORSKI	DANIEL	MT. VERNON	NY	914/468-1616
1114	GREENWALD	JANICE	NEW YORK	NY	212/588-1092
1410	HARRIS	CHARLES	STAMFORD	CT	203/781-0937
1439	HASENHAUER	CHRISTINA	BRIDGEPORT	CT	203/675-4987
1409	HAVELKA	RAYMOND	STAMFORD	CT	203/781-9697
1408	HENDERSON	WILLIAM	PRINCETON	NJ	201/812-4789
1121	HERNANDEZ	ROBERTO	NEW YORK	NY	718/384-3313
1991	HOWARD	GRETCHEN	BRIDGEPORT	CT	203/675-0007
1102	HERMANN	JOACHIM	WHITE PLAINS	NY	914/455-0976
1356	HOWARD	MICHAEL	NEW YORK	NY	212/586-8411
1545	HERRERO	CLYDE	STAMFORD	CT	203/781-1119
1292	HUNTER	HELEN	BRIDGEPORT	CT	203/675-4830
1440	JACKSON	LAURA	STAMFORD	CT	203/781-0088
1368	JEPSEN	RONALD	STAMFORD	CT	203/781-8413
1369	JONSON	ANTHONY	NEW YORK	NY	212/587-5385
1411	JOHNSEN	JACK	PATERSON	NJ	201/732-3678
1113	JOHNSON	LESLIE	NEW YORK	NY	718/383-3003
1704	JONES	NATHAN	NEW YORK	NY	718/384-0049
1900	KING	WILLIAM	NEW YORK	NY	718/383-3698
1126	KIMANI	ANNE	NEW YORK	NY	212/586-1229
1677	KRAMER	JACKSON	BRIDGEPORT	CT	203/675-7432
1441	LAWRENCE	KATHY	PRINCETON	NJ	201/812-3337
1421	LEE	RUSSELL	MT. VERNON	NY	914/468-9143
1119	LI	JEFF	NEW YORK	NY	212/586-2344

1834	LEBLANC	RUSSELL	NEW YORK	NY	718/384-0040
1777	LUFKIN	ROY	NEW YORK	NY	718/383-4413
1663	MARKS	JOHN	NEW YORK	NY	212/587-7742
1106	MARSHBURN	JASPER	STAMFORD	CT	203/781-1457
1103	MCDANIEL	RONDA	NEW YORK	NY	212/586-0013
1477	MEYERS	PRESTON	BRIDGEPORT	CT	203/675-8125
1476	MONROE	JOYCE	STAMFORD	CT	203/781-2837
1379	MORGAN	ALFRED	STAMFORD	CT	203/781-2216
1104	MORGAN	CHRISTOPHER	NEW YORK	NY	718/383-9740
1009	MORGAN	GEORGE	NEW YORK	NY	212/586-7753
1412	MURPHEY	JOHN	PRINCETON	NJ	201/812-4414
1115	MURPHY	ALICE	NEW YORK	NY	718/384-1982
1128	NELSON	FELICIA	BRIDGEPORT	CT	203/675-1166
1442	NEWKIRK	SANDRA	PRINCETON	NJ	201/812-3331
1417	NEWKIRK	WILLIAM	PATERSON	NJ	201/732-6611
1478	NEWTON	JAMES	NEW YORK	NY	212/587-5549
1673	NICHOLLS	HENRY	STAMFORD	CT	203/781-7770
1839	NORRIS	DIANE	NEW YORK	NY	718/384-1767
1347	O'NEAL	BRYAN	NEW YORK	NY	718/384-0230
1423	OSWALD	LESLIE	MT. VERNON	NY	914/468-9171
1200	OVERMAN	MICHELLE	STAMFORD	CT	203/781-1835
1970	PARKER	ANNE	NEW YORK	NY	718/383-3895
1521	PARKER	JAY	NEW YORK	NY	212/587-7603
1354	PARKER	MARY	WHITE PLAINS	NY	914/455-2337
1424	PATTERSON	RENEE	NEW YORK	NY	212/587-8991
1132	PEARCE	CAROL	NEW YORK	NY	718/384-1986
1845	PEARSON	JAMES	NEW YORK	NY	718/384-2311
1556	PENNINGTON	MICHAEL	NEW YORK	NY	718/383-5681
1413	PETERS	RANDALL	PRINCETON	NJ	201/812-2478
1123	PETERSON	SUZANNE	NEW YORK	NY	718/383-0077
1907	PHELPS	WILLIAM	STAMFORD	CT	203/781-1118
1436	PORTER	SUSAN	NEW YORK	NY	718/383-5777
1385	RAYNOR	MILTON	BRIDGEPORT	CT	203/675-2846
1432	REED	MARILYN	MT. VERNON	NY	914/468-5454
1111	RHODES	JEREMY	PRINCETON	NJ	201/812-1837
1116	RICHARDS	CASEY	NEW YORK	NY	212/587-1224
1352	RIVERS	SIMON	NEW YORK	NY	718/383-3345
1555	RODRIGUEZ	JULIA	BRIDGEPORT	CT	203/675-2401
1038	RODRIGUEZ	MARIA	BRIDGEPORT	CT	203/675-2048
1420	ROUSE	JEREMY	PATERSON	NJ	201/732-9834
1561	SANDERS	RAYMOND	NEW YORK	NY	212/588-6615
1434	SANDERSON	EDITH	STAMFORD	CT	203/781-1333
1414	SANDERSON	NATHAN	BRIDGEPORT	CT	203/675-1715
1112	SANYERS	RANDY	NEW YORK	NY	718/384-4895
1390	SMART	JONATHAN	NEW YORK	NY	718/383-1141
1332	STEPHENSON	ADAM	BRIDGEPORT	CT	203/675-1497
1890	STEPHENSON	ROBERT	NEW YORK	NY	718/384-9874
1429	THOMPSON	ALICE	STAMFORD	CT	203/781-3857
1107	THOMPSON	WAYNE	NEW YORK	NY	718/384-3785
