A GENERAL-PURPOSE TSO INTERFACE TO SAS USING SPF

John L. Dickinson, IBM Corporation

ABSTRACT
A TSO interface to SAS has been developed to take advantage of the full screen support provided by IBM's SPF (Structured Programming Facility or the newer System Productivity Facility). The interface provides access to SAS under TSO with a minimum of effort and TSO knowledge allowing a significant increase in SAS user productivity.

BACKGROUND
Improved TSO support for SAS has been a frequent topic of past SASware ballots and SUGI papers. The SASware ballot has indicated a need for a "TSO Guide," the need is possibly now so much for a guide as for additional TSO capability and simplicity. For instance, the casual SAS user can't be expected to read about or understand the TSO ALLOCATE statement. It is also unreasonable to require the SAS user to guess what portions of TSO knowledge are necessary for running SAS.

Last year, at SUGI '81, nearly everyone attending an Interactive Techniques session raised their hands when asked if they had written CLISTs to use SAS. SAS was largely developed remotely without full screen support. This may be the reason SAS T50 tools have not taken advantage of the full screen support. Improved TSO support for SAS has been a frequent topic of past SASware ballots and SUGI papers. The need is probably not so much for a guide as for additional TSO capability and simplicity. For instance, the casual SAS user can't be expected to read about or understand the TSO ALLOCATE statement. It is also unreasonable to require the SAS user to guess what portions of TSO knowledge are necessary for running SAS.

During my first exposure to SAS early in 1980, I also felt the need for an easier and better way to access and use SAS interactively under TSO on a display terminal. My initial task was to learn SAS. I wanted to try many things and see the results quickly, precluding the use of batch processing. Since I was just learning, I was making many mistakes and I had to rewrite CLISTs to use SAS. SAS was largely developed remotely without full screen support. This may be the reason SAS T50 tools have not taken advantage of the full screen support.

The interface has been in use for over a year at several IBM sites by more than 100 SAS users. It has been expanded and refined to meet nearly all user needs and problems as well as handling various idiosyncrasies in SAS and TSO.

OBJECTIVES
• General-purpose
• Simple to use
• Designed around SAS program development
• Easy to run with limited observations
• Minimum user typing
• No JCL
• Easy access to SAS, OS data sets and SAS data bases
• Fast response during SAS program development - programs and listings
• Browse, print and save SAS listing output
• Ability to recreate results
• Ability to fix and rerun a saved program
• Fully documented in one place

The Interface has options or commands for two modes of operation under TSO:

• Usually, the most useful mode of operation is "semi-interactive." In this mode the SAS program is written or changed, run directly under TSO, and the results browsed under TSO. Changes and corrections are made and the SAS program can be run again on the spot. While the session is interactive, it is not conversational.

• The other mode, interactive, is essentially the same as that normally available with the SAS and SASGO commands released by the SAS Institute. In interactive mode, the user enters SAS program statements and sees the results directly on the terminal.

The "semi-interactive" mode is used the most. The interactive mode is used only for very small, throwaway or truly interactive SAS operations. The two modes are completely compatible and both can be intermixed during the same session and use the same data.

Programs developed and tested under TSO can be run in batch mode. Batch is usually used only for debugged production work or very large runs. TSO foreground development and execution is used in all other cases. The TSO versus batch mode decision is based on appropriateness for the given task, not the facilities available in each environment.

SPF
SPF is an IBM program development tool designed to take advantage of IBM 3270 display terminals. SPF is an integral part of the SAS-TSO interface and is used for editing SAS programs and reviewing the results.

There are two versions of SPF:
• The "Structured Programming Facility, Version 2.2," which is an older version of SPF.
• The "System Productivity Facility," a newer version of SPF. It supports an expanded technique for user-written panels (or screens).
TWO SAS INTERFACES: COMMANDS AND PANELS

• The command interface is for users of the "old" SPF, Structured Programming Facility, and is implemented entirely as TSO CLIST commands. SPF is used to edit SAS programs and to browse the results. In special cases, the commands can also be incorporated into other user CLISTS.

• The SPF panel interface is the preferred choice for users of the new SPF, System Productivity Facility. The SAS-TSO interface uses new SPF facilities for special panels supporting SAS. Options are provided for all the SAS functions that are done with TSO SAS commands under the older version of SPF.

The SPF panel interface is much easier to use and requires very few keystrokes. It also tends to guide the user and reduces the number of user errors. Little TSO or SPF knowledge is required. The SPF panel interface allows most SAS development to be done using a single SPF panel. However, existing SPF facilities are used for such things as creating and deleting any OS data sets used with SAS runs.

