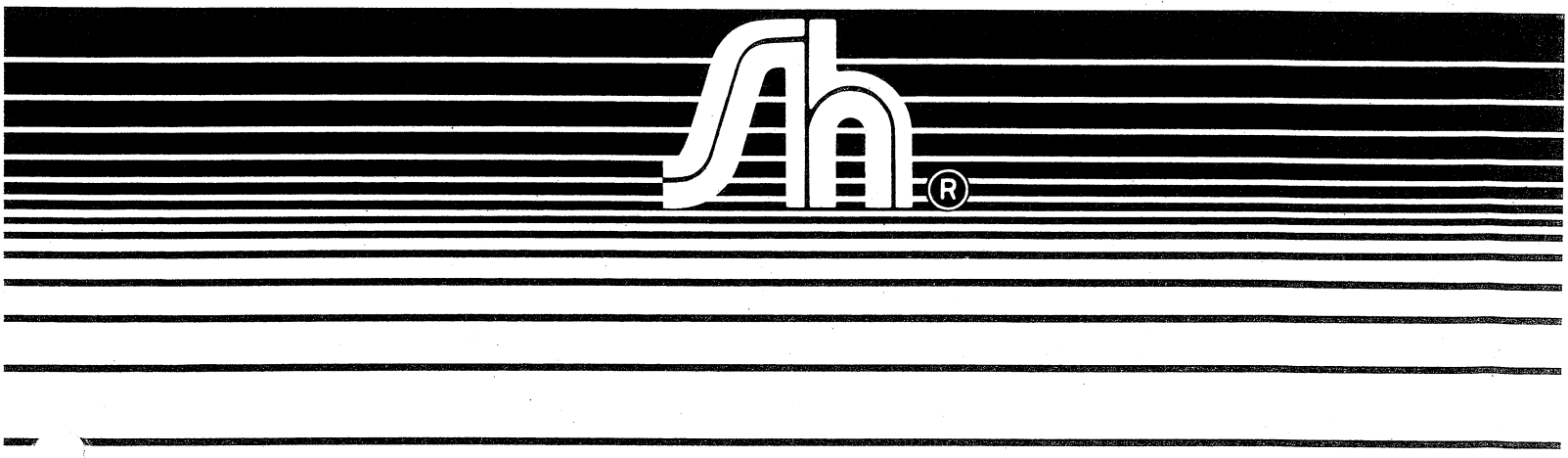
TSX-Plus
Reference Manual



s&h computer systems, inc.

TSX-Plus
Reference Manual

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INTRODUCTION

TSX-Plus is a high-performance operating system for Digital Equipment Corporation PDP-11 and LSI-11 computers supporting as many as forty concurrent time-sharing users. TSX-Plus provides a multi-user programming environment that is similar to extended-memory (XM) RT-11.

1. TSX-Plus keyboard commands are compatible with those of RT-11.

2. TSX-Plus supports most RT-11 system service calls (EMTs).

3. Most programs that run under RT-11 will run without modification under TSX-Plus. This includes RT-11 utility programs such as PIP, DUP, DIR, LINK, and MACRO.

4. TSX-Plus uses RT-11 XM version device handlers.

5. TSX-Plus provides PLAS extended memory services such as virtual overlays and virtual arrays, as well as support for extended memory regions.

TSX-Plus can simultaneously support a wide variety of jobs and programming languages including COBOL-Plus, FORTRAN, BASIC, DIBOL, DBL, Pascal, C, MACRO, IND, TECO and KED. TSX-Plus is used in educational, business, scientific and industrial environments. It can concurrently support commercial users doing transaction processing, engineering users performing scientific processing, system programmers doing program development, and real-time process control. Numerous application software packages compatible with TSX-Plus are available from other vendors.

TSX-Plus supports RT-11 system service calls (EMTs) as its basic mode of operation. The result is low system overhead and substantially improved performance over systems that emulate RT-11 services. TSX-Plus overlaps terminal interaction time, I/O wait time, and CPU execution time for all jobs on the system. The result is a tremendous increase in the productivity of the computer system.