1908	TRENTON	MELISSA	NEW YORK	NY	212/586-6262
1830	TRIPP	KATHY	BRIDGEPORT	CT	203/675-2479
1882	TUCKER	ALAN	NEW YORK	NY	718/384-0216
1050	TUTTLE	THOMAS	WHITE PLAINS	NY	914/455-2119
1425	UNDERWOOD	JENNY	STAMFORD	CT	203/781-0978
1928	UPCHURCH	LARRY	WHITE PLAINS	NY	914/455-5009
1480	UPDIKE	THERESA	NEW YORK	NY	212/587-8729

```
1100   VANDEUSEN        RICHARD          NEW YORK         NY     212/586-2531
1995   VARNER           ELIZABETH        NEW YORK         NY     718/384-7113
1135   VEGA             ANNA             NEW YORK         NY     718/384-5913
1415   VEGA             FRANKLIN         NEW YORK         NY     718/384-2823
1076   VENTER           RANDALL          NEW YORK         NY     718/383-2321
1426   VICK             THERESA          PRINCETON        NJ     201/812-2424
1564   WALTERS          ANNE             NEW YORK         NY     212/587-3257
1221   WALTERS          DIANE            NEW YORK         NY     718/384-1918
1133   WANG             CHIN             NEW YORK         NY     212/587-1956
1435   WARD             ELAINE           NEW YORK         NY     718/383-4987
1418   WATSON           BERNARD          NEW YORK         NY     718/383-1298
1017   WELCH            DARIUS           NEW YORK         NY     212/586-5535
1443   WELLS            AGNES            STAMFORD         CT     203/781-5546
1131   WELLS            NADINE           NEW YORK         NY     718/383-1045
1427   WHALEY           CAROLYN          MT. VERNON       NY     914/468-4528
1036   WONG             LESLIE           NEW YORK         NY     212/587-2570
1130   WOOD             DEBORAH          NEW YORK         NY     212/587-0013
1127   WOOD             SANDRA           NEW YORK         NY     212/587-2881
1433   YANCEY           ROBIN            PRINCETON        NJ     201/812-1874
1431   YOUNG            DEBORAH          STAMFORD         CT     203/781-2987
1122   YOUNG            JOANN            NEW YORK         NY     718/384-2021
1105   YOUNG            LAWRENCE         NEW YORK         NY     718/384-0008
;
```

PROCLIB.STAFF2

```
data proclib.staff;
   input Name & $16. IdNumber $ Salary
         Site $ HireDate date9.;
   format hiredate date9.;
   datalines;
Capalleti, Jimmy  2355 21163 BR1 30JAN2009
Chen, Len         5889 20976 BR1 18JUN2006
Davis, Brad       3878 19571 BR2 20MAR2004
Leung, Brenda     4409 34321 BR2 18SEP2014
Martinez, Maria   3985 49056 US2 10JAN2013
Orfali, Philip    0740 50092 US2 16FEB2003
Patel, Mary       2398 35182 BR3 02FEB2010
Smith, Robert     5162 40100 BR5 15APR2006
Sorrell, Joseph   4421 38760 US1 19JUN2011
Zook, Carla       7385 22988 BR3 18DEC2010
;
```

PROCLIB.SUPERV

```
data proclib.superv;
   input supid $4. +8 state $2. +5  jobcat  $2.;
   label supid='Supervisor Id' jobcat='Job Category';
   datalines;
1677        CT     BC
1834        NY     BC
1431        CT     FA
1433        NJ     FA
1983        NY     FA
1385        CT     ME
1420        NJ     ME
1882        NY     ME
1935        CT     NA
1417        NJ     NA
1352        NY     NA
1106        CT     PT
1442        NJ     PT
1118        NY     PT
1405        NJ     SC
1564        NY     SC
1639        CT     TA
1401        NJ     TA
1126        NY     TA
;
```

RADIO

This DATA step uses an INFILE statement to read data that is stored in an external file.