The SAS-TSO interface commands and panels are compatible and co-exist. The "old SPF, System Productivity Facility" user can use either the panels or the commands to interface to SAS. However, once users use the panels, they have no need for or interest in the commands. (The commands are still useful if it is ever desired to use the SAS-TSO interface functions from within a user-written CLIST.)

Except for the SAS panels, the two versions of SPF have the same external appearance to the user. The SAS panels cannot be used with the older version of SPF since the SPF internals differ considerably.

SAS-TSO INTERFACE FUNCTIONS

The SAS-TSO interface handles most of the operations needed by the SAS user:

• Creating and changing SAS programs
• Accessing OS data sets
• Invoking and running SAS in "semi-interactive" mode
• Browsing SAS results
• Printing SAS results
• Invoking and using SAS interactively; interfacing with the IBM TSO Session Manager, if installed
• Allocating a new SAS data base (temporary or permanent)

When the "semi-interactive" mode is used, both the panel and command interface implementations use simple OS data set conventions for SAS programs and SAS listing output. The interface creates these data sets and the temporary "work" SAS data base automatically, as required. These OS data sets are created for each TSO sign-on and the data set names start with the user's high-level qualifier.

• SAS.CARDS is a partitioned OS data set that contains SAS user programs.
• SAS.LOG receives the log result of a TSO SAS run.
• SAS.LIST receives the "printed" output of SAS procedures.

The SAS.LOG and SAS.LIST data sets are images of what the user would get on paper had the SAS job been run in batch mode. They are overwritten with each SAS run, but are browsed interactively and printed if desired.

THE SPF PANEL INTERFACE

There are three panels for running SAS under TSO with the System Productivity Facility version of SPF.

The three SPF SAS panels are:

- SAS: STATISTICAL ANALYSIS SYSTEM
- OS DATA SET ACCESS
- ALLOCATE A NEW SAS DATA BASE

The first panel, "SAS: STATISTICAL ANALYSIS SYSTEM," is the primary SAS panel. The other two SAS panels are used much less frequently.

Standard SPF panels are also used occasionally to allocate and delete OS data sets, review the results of batch jobs, and to do other activities that might not be directly related to SAS.

Nearly all the SAS panel field contents are "remembered" by SPF to save typing.

SAS: STATISTICAL ANALYSIS SYSTEM PANEL

The "SAS: STATISTICAL ANALYSIS SYSTEM" panel, shown in Figure 1, is the primary panel for using SAS under TSO. It is reached by entering option "S" on the SPF primary option menu.

It is possible to use SAS with just two options from this panel. They are option "C," CREATE OR CHANGE A SAS PROGRAM, and option "R," RUN A SAS PROGRAM AND BROWSE THE RESULTS.

The panel has many options and may be a little confusing at first. They permit almost all SAS activities to be done from this one panel, eliminating most of the need to switch back and forth to other panels. Besides SAS options, the primary SAS panel provides, for convenience, SPF options of BROWSE, EDIT, and TSO COMMAND on the same screen.

Option C: Change Program—Create or Change a SAS Program

Option "C" invokes the SPF editor and is used to edit SAS programs. Once entered, the environment is just as if SPF edit, SPF primary option "2." had been used. If the "PROGRAM MEMBER OR DSN" field is specified without quotes, the member is assumed to be in the user's OS data set SAS.CARDS.

Option O: OS Data Set Access—Display Panel to Access OS Data Sets

Option "O" causes the "OS DATA SET ACCESS" panel to be displayed. It allows entry of OS data set names and corresponding DD names to be used by SAS.

Option R: Run—Run a SAS Program and Browse Results

Option "R" runs SAS in "semi-interactive" mode after SAS program statements have been prepared and input data, if any, is ready. After requesting the option, SAS is executed directly in the TSO foreground using the SAS program specified in the "PROGRAM MEMBER OR DSN" field.
### SAS: Statistical Analysis System

**Options:**
- **C**: Change Program
  - Create or change a SAS program in SAS.CARDS
- **O**: OS Data Set Access
  - Display panel to access OS data sets
- **R**: Run
  - Run a SAS program and browse SAS.LOG and SAS.LIST
- **I**: Interactive
  - Invoke SAS in Interactive mode (enter X to exit)
- **P**: Print
  - Print SAS.LOG and SAS.LIST on hard copy
- **D**: SAS Data Base
  - Display panel to allocate a new SAS data base
- **B,E**: Browse or Edit
  - Browse or edit an OS data set
- **T**: TSO
  - Enter TSO command or CLIST