In addition to the basic RT-11 functionality, TSX-Plus provides extended features such as: process windows; shared file record locking; inter-job message communication; program performance monitoring; command file parameters; logon and usage accounting; directory and data caching; multitasking; and system I/O buffering.

This manual describes all the features unique to TSX-Plus as well as any differences from RT-11. Many of the special features of TSX-Plus are available as EMTs available to the MACRO programmer. Access to these features from other languages requires the appropriate subroutine interface.

TSX-Plus will run on any PDP-11 or LSI-11 computer with memory management hardware and at least 128Kb of memory. The system must also have a disk suitable for program swapping (the swapping disk can be used for regular file storage as well). Time-sharing lines and serial printers may be connected to the system through DH(V)-11, DL(V)-11 or DZ(V)-11 communication devices. Both hard-wired and dial-up time-sharing lines are supported by TSX-Plus.

MANAGEMENT OF SYSTEM RESOURCES

Memory Management

TSX-Plus uses the memory management facilities of PDP-11 computers to keep several user jobs in memory simultaneously and switch rapidly among them. TSX-Plus protects the system by preventing user jobs from halting the machine or storing outside their program regions. TSX-Plus provides several ways to control the amount of memory used by individual jobs. Programs may be allowed to use up to 64Kb of memory and, if additional space is needed, may also use extended memory regions, virtual overlays and virtual arrays. The system manager may enable job-swapping to accommodate more user jobs than can fit in existing memory.

Execution Scheduling

TSX-Plus provides fast response to interactive jobs but minimizes job-swapping by use of the unique Adaptive Scheduling Algorithm (tm) (patent pending). TSX-Plus permits job scheduling on both an absolute priority basis and by a method based on job states. For most applications, the method based on job states is preferred. The state-driven method provides the most transparent time-sharing scheduling, suitable for interactive environments. The absolute priority method always runs the highest priority executable job, when not servicing interrupts, regardless of that job's state. This state-free method is most suitable for an environment in which several real-time jobs must be assigned absolute priorities. TSX-Plus permits both kinds of jobs to co-exist in the same system, with interactive jobs being scheduled whenever higher priority state-free jobs are not executing.

Job priorities may be assigned over a range of 0 to 127. The lowest priority jobs, typically 0 to 19, are reserved for fixed priority jobs which can soak up system idle time without disturbing interactive or real-time jobs. The medium priority range, typically 20 to 79, is assigned to interactive jobs which are scheduled according to a unique and efficient algorithm which makes time-sharing nearly transparent to several users. The highest priority range, typically 80 to 127, is reserved for jobs which must execute according to a rigid priority scheme such as might be found in a real-time environment. In addition, real-time jobs may execute interrupt service routines at fork level processing or schedule interrupt completion routines to run as fixed-high-priority jobs.

Job scheduling is controlled by several system parameters relating job priorities, system timing and other events. The TSX-Plus System Manager's Guide includes a more complete description of job priority and scheduling.

Subprocesses and Process Windowing

TSX-Plus allows the time-sharing user to interact with and control multiple executing processes. The primary process for a user is invoked when the user logs on; subprocesses can easily be initiated by typing a control-character-digit sequence. The Process Windowing (tm) facility causes the system to monitor all characters sent to the terminal and maintain an in-memory image of what is currently presented on the terminal screen. This allows the system to

restore the terminal display when switching between processes. Process windowing also provides a "print window" function which, when invoked by typing a control character, causes the current window contents to be printed on a specified hard-copy printer.

Directory and Data Caching

TSX-Plus provides a mechanism to speed up directory operations by caching device directories. This reduces disk I/O necessary to open existing files. Caching of file data is also possible to further improve system throughput. The information kept in the cache buffers is managed according to a least-recently-used algorithm. Directory and data caching are discussed in the System Manager's Guide.

System Administrative Control

TSX-Plus allows the system manager to limit access to the system through a logon facility and to restrict user access to peripheral devices. These features are described in the TSX-Plus System Manager's Guide.