```
data radio;
   infile 'input-file' missover;
   input /(time1-time7) ($1. +1);
   listener=_n_;
run;
```

Here is the data that is stored in the external file:

```
967 32 f 5 3 5
7 5 5 5 7 0 0 0 8 7 0 0 8 0
781 30 f 2 3 5
5 0 0 0 5 0 0 0 4 7 5 0 0 0
859 39 f 1 0 5
```

```
1 0 0 0 1 0 0 0 0 0 0 0 0 0
859 40 f 6 1 5
7 5 0 5 7 0 0 0 0 0 0 5 0 0
467 37 m 2 3 1
1 5 5 5 5 4 4 8 8 0 0 0 0 0
220 35 f 3 1 7
7 0 0 0 7 0 0 0 7 0 0 0 0 0
833 42 m 2 2 4
7 0 0 0 7 5 4 7 4 0 1 4 4 0
967 39 f .5 1 7
7 0 0 0 7 7 0 0 0 0 0 0 8 0
677 28 m .5 .5 7
7 0 0 0 0 0 0 0 0 0 0 0 0 0
833 28 f 3 4 1
1 0 0 0 0 1 1 1 1 0 0 0 1 1
677 24 f 3 1 2
2 0 0 0 0 0 0 2 0 8 8 0 0 0
688 32 m 5 2 4
5 5 0 4 8 0 0 5 0 8 0 0 0 0
542 38 f 6 8 5
5 0 0 5 5 5 0 5 5 5 5 5 5 0
677 27 m 6 1 1
1 1 0 4 4 0 0 1 4 0 0 0 0 0
779 37 f 2.5 4 7
7 0 0 0 7 7 0 7 7 4 4 7 8 0
362 31 f 1 2 2
8 0 0 0 8 0 0 0 0 0 8 8 0 0
859 29 m 10 3 4
4 4 0 2 2 0 0 4 0 0 0 4 4 0
467 24 m 5 8 1
7 1 1 1 7 1 1 0 1 7 1 1 1 1
851 34 m 1 2 8
0 0 0 0 8 0 0 0 4 0 0 0 8 0
859 23 f 1 1 8
8 0 0 0 8 0 0 0 0 0 0 0 0 8
781 34 f 9 3 1
2 1 0 1 4 4 4 0 1 1 1 1 4 4
851 40 f 2 4 5
5 0 0 0 5 0 0 5 0 0 5 5 0 0
783 34 m 3 2 4
7 0 0 0 7 4 4 0 0 4 4 0 0 0
848 29 f 4 1.5 7
7 4 4 1 7 0 0 0 7 0 0 7 0 0
851 28 f 1 2 2
2 0 2 0 2 0 0 0 0 2 2 2 0 0
856 42 f 1.5 1 2
2 0 0 0 0 0 0 2 0 0 0 0 0 0
859 29 m .5 .5 5
5 0 0 0 1 0 0 0 0 0 0 8 8 5 0
833 29 m 1 3 2
2 0 0 0 2 2 0 0 4 2 0 2 0 0
859 23 f 10 3 1
1 5 0 8 8 1 4 0 1 1 1 1 1 4
781 37 f .5 2 7
7 0 0 0 1 0 0 0 1 7 0 1 0 0
833 31 f 5 4 1
```

```
1 0 0 0 1 0 0 0 4 0 4 0 0 0
942 23 f 4 2 1
1 0 0 0 1 0 1 0 1 1 0 0 0 0
848 33 f 5 4 1
1 1 0 1 1 0 0 0 1 1 1 0 0 0
222 33 f 2 0 1
1 0 0 0 1 0 0 0 0 0 0 0 0 0
851 45 f .5 1 8
8 0 0 0 8 0 0 0 0 0 8 0 0 0
848 27 f 2 4 1
1 0 0 0 1 1 0 0 4 1 1 1 1 1
781 38 m 2 2 1
5 0 0 0 1 0 0 0 0 0 1 1 0 0
222 27 f 3 1 2
2 0 2 0 2 2 0 0 2 0 0 0 0 0
467 34 f 2 2 1
1 0 0 0 0 1 0 1 0 0 0 0 1 0
833 27 f 8 8 1
7 0 1 0 7 4 0 0 1 1 1 4 1 0
677 49 f 1.5 0 8
8 0 8 0 8 0 0 0 0 0 0 0 0 0
849 43 m 1 4 1
1 0 0 0 4 0 0 0 4 0 1 0 0 0
467 28 m 2 1 7
7 0 0 0 7 0 0 7 0 0 1 0 0 0
732 29 f 1 0 2
2 0 0 0 2 0 0 0 0 0 0 0 0 0
851 31 m 2 2 2
2 5 0 6 0 0 8 0 2 2 8 2 0 0
779 42 f 8 2 2
7 2 0 2 7 0 0 0 0 0 0 0 2 0
493 40 m 1 3 3
3 0 0 0 5 3 0 5 5 0 0 0 1 1
859 30 m 1 0 7
7 0 0 0 7 0 0 0 0 0 0 0 0 0
833 36 m 4 2 5
7 5 0 5 0 5 0 0 7 0 0 0 5 0
467 30 f 1 4 1
0 0 0 0 1 0 6 0 0 1 1 1 0 6
859 32 f 3 5 2
2 2 2 2 2 2 6 6 2 2 2 2 2 6
851 43 f 8 1 5
7 5 5 5 0 0 0 4 0 0 0 0 0 0
848 29 f 3 5 1
7 0 0 0 7 1 0 0 1 1 1 1 1 0
833 25 f 2 4 5
7 0 0 0 5 7 0 0 7 5 0 0 5 0
783 33 f 8 3 8
8 0 8 0 7 0 0 0 8 0 5 4 0 5