**Select Option ==>** Press End key to terminate

<table>
<thead>
<tr>
<th>Options</th>
<th>(Optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C,R</td>
<td>PROGRAM MEMBER OR DSN ==&gt;</td>
</tr>
<tr>
<td>R</td>
<td>(OPTIONAL) MASTER DSN ==&gt;</td>
</tr>
<tr>
<td>R,I</td>
<td>(OPTIONAL) OBS COUNT ==&gt;</td>
</tr>
<tr>
<td>R,I</td>
<td>(OPTIONAL) SAS SYSPARM ==&gt;</td>
</tr>
<tr>
<td>B,E</td>
<td>(OPTIONAL) SAS OPTIONS ==&gt;</td>
</tr>
<tr>
<td>P</td>
<td>(OPTIONAL) PRINT CLASS ==&gt;</td>
</tr>
<tr>
<td>T</td>
<td>TSO COMMAND ==&gt;</td>
</tr>
</tbody>
</table>

**OS Data Set Access**

**Options:**
- **R**: Read
  - Prepare to read an existing OS data set
- **W**: Write
  - Prepare to write and/or read an existing OS data set
- **F**: Free
  - Free a reference to an OS data set
- **L**: List
  - List all OS data set references for this TSO session

**Select Option ==>** Press End key to terminate

<table>
<thead>
<tr>
<th>Options</th>
<th>(Optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R,W</td>
<td>DD NAME ==&gt;</td>
</tr>
<tr>
<td>R,W,F</td>
<td>OS DATA SET NAME ==&gt;</td>
</tr>
<tr>
<td>R,W</td>
<td>(OPTIONAL) CONCATENATE ==&gt; (YES OR NO)</td>
</tr>
</tbody>
</table>

To Concatenate OS data sets:
1. Understand that the Concatenate feature is not supported.
2. Do not concatenate SAS data bases.
3. Leave Concatenate blank or NO for first data set.
4. Specify Concatenate 'YES' for each following data set.

Concatenated data sets must have identical record format (RECFM), logical record length (LRECL), and blocksize (BLKSIZE) DCB DATA.

**Allocate a New SAS Data Base**

**Options:**
- **T**: Temporary
  - Allocate or reallocate the temporary SAS data base
- **P**: Permanent
  - Allocate a new permanent SAS data base

**Select Option ==>** Press End key to terminate

**Temporary Data Base (Option T):**
- Primary Cylinder Allocation

**Permanent Data Base (Option P):**
- OS Data Set Name
- Volume Serial
- Primary Cylinder Allocation
- Secondary Cylinder Allocation
- Unit Type

(Such as 3330-1, 3350, or 3330v)

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Figure 1. Primary SAS Panel: Some of the options have required and/or optional fields. The table in the lower left of the panel indicates options that use the corresponding fields to the right. Other options do not have any fields associated with them.

Figure 2. OS Data Set Access Panel

Figure 3. Allocate a New SAS Data Base Panel
The user is notified that SAS is finished by a display of the SAS.LOG OS data set in SPF browse mode. Using the PF (program function) keys, the user can scan the log, checking to see that the statements were executed as expected.

After checking SAS.LOG, the user presses "END," PF key 3. The SAS.LIST OS data set is then displayed in SPF browse mode. Any "printed" output from the SAS procedures that were executed is displayed.

The user presses the "END" key once more to return to the primary SAS panel.

The "MASTER DSN" field is an optional field that specifies the name of an OS data set that contains the data to be analyzed. The specified OS data set name is associated with the DD name of MASTER.

Optionally, a number can be specified in the "OBS COUNT" field to set the initial SAS OBS option value. Limiting the number of observations processed is important during debugging to get quick results when there is a large amount of data. Use SYSPARM or any other OPTIONS can also be entered. SYSPARM data is entered without any extra quotes.

Options 1 and 2: Review Run Listing
Listing-1=SAS.LOG, 2=SAS.LIST
Options "1" and "2" are simply an easy way to browse the SAS.LOG and SAS.LIST OS data sets, respectively.

Option "R," RUN on the primary SAS panel, forces an SPF browse of these two data sets, in order, after each SAS execution. However, the user may want to go back to look at them later.

Option I: Interactive—Invoke SAS in Interactive Mode
Option "I" invokes SAS in an interactive mode very similar to the SAS and SAS/DSI command CLISTS released by the SAS Institute and documented in Appendix 3 of the SAS User’s Guide. After entering option "I," the user "converses" directly with SAS, entering SAS program statements and seeing the results directly on the terminal. However, the program statements entered, the SAS log, and the listing outputs from SAS procedures are not saved.