Time-sharing lines and CL units

TSX-Plus supports time-sharing terminal lines interfaced through several types of interface cards: DH(V)11, DL(V)11 and DZ(V)11. Using the CL feature provided with TSX-Plus, other serial devices such as printers, plotters and communications devices can also be attached using the same types of interfaces. Up to 16 CL units may be attached to TSX-Plus. (Units 0 through 7 are referenced as CL0 through CL7 respectively; units 8 through 15 are referenced as C10 through C17 respectively.) These devices may either be permanently assigned as CL units or may be used at some times as time-sharing lines and other times as I/O devices by having a CL unit "take over" an inactive time-sharing line. See the SET CL and SHOW CL commands for more information on using CL units. See the TSX-Plus Installation Guide for more information on including dedicated and extra CL units during system generation.

SUMMARY OF CHAPTER CONTENTS

CHAPTER 1. Basic Operations and Starting Time-sharing Sessions
Chapter 1 of this manual describes the procedure for starting and stopping a time-sharing session with TSX-Plus; process windows and subprocesses; the special functions of some control-characters; use of the single line editor for correction of typing errors in command lines or data entry fields; and user-defined keys.

CHAPTER 2. Keyboard Commands
TSX-Plus responds to keyboard commands that are simple and natural (PRINT, RUN, COMPILE, TYPE, etc.). TSX-Plus also provides user-definable commands, and includes support for a menu driven command interface. Chapter 2 discusses command interpretation sequence, user-defined commands, the menu interface and lists all TSX-Plus keyboard commands. It provides full descriptions of commands unique to TSX-Plus, describes differences between TSX-Plus and RT-11 commands, and lists the RT-11 commands which are not supported by TSX-Plus. Many of the commands are identical to their RT-11 counterparts; the RT-11 System User's Guide should be consulted for detailed descriptions.

CHAPTER 3. Command Files
Frequently used sets of commands may be stored in a disk file and executed by invoking the command file. Parameters may be passed to the command file and interpreted as though they were included at designated places in the file. This provides an alternative way for users to create their own commands.

CHAPTER 4. Detached Jobs
Detached jobs provide a batch-like environment in which jobs may be started that run independently of a terminal. They may be started when TSX-Plus is started, with a keyboard command, or from within a program. Detached jobs inherit the environment characteristics (e.g., process name, logical assignments, logical subset disk mounts, privilege, etc.) of the job which starts them. Detached jobs are command files which may issue most keyboard commands and run programs. All terminal input to detached jobs must come from the command file; all terminal output from detached jobs is discarded unless sent to a log file. Programs run from detached jobs may accept and send messages to other processes via named message channels and may even acquire the file context of other processes.

CHAPTER 5. Printer Spooling System
TSX-Plus provides a convenient and powerful facility for automatic spooling of output to line printers and other devices. The spooler may simultaneously drive several devices. If the line printer is spooled, then simply directing output to device "LP" from a program causes the output to be spooled. A spooled file may designate the name of a form on which it is to be printed. When a form change is required, the spooled device is suspended and a message is sent to the operator requesting the form. After mounting the new form, the operator may print a form alignment file. Once a form is mounted, all files requiring the form are printed without further operator intervention. The operator may also lock a particular form on the printer, preventing automatic

form change requests. Keyboard commands are provided to check the status of spooled devices, delete current or pending files from the output queue, and reprint the most recent portion of the current file. Files sent to a spooled device may be released to the printer as data becomes available or held until the output file is closed.

CHAPTER 6. Program Controlled Terminal Options

TSX-Plus allows the programmer to modify terminal handling characteristics during program execution. For example, a program may disable character echoing, use single character activation, use high efficiency output mode, enable lower case input, activate on field width, or disable automatic echoing of line-feed after carriage-return. These terminal options may be selected either by issuing the appropriate EMT request or by writing a special sequence of two or three characters to the terminal.