222 26 f 10 2 1
1 1 0 1 1 0 0 0 3 1 1 0 0 0
222 23 f 3 2 2
2 2 2 2 7 0 0 2 2 0 0 0 0 0
859 50 f 1 5 4
7 0 0 0 7 0 0 5 4 4 4 7 0 0
833 26 f 3 2 1
```

```
1 0 0 1 1 0 0 5 5 0 1 0 0 0
467 29 m 7 2 1
1 1 1 1 1 0 0 1 1 1 0 0 0 0
859 35 m .5 2 2
7 0 0 0 2 0 0 7 5 0 0 4 0 0
833 33 f 3 3 6
7 0 0 0 6 8 0 8 0 0 0 8 6 0
221 36 f .5 1 5
0 7 0 0 0 7 0 0 7 0 0 7 7 0
220 32 f 2 4 5
5 0 5 0 5 5 5 0 5 5 5 5 5 5
684 19 f 2 4 2
0 2 0 2 0 0 0 0 0 2 2 0 0 0
493 55 f 1 0 5
5 0 0 5 0 0 0 0 7 0 0 0 0 0
221 27 m 1 1 7
7 0 0 0 0 0 0 0 5 0 0 0 5 0
684 19 f 0 .5 1
7 0 0 0 0 1 1 0 0 0 0 0 1 1
493 38 f .5 .5 5
0 8 0 0 5 0 0 0 5 0 0 0 0 0
221 26 f .5 2 1
0 1 0 0 0 1 0 0 5 5 5 1 0 0
684 18 m 1 .5 1
0 2 0 0 0 0 1 0 0 0 0 1 1 0
684 19 m 1 1 1
0 0 0 1 1 0 0 0 0 0 1 0 0 0
221 29 m .5 .5 5
0 0 0 0 0 5 5 0 0 0 0 0 5 5
683 18 f 2 4 8
0 0 0 0 8 0 0 0 8 8 8 0 0 0
966 23 f 1 2 1
1 5 5 5 1 0 0 0 0 1 0 0 1 0
493 25 f 3 5 7
7 0 0 0 7 2 0 0 7 0 2 7 7 0
683 18 f .5 .5 2
1 0 0 0 0 0 5 0 0 1 0 0 0 1
382 21 f 3 1 8
0 8 0 0 5 8 8 0 0 8 8 0 0 0
683 18 f 4 6 2
2 0 0 0 2 2 2 0 2 0 2 2 2 0
684 19 m .5 2 1
0 0 0 0 1 1 0 0 0 1 1 1 1 5
684 19 m 1.5 3.5 2
2 0 0 0 2 0 0 0 0 0 2 5 0 0
221 23 f 1 5 1
7 5 1 5 1 3 1 7 5 1 5 1 3 1
684 18 f 2 3 1
2 0 0 1 1 1 1 7 2 0 1 1 1 1
683 19 f 3 5 2
2 0 0 2 0 6 1 0 1 1 2 2 6 1
683 19 f 3 5 1
2 0 0 2 0 6 1 0 1 1 2 0 2 1
221 35 m 3 5 5
7 5 0 1 7 0 0 5 5 5 0 0 0 0
221 43 f 1 4 5
```

1 0 0 0 5 0 0 5 5 0 0 0 0 0
493 32 f 2 1 6
0 0 0 6 0 0 0 0 0 0 0 0 4 0
221 24 f 4 5 2
2 0 5 0 0 2 4 4 4 5 0 0 2 2
684 19 f 2 3 2
0 5 5 2 5 0 1 0 5 5 2 2 2 2
221 19 f 3 3 8
0 1 1 8 8 8 4 0 5 4 1 8 8 4
221 29 m 1 1 5
5 5 5 5 5 5 5 5 5 5 5 5 5 5
221 21 m 1 1 1
1 0 0 0 0 0 5 1 0 0 0 0 0 5
683 20 f 1 2 2
0 0 0 0 2 0 0 0 2 0 0 0 0 0
493 54 f 1 1 5
7 0 0 5 0 0 0 0 0 0 5 0 0 0
493 45 m 4 6 5
7 0 0 0 7 5 0 0 5 5 5 5 5 5
850 44 m 2.5 1.5 7
7 0 7 0 4 7 5 0 5 4 3 0 0 4
220 33 m 5 3 5
1 5 0 5 1 0 0 0 0 0 0 0 5 5
684 20 f 1.5 3 1
1 0 0 0 1 0 1 0 1 0 0 1 1 0
966 63 m 3 5 3
5 4 7 5 4 5 0 5 0 0 5 5 4 0
683 21 f 4 6 1
0 1 0 1 1 1 1 0 1 1 1 1 1 1
493 23 f 5 2 5
7 5 0 4 0 0 0 0 1 1 1 1 1 0
493 32 f 8 8 5
7 5 0 0 7 0 5 5 5 0 0 7 5 5
942 33 f 7 2 5
0 5 5 4 7 0 0 0 0 0 0 7 8 0
493 34 f .5 1 5
5 0 0 0 5 0 0 0 0 0 6 0 0 0
382 40 f 2 2 5
5 0 0 0 5 0 0 5 0 0 5 0 0 0
362 27 f 0 3 8
0 0 0 0 0 0 0 0 0 0 0 0 8 0
542 36 f 3 3 7
7 0 0 0 7 1 0 0 0 7 1 1 0 0
966 39 f 3 6 5
7 0 0 0 7 5 0 0 7 0 5 0 5 0
849 32 m 1 .5 7
7 0 0 0 5 0 0 0 7 4 4 5 7 0
677 52 f 3 2 3
7 0 0 0 0 7 0 0 0 7 0 0 3 0
222 25 m 2 4 1
1 0 0 0 1 0 0 0 1 0 1 0 0 0
732 42 f 3 2 7
7 0 0 0 1 7 5 5 7 0 0 3 4 0
467 26 f 4 4 1
7 0 1 0 7 1 0 0 7 7 4 7 0 0