Option D: SAS Data Base—Display Data Base Panel
Option "D" causes the "ALLOCATE A NEW SAS DATA BASE" panel to be displayed. It allows either a new temporary or a new permanent SAS data base to be created.

Options B and E: Browse or Edit—Browse or Edit an OS Data Set
Options "B" and "E" simply provide an easy way to access SPF browse or edit respectively. This can eliminate the need to go to another SPF panel to work with OS data sets that are used as input or output with SAS.

Option T: TSO—Enter TSO Command or CLIST
Option "T" is an easy way to directly enter a TSO command, avoiding the need to go to SPF primary option "6."

OS DATA SET ACCESS PANEL
The "OS DATA SET ACCESS" panel, shown in Figure 2, provides access to OS data sets to be used with SAS. It is reached by entering option "O" on the primary SAS panel.

The options on this panel provide an interface to the TSO commands ALLOCATE, FREE, and LISTALC. The panel is easier to use than the corresponding TSO commands because there is no extra typing and filling in the blanks is easier than remembering what to type.

Options R and W: Prepare to Read or Read/Write an Existing Data Set
Options "R" and "W" make the association between a DD name specified in a SAS program and the name of an OS data set. If needed, options "R" and/or "W" are entered before running SAS. The associations remain for the duration of the TSO session.

The options have the same effect under TSO that DD cards have when running batch with JCL. (Option "R" is like specifying DISP=SHR and option "W" is like specifying DISP=OLD in JCL.)

Option F: Free—Free a Reference to an OS Data Set
This option frees a TSO reference to an OS data set, removing the DD name and OS data set name association made by options "R" and "W," or the "MASTER DSN" field on the primary SAS panel. Option "F" is rarely used unless the user is sharing one or more OS data sets with other TSO or batch users.

Option L: List—List All OS Data Set References
Option "L" lists all the DD names and associated OS data set names for the current TSO session. DD name and OS data set name associations from entering options "R" and "W" on the "OS DATA SET ACCESS" panel are displayed.

ALLOCATE A NEW SAS DATA BASE PANEL
The "ALLOCATE A NEW SAS DATA BASE" Panel, shown in Figure 3, allows allocating a new SAS data base, either the temporary work data base or a permanent data base. It is reached by entering option "O" on the primary SAS panel.

Option T: Temporary—Allocate the Temporary SAS Data Base
Option "T" creates or replaces the temporary SAS data base. It is implicitly executed at the start of the first SAS run in the TSO session. The temporary SAS data base is built and remains until the user logs off or replaces it. By default, this gives the SAS user access to all temporary SAS data sets created during the session.

Option P: Permanent—Allocate a New Permanent SAS Data Base
Option "P" reserves and names space for a new, permanent SAS data base. It is not used again after the data base is allocated (unless the user wants to make another permanent SAS data base).
LOGON
enter SPF
via "ISPF" command

Write initial SAS program
using SPF editor, option C
on the main SAS panel.

Options R or W on the
OS DATA SET ACCESS panel
if needed.

Figure 4. Typical SPF SAS Panel Interface TSO

THE TSO COMMAND INTERFACE

If the newer "System Productivity Facility"
version of SPF is not installed, the user can
use nine TSO commands (implemented as CLISTs)
for running SAS under TSO. The commands are
usually used under SPF primary option 6: Enter
TSO Command. In addition to using the commands,
SPF is used to edit SAS programs and data, to
browse SAS results, and to maintain any OS data
sets that may be used for input and output data.

The nine SAS TSO commands are:

- **SASRUN** - The basic command to invoke SAS in "semi-interactive" mode.
- **SA** (for SAS Again) - Rerun a SAS program after corrections.
- **SASPRINT** - Print SAS results.
- **SASDB** - Allocate a new, permanent SAS data base.
- **SASWRITE** - Prepare for write access to an OS data set.
- **SASREAD** - Prepare for read access to an OS data set.
- **SASWORK** - Allocate a temporary SAS data base.
- **SASFREE** - Free a reference to an OS data set.
- **SASI** (for SAS Interactive) - Invoke SAS in interactive mode.

It is possible to use SAS with nothing more than
the SASRUN command. Once the user gets a good
run, the SASPRINT command can be used to get
hard copy output.

**COMMANDS**

SASRUN programname mastername
  'datastname' *
  'datasetname(programname)' *

[OBS(n)]

The SASRUN command is used to run SAS in
"semi-interactive" mode after the SAS program
statements and input data, if any, are ready.

Two operands are always required. They are: the
name of the OS data set containing the SAS
program statements; and the name of an OS data
set containing the user's input data, or an * if
none.