CHAPTER 7. TSX-Plus EMTs

TSX-Plus supports most of the system service calls (EMTs) provided by RT-11 and, in addition, provides many more to utilize the special features of TSX-Plus. For example, EMTs are provided to determine the TSX-Plus line number and the user name, to send messages to another time-sharing line, to check for terminal input errors, and to check for activation characters. EMTs related to specific features, such as detached jobs, inter-program messages or real-time programming, are described in the relevant chapters. The TSX-Plus EMTs which are not closely related to features described elsewhere are discussed in Chapter 7.

CHAPTER 8. TSX-Plus Job Environment

TSX-Plus supports the use of extended memory regions through EMT calls compatible with those provided by the RT-11 XM monitor. This allows the use of virtual overlays and FORTRAN virtual arrays. Users can also expand programs to use the full 16-bit virtual address space. That is, by giving up direct access to the I/O page and direct access to fixed offsets in RMON, a program may directly address a full 64Kb.

CHAPTER 9. Shared Files, Record Locking and Data Caching

TSX-Plus provides a file sharing mechanism whereby several cooperating programs may coordinate their access to common data files. Programs may request different levels of shared file access, and control shared access on a record-by-record basis. Two methods of data caching are also provided: 1) generalized data caching which is enabled when devices are MOUNTed; and 2) record caching which is only available to shared files. Directory caching is also enabled by the MOUNT request. This accelerates directory searching for file LOOKUPs.

CHAPTER 10. Inter-program Message Communication

TSX-Plus offers a message communication facility that allows running programs to exchange messages. Messages are transmitted through named "message channels". A program can queue messages on one or more message channels. Receiving programs can test for the presence of messages on a named channel and can suspend their execution until a message arrives. Receiving programs may

also schedule a completion routine to be entered when a message arrives and continue other processing in the meanwhile. A message can be queued for a program that will run at a later time.

CHAPTER 11. Real-time Support

TSX-Plus provides real-time program support services that allow multiple real-time programs to run concurrently with normal time-sharing operations. Real-time programs may optionally lock themselves in memory, directly access the I/O page, redefine their memory mapping, and connect device interrupts to subroutines within the program.

CHAPTER 12. Shared Run-time System Support

TSX-Plus allows one or more shared run-time systems to be mapped into the address space of multiple TSX-Plus time-sharing jobs. This saves memory space when multiple users are running the same types of programs (e.g., COBOL-Plus or DBL) and can also be used in situations where programs wish to communicate through a shared data region.

CHAPTER 13. Program Performance Analysis Facility

TSX-Plus includes a performance analysis facility that can be used to monitor the execution of a program and determine what percentage of the run time is spent within certain program regions. When the performance analysis facility is being used, TSX-Plus examines the program being monitored at each clock tick (50 or 60 times per second) and notes the value of the program counter. On completion of the analysis, the TSX-Plus performance reporting program can produce a histogram of the time spent in various parts of the monitored program.

CHAPTER 14. Differences from RT-11

Some inevitable differences exist between RT-11 and TSX-Plus. Chapter 2 describes the additional keyboard commands provided by TSX-Plus, the minor differences in some commands, and the RT-11 keyboard commands not supported by TSX-Plus. Some other differences between RT-11 and TSX-Plus may not be obvious. The FORMAT utility is not supported. A few system service calls (EMTs) behave slightly differently in the two systems and some RT-11 EMTs are not supported by TSX-Plus (notably those supporting multi-terminal operations). A section is also included on special use and programming characteristics of some utility programs which have caused confusion because of their non-obvious features and their interaction with TSX-Plus.

APPENDICES

Appendix A describes the SETSIZ utility program which may be used to control the amount of memory available to programs. Appendix B describes a library of subroutines which are available to the DIBOL user to take advantage of some of the special features of TSX-Plus. Appendix C describes the FILTIM utility which displays directory information about files, including the file creation time. Appendix D provides a table of EMT function and subfunction codes, and brief descriptions of both RT-11 and TSX-Plus EMTs; these are useful in conjunction with the SET EMT TRACE command. Appendix E contains listings of common subroutines called by the example programs throughout this manual.

Appendix F contains explanations of monitor error messages; fatal system error messages are covered in the TSX-Plus System Manager's Guide. Appendix G describes the commands and techniques used to work with logical subset disks. Appendix H describes job execution priorities. Appendix I describes the commands and use of the TSX-Plus symbolic program debugger.