467 38 m 2.5 0 1

```
1 0 0 0 1 0 0 0 0 0 0 0 0 0
382 37 f 1.5 .5 7
7 0 0 0 7 0 0 0 3 0 0 0 3 0
856 45 f 3 3 7
7 0 0 0 7 5 0 0 7 7 4 0 0 0
677 33 m 3 2 7
7 0 0 4 7 0 0 0 7 0 0 0 0 0
490 27 f .5 1 2
2 0 0 0 2 0 0 0 2 0 2 0 0 0
362 27 f 1.5 2 2
2 0 0 0 1 0 4 0 1 0 0 0 4 4
783 25 f 2 1 1
1 0 0 0 1 7 0 0 0 0 1 1 1 0
546 30 f 8 3 1
1 1 1 1 1 0 0 1 0 5 5 0 0 0
677 30 f 2 0 1
1 0 0 0 0 1 0 0 0 0 0 0 0 1
221 35 f 2 2 1
1 0 0 0 1 0 1 0 1 1 1 0 0 0
966 32 f 6 1 7
7 1 1 1 7 4 0 1 7 1 8 8 4 0
222 28 f 1 5 4
7 0 0 0 4 0 0 4 4 4 4 0 0 0
467 29 f 5 3 4
4 5 5 5 1 4 4 5 1 1 1 1 4 4
467 32 m 3 4 1
1 0 1 0 4 0 0 0 4 0 0 0 1 0
966 30 m 1.5 1 7
7 0 0 0 7 5 0 7 0 0 0 0 5 0
967 38 m 14 4 7
7 7 7 7 7 0 4 8 0 0 0 0 4 0
490 28 m 8 1 1
7 1 1 1 1 0 0 7 0 0 8 0 0 0
833 30 f .5 1 6
6 0 0 0 6 0 0 0 0 0 6 0 0 6 0
851 40 m 1 0 7
7 5 5 5 7 0 0 0 0 0 0 0 0 0 0
859 27 f 2 5 2
6 0 0 0 2 0 0 0 0 0 0 0 2 2 2
851 22 f 3 5 2
7 0 2 0 2 2 0 0 2 0 8 0 2 0
967 38 f 1 1.5 7
7 0 0 0 7 5 0 7 4 0 0 7 5 0
856 34 f 1.5 1 1
0 1 0 0 0 1 0 0 4 0 0 0 0 0
222 33 m .1 .1 7
7 0 0 0 7 0 0 0 0 0 0 7 0 0 0
856 22 m .50 .25 1
0 1 0 0 1 0 0 0 0 0 0 0 0 0 0
677 30 f 2 2 4
1 0 4 0 4 0 0 0 4 0 0 0 0 0 0
859 25 m 2 3 7
0 0 0 0 0 0 7 0 0 7 0 2 0 0 1
833 35 m 2 6 7
7 0 0 0 7 1 1 0 4 7 4 7 1 1
677 35 m 10 4 1
```

```
1 1 1 1 1 8 6 8 1 0 0 8 8 8
848 29 f 5 3 8
8 0 0 0 8 8 0 0 0 8 8 8 0 0
688 26 m 3 1 1
1 1 7 1 1 7 0 0 0 8 8 0 0 0
490 41 m 2 2 5
5 0 0 0 0 0 5 5 0 0 0 0 0 5
493 35 m 4 4 7
7 5 0 5 7 0 0 7 7 7 7 0 0 0
677 27 m 15 11 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1
848 27 f 3 5 1
1 1 0 0 1 1 0 0 1 1 1 1 0 0
362 30 f 1 0 1
1 0 0 0 7 5 0 0 0 0 0 0 0 0
783 29 f 1 1 4
4 0 0 0 4 0 0 0 4 0 0 0 4 0
467 39 f .5 2 4
7 0 4 0 4 4 0 0 4 4 4 4 4 4
677 27 m 2 2 7
7 0 0 0 7 0 0 7 7 0 0 7 0 0
221 23 f 2.5 1 1
1 0 0 0 1 0 0 0 0 0 0 0 0 0
677 29 f 1 1 7
0 0 0 0 7 0 0 0 7 0 0 0 0 0
783 32 m 1 2 5
4 5 5 5 4 2 0 0 0 0 3 2 2 0
833 25 f 1 0 1
1 1 0 0 0 0 0 0 0 0 0 0 0 0
859 24 f 7 3 7
1 0 0 0 1 0 0 0 0 1 0 0 1 0
677 29 m 2 2 8
0 8 8 0 8 0 0 0 8 8 8 0 0 0
688 31 m 8 2 5
7 5 5 5 5 7 0 0 7 7 0 0 0 0
856 31 m 9 4 1
1 1 1 1 1 0 0 0 0 0 0 0 1 0
856 44 f 1 0 6
6 0 0 0 6 0 0 0 0 0 0 0 0 0
677 37 f 3 3 1
0 0 1 0 0 0 0 0 4 4 0 0 0 0
859 27 m 2 .5 2
2 2 2 2 2 2 2 2 0 0 0 0 0 2
781 30 f 10 4 2
2 0 0 0 2 0 2 0 0 0 0 0 0 2
362 27 m 12 4 3
3 1 1 1 1 3 3 3 0 0 0 0 3 0
362 33 f 2 4 1
1 0 0 0 7 0 0 7 1 1 1 1 1 0
222 26 f 8 1 1
1 1 1 1 0 0 0 1 0 0 0 0 0 0
779 37 f 6 3 1
1 1 1 1 1 0 0 1 1 0 0 0 1 0
467 32 f 1 1 2
2 0 0 0 0 0 0 0 2 0 0 2 0 0
859 23 m 1 1 1
```

```
1 0 0 0 1 1 0 1 0 0 0 0 1 1
781 33 f 1 .5 6
6 0 0 0 6 0 0 0 0 0 0 0 0 0