After the SASRUN command is completed, SPF
browse, option "I", is used to see the results
in SAS.LOG and SAS.LIST.

SA [OBS(n)]

The SA command (for SAS Again) is for rerunning
a SAS program after corrections. In the process
of developing a SAS program, it would usually be
necessary to use the SASRUN command with the
same operands over and over as the program is
developed. The SA command enables the user to
avoid retyping the complete SASRUN command and
its operands.

SASPRINT [CLASS(class)]

The commands SASRUN and SA leave the listing
results in the OS data sets SAS.LOG and
SAS.LIST. The SASPRINT command prints the
current contents of SAS.LOG and SAS.LIST on hard

SASDB ddname volser pricyls
  secyls unittype

The SASDB command reserves and names space for a
new, permanent SAS data base. SASDB is not used
again once the data base is allocated (unless
another permanent SAS data base is needed.)

SASWRITE ddname dsname
SASREAD ddname dsname

The SASWRITE and SASREAD commands make the
association between a DD name specified in a SAS
program and the name of an OS data set. If
needed, SASWRITE and/or SASREAD are entered
before running SAS. One SASWRITE or SASREAD
command is used for each OS data set that the
SAS program will access. The commands have the
same effect under TSO that DD cards have when
running batch with JCL. The association made by
entering SASWRITE or SASREAD remains for the
duration of the TSO session.

SASFREE dsname

The SASFREE command frees a TSO reference to an
OS data set, removing the DD name and OS data
set name association made by the SASREAD
command, SASWRITE command, or the master operand
of the SASRUN command.
SASWORK [SPACE(cyls)]

The SASWORK command creates or replaces the user's temporary SAS data base. The SASWORK command is implicitly executed at the start of the first SAS run in the TSO session. The temporary SAS data base SASWORK builds remains until the user logs off or replaces it.

SASI [OBS(n)]

The SASI command invokes SAS in an interactive mode very nearly like the SAS and SASGO command CLISTs released by the SAS Institute. After entering the SASI command the user "converses" directly with SAS, entering SAS program statements and seeing the results directly on the terminal. The program statements the user enters, the SAS log, and listing outputs from SAS procedures are not saved.

PERFORMANCE

The interface itself does not introduce significant overhead. Therefore, performance is mostly determined by SAS itself under TSO. If normal TSO-SPF functions and operations are satisfactory, then SAS performance will probably be acceptable.

User perceptions of what constitutes a "large" job vary widely. Many thousands of observations are routinely processed, using the interface under TSO, without significant impact. Of course, SAS program development should be done with the minimum number of observations necessary to test the program. As always, SAS users should be educated in the proper and efficient use of system resources.

INSTALLATION

This interface does not require any changes to SAS and can be installed alongside existing SAS CLISTs. The interface is implemented as two OS data sets, one for CLISTs and one for the SPF panels. Installation takes about an hour and consists of putting the data sets on the system, local tuning if required, and providing user access to the CLISTs and panels.

There are a few dependencies which are more fully documented in the interface user's guide:

- TSO SPF and a display terminal such as an IBM 3270 series device.
- PRINTOFF command to support hard copy.
- CONCAT command to support OS data set concatenation (if desired).
- Operating systems other than MVS(VS2) require changes to SAS data base allocate functions in the interface.

The interface should be installed by the SAS coordinator for the use of the installation's entire user community. This reduces the number of copies and aids in maintenance.

FUTURE POSSIBILITIES

While the interface performance is adequate, it would be faster if the panel support was in PL/I rather than CLISTs.

The interface could be implemented on VM/CMS providing a nearly identical interface by using the "System Productivity Facility" version of SPF under CMS. The SPF panel portion would no doubt be the same and the CLIST portion would have to be recoded in EXEC2 language.

The interface functions are implemented entirely outside of SAS. The SAS Institute could provide the functions as an integral part of SAS itself.

USER IMPRESSIONS

New SAS users accept the interface as if it is a part of SAS. Experienced SAS users get enthused and report significant productivity improvements. Users become accustomed to the interface and dependent on it. They would consider SAS unavailable without it.

Interface operation can be learned in a few hours or less. The basics can be understood and picked up in as little as five minutes with an on-line demonstration.

AVAILABILITY

Since the interface is general-purpose, it could be useful to many SAS users outside IBM. IBM has made the code and documentation for this interface available to the SAS Institute on an as-is basis. There is no warranty either express or implied and the code has not been submitted to any formal IBM test. SAS has agreed to distribute it on request for the cost of distribution. Evaluation, implementation and use of the interface is solely a user responsibility. Contact the SAS Marketing Division for the code and documentation.