1. BASIC OPERATION

1.1 Logging on

Each user communicates with the TSX-Plus system through a time-sharing line (often referred to in this manual simply as a "line"). Lines are normally started by typing a carriage return at the terminal. (If a time-sharing line is set for automatic baud rate detection and the terminal speed is less than 1200 baud, two carriage returns are necessary. Automatic speed selection is allowed for baud rates 110, 300, 1200, 4800, 9600 and 19200.) The system manager may designate lines to automatically initiate time-sharing whenever the system is started.

When each line is first started, a greeting message will normally be displayed at the terminal. Some lines, especially dial-in lines, may require an additional system password before getting the greeting message. On those lines, the system will prompt for the password with a single exclamation point (!). The system password will not be echoed as you type it. If you do not correctly type the system password in two tries or in less than 30 seconds, then the system will hang up. (The actual time limit may vary on your system.) The system password is selected during system generation and may be obtained from your system manager.

The system manager may assign a start-up command file to be executed whenever a time-sharing line is started. A start-up command file contains initialization commands for a line. It can end by either starting execution of some program, or by waiting for a system command. (The default keyboard monitor prompt is a period.) It is possible for a start-up command file to lock a program to a line so that on termination of the program the line is automatically logged off and an optional logoff command file is executed. Typing control-C will not abort start-up or logoff command files.

The system manager may also require "log on" authorization. In this case, the system manager assigns each user a user name (and project/programmer number) and password. After the greeting message, the message "Logon please:" is printed. The user responds by typing the user name (or project,programmer number) followed by a carriage return. TSX-Plus then requests the password. The password is not echoed to the terminal as it is typed. After the user name (or project,programmer number) and password are validated, TSX-Plus types the message "Welcome to the system". The system manager may also designate a "start-up" command file for each account to control system access and set certain operating parameters.

The following example illustrates a typical logon sequence. The information typed by the user is underlined.

```
(carriage return pressed)
    (                )
    (greeting message)
    (                )
23-Jan-84   13:39:50
Line #2


Logon please:JOHNSON
Password:MYPASS          (Password is not displayed.)
Welcome to the system

.   (TSX-Plus is now waiting for a system command.)
```

A user may adopt a new password while logging on. To do this, enter a slash and the new password immediately after typing the old password. The new password must then be used for future logons. Passwords may be from 1 to 7 characters in length and must be composed only of letters and digits. Changing your password requires SETNAME privilege. The following example shows the password being changed from "OLDP" to "NEWP". Note that neither the old nor the new password would actually be echoed.

```
(carriage return pressed)
    (                )
    (greeting message)
    (                )
20-Jun-83  14:17:43
Line #5

Logon please:107,24      (Either user name or PPN may be used.)
Password:OLDP/NEWP       (Passwords are not displayed.)
Welcome to the system

.   (TSX-Plus is now waiting for a system command.)
```

If the system manager has not required "log on" account authorization, then the system will either execute a start-up command file or simply display the monitor prompt (".") and wait for a system command to be entered.

1.2 Logging off

The OFF keyboard command is used to terminate ("log off") a time-sharing session.

The system manager may specify a "log off" command file to be executed whenever a job logs off. Control-C will not abort a "log off" command file.

1.3 Control characters

Certain control characters have special meaning to the system. These "control characters" control certain terminal operations. They are entered by holding down the "CTRL" key while pressing the selected character.

Some of these special characters may be redefined locally during system generation. (Ctrl-B - the PRINTWINDOW command; Ctrl-W - the subprocess switch.)

Note also that the function of some "control characters" may be altered when the single line editor is in use; see a separate section in this chapter for more information on the Single Line Editor.

Some "control characters" can also be used as defined keys, which causes the defined text to be substituted when the key is typed. See a separate section in this chapter for more information on defined keys.

NULL - The null character is ignored when typed. (Ctrl-@, Ctrl-SPACE)

CTRL-A - Is the special command character for the time-sharing line/CL line cross connection. See the SET HOST command.