779 28 m 5 2 1
1 1 1 1 1 0 0 0 0 7 7 1 1 0
677 28 m 3 1 5
7 5 5 5 5 6 0 0 6 6 6 6 6 0
677 25 f 9 2 5
1 5 5 5 5 1 1 0 1 1 1 1 1 1
848 30 f 6 2 8
8 0 0 0 2 7 0 0 0 0 2 0 2 0
546 36 f 4 6 4
7 0 0 0 4 4 0 5 5 5 5 2 4 4
222 30 f 2 3 2
2 2 0 0 2 0 0 0 2 0 2 2 0 0
383 32 m 4 1 2
2 0 0 0 2 0 0 2 0 0 0 0 0 0
851 43 f 8 1 6
4 6 0 6 4 0 0 0 0 0 0 0 0 0
222 27 f 1 3 1
1 1 0 1 1 1 0 0 1 0 0 0 4 0
833 22 f 1.5 2 1
1 0 0 0 1 1 0 0 1 1 1 0 0 0
467 29 f 2 1 8
8 0 8 0 8 0 0 0 0 0 8 0 0 0
856 28 f 2 3 1
1 0 0 0 1 0 0 0 1 0 0 1 0 0
580 31 f 2.5 2.5 6
6 6 6 6 6 6 6 6 1 1 1 1 6 6
688 39 f 8 8 3
3 3 3 3 3 3 3 3 3 3 3 3 3 3
677 37 f 1.5 .5 1
6 1 1 1 6 6 0 0 1 1 6 6 6 0
859 38 m 3 6 3
7 0 0 0 7 3 0 0 3 0 3 0 0 0
677 25 f 7 1 1
0 1 1 1 2 0 0 0 1 2 1 1 1 0
848 36 f 7 1 1
0 1 0 1 1 0 0 0 0 0 0 1 1 0
781 31 f 2 4 1
1 0 0 0 1 1 0 1 1 1 1 1 0 0
781 40 f 2 2 8
8 0 0 8 8 0 0 0 0 0 8 8 0 0
677 25 f 3 5 1
1 6 1 6 6 3 0 0 2 2 1 1 1 1
779 33 f 3 2 1
1 0 1 0 0 0 1 0 1 0 0 0 1 0
677 25 m 7 1.5 1
1 1 0 1 1 0 0 0 0 0 1 0 0 0
362 35 f .5 0 1
1 0 0 0 1 0 0 0 0 0 0 0 0 0
677 41 f 6 2 7
7 7 0 7 7 0 0 0 0 0 8 0 0 0
677 24 m 5 1 5
1 5 0 5 0 0 0 0 1 0 0 0 0 0
833 29 f .5 0 6
```

6 0 0 0 6 0 0 0 0 0 0 0 0 0
362 30 f 1 1 1
1 0 0 0 1 0 0 0 1 0 0 0 0 0
850 26 f 6 12 6
6 0 0 0 2 2 2 6 6 6 0 0 6 6
467 25 f 2 3 1
1 0 0 6 1 1 0 0 0 0 1 1 1 1
967 29 f 1 2 7
7 0 0 0 7 0 0 7 7 0 0 0 0 0
833 31 f 1 1 7
7 0 7 0 7 3 0 0 3 3 0 0 0 0
859 40 f 7 1 5
1 5 0 5 5 1 0 0 1 0 0 0 0 0
848 31 m 1 2 1
1 0 0 0 1 1 0 0 4 4 1 4 0 0
222 32 f 2 3 3
3 0 0 0 0 7 0 0 3 0 8 0 0 0
783 33 f 2 0 4
7 0 0 0 7 0 0 0 4 0 4 0 0 0
856 28 f 8 4 2
0 2 0 2 2 0 0 0 2 0 2 0 4 0
781 30 f 3 5 1
1 1 1 1 1 1 0 0 1 1 1 1 1 0
850 25 f 6 3 1
7 5 0 5 7 1 0 0 7 0 1 0 1 0
580 33 f 2.5 4 2
2 0 0 0 2 0 0 0 0 0 8 8 0 0
677 38 f 3 3 1
1 0 0 0 1 0 1 1 1 0 1 0 0 4
677 26 f 2 2 1
1 0 1 0 1 0 0 0 1 1 1 0 0 0
467 52 f 3 2 2
2 6 6 6 6 2 0 0 2 2 2 2 0 0
542 31 f 1 3 1
1 0 1 0 1 0 0 0 1 1 1 1 1 0
859 50 f 9 3 6
6 6 6 6 6 6 6 6 6 3 3 3 6 6
779 26 f 1 2 1
7 0 1 0 1 1 4 1 4 1 1 1 4 4
779 36 m 1.5 2 4
1 4 0 4 4 0 0 4 4 4 4 0 0 0
222 31 f 0 3 7
1 0 0 0 7 0 0 0 0 0 0 0 0 0
362 27 f 1 1 1
1 0 1 0 1 4 0 4 4 1 0 4 4 0
967 32 f 3 2 7
7 0 0 0 7 0 0 0 1 0 0 1 0 0
362 29 f 10 2 2
2 2 2 2 2 2 2 2 2 2 2 7 0 0
677 27 f 3 4 1
0 5 1 1 0 5 0 0 0 1 1 1 0 0
546 32 m 5 .5 8
8 0 0 0 8 0 0 0 8 0 0 0 0 0
688 38 m 2 3 2
2 0 0 0 2 0 0 0 2 0 0 0 1 0
362 28 f 1 1 1

```
1 0 0 0 1 1 0 4 0 0 0 0 4 0
851 32 f .5 2 4
5 0 0 0 4 0 0 0 0 0 0 0 2 0
967 43 f 2 2 1
1 0 0 0 1 0 0 1 7 0 0 0 1 0
467 44 f 10 4 6
7 6 0 6 6 0 6 0 0 0 0 0 0 6
467 23 f 5 3 1
0 2 1 2 1 0 0 0 1 1 1 1 1 1
783 30 f 1 .5 1