CTRL-B - Causes the current process window to be transmitted to the printer. See the SET PRINTWINDOW command. (May be redefined during system generation.)

CTRL-C - Interrupts the current program and returns control to the keyboard monitor. If the running program is not waiting for input, two successive CTRL-C's are required to interrupt its execution. CTRL-C will not interrupt start-up or logoff command files.

CTRL-D - May interrupt the execution of the program and transfer control to the symbolic debugger. This depends on whether the debugging facility has been included during system generation and whether the SET CTRLD DEBUG command has been issued. See the description of the SET CTRLD DEBUG command in Chapter 2, and the description of the program debugger in Appendix I.

CTRL-O - Suppresses program output to the terminal until one of the following conditions occurs:

1. A second CTRL-O is typed
2. The program returns to the monitor
3. The running program issues a .RCTRLO EMT

CTRL-P - Has no special meaning to TSX-Plus, but is used as the command signal character for the RT-11 VTCOM program and as the console break character on some types of processors.

CTRL-Q - Resumes printing on the terminal from the point at which printing was previously suspended by CTRL-S.

CTRL-R - Causes the current characters in the terminal input buffer to be displayed. This can be used to check the actual contents of an input line when rubout editing has been done on the line. Also used by KED, KEX and K52 to repaint the screen.

CTRL-S - Temporarily suspends output to the terminal until CTRL-Q is typed.

CTRL-U - Deletes the current input line.

CTRL-W - Used to switch to a TSX-Plus subprocess. However, the subprocess switch character may be redefined during system generation. Typing two successive control-W's passes one control-W to the program. Used by KED, KEX and K52 to repaint the screen.

CTRL-Z - Indicates end-of-file when input is being read from device "TT".

Escape - Used for terminal control sequences. The escape character is echoed as a dollar-sign ("$"), thus preventing direct entry of terminal control sequences from the keyboard.

CTRL-\ - Used to break a time-sharing line/CL line cross connection. Only significant to the system during a cross connection. See the SET HOST command.

DELETE - Removes preceding character (on the same line) from the terminal input buffer. See also the description of the rubout filler character in Chapter 6.

The normal function of these keys may be altered during program execution. Chapter 6 describes program controlled terminal options that influence these functions. When enabled, the single line editor defines additional special purpose keys; see the next section for further information about the single line editor.

1.4 Subprocesses and Process Windows

TSX-Plus allows a single terminal to control several processes at once. Control may be switched from one process to another by typing a control-W (hold down the CTRL key while pressing the W key), followed by a single digit (do not hold down CTRL while typing the digit). The digit identifies the number of the subprocess to be logically attached. Switching the terminal's logical connection between processes in this manner can be thought of as opening a "window" into each process. (A subset of the subprocess facility was known in earlier versions of TSX-Plus as "virtual lines".) The ability to use subprocesses requires SUBPROCESS privilege.

When initially logging on to TSX-Plus, the terminal is connected to the "primary" process, also called process window number 0 (zero) or the primary time-sharing line. The terminal may be connected to a different subprocess window at any time by typing the <control-W><digit> sequence. You may then proceed with ordinary time-sharing operations on the subprocess while processing continues on the primary line. When initiating the subprocess, the system will display a string to identify the subprocess number (same as <digit>) and the TSX-Plus job number. For example, switching to subprocess number one might result in something like the following:

```
.FORTRAN BIGJOB     [Start large compilation]
^W1                 [Switch to subprocess - this does not echo]
1>Line # 21         [Greeting for subprocess 1, job number 21]

.SYSTAT             [Perform normal time-sharing operations on subprocess]
Uptime: 01:20:21
System use:   Run=13%, I/O-wait=1%, Swap-wait=0%, Idle=84%
I/O Activity: User I/O=4%, Swapping I/O=0%

Job   Line    Pri   State     Size    Connect    CPU time   Program    Job name
---   ------  ---   -------   -----   ---------  --------   -------   ------------
 1    1(0)     50   TI        62Kb    01:21:00   00:01:55   SRCCOM    HAIKU
 2    2(0)     40   IN        62Kb    00:10:00   00:00:40   FORTRA    Pacific
16    Det.     50   SL        62Kb    01:21:00   00:00:01   RTSORT    SYSTEM
17    Det.     50   SL        30Kb    01:21:00   00:00:00   WINPRT
21*   2(1)     50   IN        36Kb    00:01:00   00:00:01   KMON      Pacific
.^W0                [Bell rings, return to primary - this does not echo]
.MAIN.              [Display continues where it left off]
SBRTN1
SBRTN2
SBRTN3
SBRTN4
SBRTN5
.
```