1 0 0 0 1 0 0 0 0 0 0 7 0 0
677 29 f 3 1 2
2 2 2 2 2 0 0 0 0 0 0 0 0 0
859 26 f 9.5 1.5 2
2 2 2 2 2 0 0 2 2 0 0 0 0 0
222 28 f 3 0 2
2 0 0 0 2 0 0 0 0 0 2 0 0 0
966 37 m 2 1 1
7 1 1 1 7 0 0 0 7 0 0 0 0 0
859 31 f 10 10 1
0 1 1 1 1 0 0 0 1 1 0 0 1 0
781 27 f 2 1 2
2 0 0 0 1 0 0 0 4 0 0 0 0 0
677 31 f .5 .5 6
7 0 0 0 0 0 0 0 6 0 0 0 0 0
848 28 f 5 1 2
2 2 0 2 0 0 0 0 2 0 0 0 0 0
781 24 f 3 3 6
1 6 6 6 1 6 0 0 0 0 1 0 1 1
856 27 f 1.5 1 6
2 6 6 6 2 5 0 2 0 0 5 2 0 0
382 30 m 1 2 7
7 0 0 0 7 0 4 7 0 0 0 7 4 4
848 25 f 9 3 1
7 1 1 5 1 0 0 0 1 1 1 1 1 0
382 30 m 1 2 4
7 0 0 0 7 0 4 7 0 0 0 7 4 4
688 40 m 2 3 1
1 0 0 0 1 3 1 0 5 0 4 4 7 1
856 40 f .5 5 5
3 0 0 0 3 0 0 0 0 0 5 5 0 0
966 25 f 2 .5 2
1 0 0 0 2 6 0 0 4 0 0 0 0 0
859 30 f 2 4 2
2 0 0 0 0 2 0 0 0 0 2 0 0 0
849 29 m 10 1 5
7 5 5 5 7 5 5 0 0 0 0 0 7 0
781 28 m 1.5 3 4
1 0 0 0 1 4 4 0 4 4 1 1 4 0
467 35 f 4 2 6
7 6 7 6 6 7 6 7 7 7 7 7 7 6
222 32 f 10 5 1
1 1 0 1 1 0 0 1 1 1 0 0 1 0
677 32 f 1 0 1
1 0 1 0 0 0 0 0 0 0 0 0 0 0
222 54 f 21 4 3
```

```
5 0 0 0 7 0 0 7 0 0 0 0 0 0
677 30 m 4 6 1
7 0 0 0 0 1 1 1 7 1 1 0 8 1
683 29 f 1 2 8
8 0 0 0 8 0 0 0 0 8 8 0 0 0
467 38 m 3 5 1
1 0 0 0 1 0 0 1 1 0 0 0 0 0
781 29 f 2 3 8
8 0 0 0 8 8 0 0 8 8 0 8 8 0
781 30 f 1 0 5
5 0 0 0 0 5 0 0 0 0 0 0 0 0
783 40 f 1.5 3 1
1 0 0 0 1 4 0 0 1 1 1 0 0 0
851 30 f 1 1 6
6 0 0 0 6 0 0 0 6 0 0 6 0 0
851 40 f 1 1 5
5 0 0 0 5 0 0 0 0 1 0 0 0 0
779 40 f 1 0 2
2 0 0 0 2 0 0 0 0 0 0 0 0 0
467 37 f 4 8 1
1 0 0 0 1 0 3 0 3 1 1 1 0 0
859 37 f 4 3 3
0 3 7 0 0 7 0 0 0 7 8 3 7 0
781 26 f 4 1 2
2 2 0 2 1 0 0 0 2 0 0 0 0 0
859 23 f 8 3 3
3 2 0 2 3 0 0 0 1 0 0 3 0 0
967 31 f .5 0 1
1 0 0 0 0 0 0 0 0 0 0 0 0 0
851 38 m 4 2 5
7 5 0 5 4 0 4 7 7 0 4 0 8 0
467 30 m 2 1 2
2 2 0 2 0 0 0 0 2 0 2 0 0 0
848 33 f 2 2 7
7 0 0 0 0 7 0 7 7 0 0 0 7 0
688 35 f 5 8 3
2 2 2 2 2 0 0 3 3 3 3 3 0 0
467 27 f 2 3 1
1 0 1 0 0 1 0 0 1 1 1 0 0 0
783 42 f 3 1 1
1 0 0 0 1 0 0 0 1 0 1 1 0 0
687 40 m 1.5 2 1
7 0 0 0 1 1 0 0 1 0 7 0 1 0
779 30 f 4 8 7
7 0 0 0 7 0 6 7 4 2 2 0 0 6
222 34 f 9 0 8
8 2 0 2 8 0 0 0 0 0 0 0 0 0
467 28 m 3 1 2
2 0 0 0 2 2 0 0 0 2 2 0 0 0
222 28 f 8 4 2
1 2 1 2 2 0 0 1 2 2 0 0 2 0
542 35 m 2 3 2
6 0 7 0 7 0 7 0 0 0 2 2 0 0
677 31 m 12 4 3
7 3 0 3 3 4 0 0 4 4 4 0 0 0
783 45 f 1.5 2 6
```

```
6 0 0 0 6 0 0 6 6 0 0 0 0 0
942 34 f 1 .5 4
4 0 0 0 1 0 0 0 0 0 2 0 0 0
222 30 f 8 4 1
1 1 1 1 1 0 0 0 1 1 0 0 0 0
967 38 f 1.5 2 7
7 0 0 0 7 0 0 7 1 1 1 1 0 0
783 37 f 2 1 1
6 6 1 1 6 6 0 0 6 1 1 1 6 0
467 31 f 1.5 2 2
2 0 7 0 7 0 0 7 7 0 0 0 7 0
859 48 f 3 0 7
7 0 0 0 0 0 0 0 0 7 0 0 0 0
490 35 f 1 1 7
7 0 0 0 7 0 0 0 0 0 0 0 8 0
222 27 f 3 2 3
8 0 0 0 3 8 0 3 3 0 0 0 0 0
382 36 m 3 2 4
7 0 5 4 7 4 4 0 7 7 4 7 0 4
859 37 f 1 1 2
7 0 0 0 0 2 0 2 2 0 0 0 0 2
856 29 f 3 1 1
1 0 0 0 1 1 1 1 0 0 1 1 0 1
542 32 m 3 3 7
7 0 0 0 0 7 7 7 0 0 0 0 7 7
783 31 m 1 1 1
1 0 0 0 1 0 0 0 1 1 1 0 0 0
833 35 m 1 1 1
5 4 1 5 1 0 0 1 1 0 0 0 0 0
782 38 m 30 8 5
7 5 5 5 5 0 0 4 4 4 4 4 0 0
222 33 m 3 3 1
1 1 1 1 1 1 1 1 4 1 1 1 1 1
467 24 f 2 4 1
0 0 1 0 1 0 0 0 1 1 1 0 0 0
467 34 f 1 1 1
1 0 0 0 1 0 0 1 1 0 0 0 0 0
781 53 f 2 1 5
5 0 0 0 5 5 0 0 0 0 5 5 5 0
222 30 m 2 5 3
6 3 3 3 6 0 0 0 3 3 3 3 0 0
688 26 f 2 2 1
1 0 0 0 1 0 0 0 1 0 1 1 0 0
222 29 m 8 5 1
1 6 0 6 1 0 0 1 1 1 1 0 0 0
783 33 m 1 2 7
7 0 0 0 7 0 0 0 7 0 0 0 7 0
781 39 m 1.5 2.5 2
2 0 2 0 2 0 0 0 2 2 2 0 0 0
850 22 f 2 1 1
1 0 0 0 1 1 1 0 5 0 0 1 0 0
493 36 f 1 0 5
0 0 0 0 7 0 0 0 0 0 0 0 0 0
967 46 f 2 4 7
7 5 0 5 7 0 0 0 4 7 4 0 0 0
856 41 m 2 2 4
```

```
7 4 0 0 7 4 0 4 0 0 0 7 0 0
546 25 m 5 5 8
8 8 0 0 0 0 0 0 0 0 0 0 0 0
222 27 f 4 4 3
2 2 2 3 7 7 0 2 2 2 3 3 3 0
688 23 m 9 3 3
3 3 3 3 3 7 0 0 3 0 0 0 0 0
849 26 m .5 .5 8
8 0 0 0 8 0 0 0 0 8 0 0 0 0
783 29 f 3 3 1
1 0 0 0 4 0 0 4 1 0 1 0 0 0
856 34 f 1.5 2 1
7 0 0 0 7 0 0 7 4 0 0 7 0 0
966 33 m 3 5 4
7 0 0 0 7 4 5 0 7 0 0 7 4 4
493 34 f 2 5 1
1 0 0 0 1 0 0 0 7 0 1 1 8 0
467 29 m 2 4 2
2 0 0 0 2 0 0 2 2 2 2 2 2 2
677 28 f 1 4 1
1 1 1 1 1 0 0 0 1 0 1 0 0 0
781 27 m 2 2 1
1 0 1 0 4 2 4 0 2 2 1 0 1 4
467 24 m 4 4 1
7 1 0 1 1 1 0 7 1 0 0 0 0 0
859 26 m 5 5 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1
848 27 m 7 2 5
7 5 0 5 4 5 0 0 0 7 4 4 0 4
677 25 f 1 2 8
8 0 0 0 0 5 0 0 8 0 0 0 2 0
222 26 f 3.5 0 2
2 0 0 0 2 0 0 0 0 0 0 0 0 0
833 32 m 1 2 1
1 0 0 0 1 0 0 0 5 0 1 0 0 0
781 28 m 2 .5 7
7 0 0 0 7 0 0 0 4 0 0 0 0 0
783 28 f 1 1 1
1 0 0 0 1 0 0 0 0 0 1 1 0 0
222 28 f 5 5 2
2 6 6 2 2 0 0 0 2 2 0 0 2 2
851 33 m 4 5 3
1 0 0 0 7 3 0 3 3 3 3 3 7 5
859 39 m 2 1 1
1 0 0 0 1 0 0 0 0 0 0 1 0 0
848 45 m 2 2 7
7 0 0 0 7 0 0 0 7 0 0 0 0 0
467 37 m 2 2 7
7 0 0 0 0 7 0 0 0 7 0 0 7 0
859 32 m .25 .25 1
1 0 0 0 0 0 0 0 1 0 0 0 0 0
```

SALES

```
data sales;
   input Region $ CitySize $ Population Product $ SaleType $ Units NetSales;
   cards;
NC S 25000 A100 R 150 3750.00
NC M  125000 A100 R 350 8650.00
NC L 837000 A100 R 800 20000.00
NC S 25000 A100 W 150 3000.00
NC M 125000 A100 W 350 7000.00
NC M 625000 A100 W 750 15000.00
TX M 227000 A100 W 350 7250.00
TX L 5000 A100 W 750 5000.00
;
```

Appendix 4

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2. Chinese/Japanese Word Break Dictionary Data (cjdict.txt)

```
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