It is possible to specify during a start-up command file the name of a command file to execute when initiating a subprocess. See the description of the SET SUBPROCESS command in the TSX-Plus System Manager's Guide for more information on subprocess initiation command files.

The relative subprocess number is specified by the digit which follows the control-W. The job number (process number) is assigned automatically by the system. Subprocesses are assigned the first available job number from among those reserved system-wide for subprocesses. Job numbers are allocated first for all primary processes, in the order in which they were declared during system generation. The next range of job numbers is reserved for detached jobs. Subprocesses are assigned the first unused job number following the last number reserved for detached jobs. The maximum number of subprocesses which may be active for all users is selected during system generation. In addition, each primary process may be restricted to a maximum number of subprocesses. If either of these quotas is filled, then the <control-W><digit> sequence used to initiate a subprocess will be ignored. The SYSTAT command may be used to determine information about primary processes and subprocesses.

Switching to a subprocess by typing <control-W><digit> has the effect of logically disconnecting the terminal from the primary window and connecting it to a different subprocess window. The terminal may be reconnected to the primary process at any time by typing <control-W>0. (Zero is the subprocess number for the primary process.)

To stop a subprocess, connect the terminal to it and use the OFF command. The terminal will then be reconnected to the primary process. Subprocesses which are active when the primary process is logged off are aborted. It is not necessary to log off from a subprocess before connecting to a different subprocess. However, only a limited number of subprocess job slots are available in the system; if they are all busy, then no one will be able to initiate a new subprocess.

Process windows have the option of retaining the screen display when they are disconnected and then refreshing the display when they are reconnected. Or, they may begin from the terminal's current cursor position. Using the window refresh option reduces the confusion which can result from working with multiple subprocesses on the same screen. The SET WINDOW command is used to control process windowing. The simplest form of this command, which enables the process window refresh feature for the current process, is:

```
SET WINDOW
```

See Chapter 2 for a full description of the SET WINDOW command.

Control-W is also used by the KED, KEX and K52 editors to repaint the screen. Typing two successive control-W's passes one control-W through to the program and will cause these editors to repaint the screen. Note that they will also accept control-R to repaint the screen and only one need be typed. If windows with refresh are in effect, you may also refresh the screen by typing control-W followed by the current relative subprocess number.

A single process may use multiple windows by using the EMT's to create and select windows described in Chapter 7. Use of the window refresh option requires SYSGBL privilege.

Enabling window refresh also permits use of the PRINTWINDOW screen print facility. This allows an image of the current screen display to be sent to a printing device at any time a window with refresh is in effect by simply typing a control character. See the description of the SET WINDOW and SET PRINTWINDOW commands in Chapter 2 for a more complete description of screen refreshing when switching among different process windows with refresh and use of the PRINTWINDOW facility.

If a process is disconnected by switching to a different process window while a program is running, the program continues to execute just as it would if it were still connected. However, the priority of the disconnected process is reduced by an amount selected during system generation. If the disconnected process reaches a point at which it requires terminal input or it would begin to lose terminal output, then its execution is suspended and the terminal bell is rung to indicate that one of its disconnected subprocesses requires service. See also the description of the SCROLL option to the SET WINDOW command.

When a separate process window is initiated, it "inherits" most of its characteristics from those current for the primary process. (Detached jobs inherit their environment in much the same way, except that detached jobs inherit from the (sub)process which starts them, not always from the primary process and they always begin executing a command file.) The startup command file for the primary process is NOT executed for each process window. However, a command file may be specified to be executed when a subprocess is initiated; see the description of the SET SUBPROCESS command in the TSX-Plus System Manager's Guide. Each process may change its characteristics (within authorized ranges) subsequent to its initiation. If the process window screen refresh option is enabled, then the screen of a subprocess window is cleared during initiation and windowing is begun, as if an implicit SET WINDOW command had been issued for the subprocess. The characteristics inherited by the subprocess do not include an executing program; the subprocess is entered at the keyboard monitor, waiting for a command. The characteristics inherited when a subprocess (or detached job) is initiated include the following:

1. Project/programmer numbers and process name
2. Authorized and Set privileges
3. File access controls
4. Maximum authorized priority
5. Logical assignments (ASSIGN command)
6. Logical subset disk mounts (MOUNT LD command)
7. Mounts of disks to enable caching
8. User defined commands
9. User command interface (SET KMON UCI command)
10. Single line editor status (SET SL command)
11. User defined terminal keys (DEFINE KEY command)
12. Monitor prompt string (SET PROMPT command)
13. SET PRINTWINDOW device name and type

The terminal may be switched back and forth among any of its active processes without reinitiating them. While it is disconnected, each process retains whatever characteristics it has acquired; they are not re-established from the primary process for each connection, only when initiated.

1.5 Single Line Editor

It is often desirable to correct typing mistakes made in the entry of command input lines or to correct data entry fields while executing some program. This can be done to a limited extent by use of the DELETE and CTRL-U keys, however much more editing capability is available if the "Single Line Editor" facility is used. To use the single line editor, the system manager must enable it during the TSX-Plus system generation process. In addition, it must be turned on for each time-sharing line before use. To use the single line editor, issue the command:

```
SET SL ON
```

either in a start-up command file or as a keyboard command. The single line editor may be used only with VT200, VT100 or VT52 type terminals.

Several other SET options are available for use with the single line editor. These are described in Chapter 2 in the section on keyboard commands.

The single line editor accepts special key commands to direct its operation. Under TSX-Plus, there are two modes of operation of the single line editor: normal mode (RT-11 compatible); and KED mode. In normal mode, the TSX-Plus single line editor is compatible with the RT-11 single line editor except for the differences noted in the table at the end of this section. The following tables summarize the functions performed by the editing control keys.

Single Line Editor Key Functions

Normal (RT-11 compatible) Mode

Primary Key Functions (Not prefixed by PF1)	
Key	Function
Up arrow	Retrieve previous input lines
Down arrow	Retrieve line from save buffer
Left arrow	Move cursor left one character
Right arrow	Move cursor right one character
BACK SPACE	Exchange char under cursor with char to right
DELETE	Delete character to left of cursor
LINE FEED	Delete word to left of cursor
RETURN	Pass current line to running program
PF1	Used before other keys to perform second function
PF2	Not implemented
PF3	VT52: Delete from cursor to right end of line
PF4	VT100: Delete from cursor to right end of line
Ctrl-U	Delete from cursor to left end of line
Ctrl-R	Redisplay current line

Secondary Functions (Keys Prefixed by PF1)	
Key	Function
Up arrow	Retrieve second previous input line
Down arrow	Save current line in "save buffer" for recall later
Left arrow	Move cursor to left end of line
Right arrow	Move cursor to right end of line
BACK SPACE	Exchange char under cursor with char to left
DELETE	Retrieve last deleted character
LINE FEED	Retrieve last deleted word
RETURN	Truncate from cursor to end of line and execute
PF1	Ignored
PF2	Not implemented
PF3	VT52: Retrieve last deleted line
PF4	VT100: Retrieve last deleted line
Ctrl-U	Retrieve last deleted line

In addition to the normal (RT-11 compatible) mode of operation for the single line editor, TSX-Plus also permits use of some of the keypad functions in a fashion similar to KED (or K52). These keypad operations are available in addition to the functions described above for the single line editor. In order to use the extended (KED) mode with the single line editor, issue the following command:

```
SET SL KED
```

When the KED mode is enabled, the following tables describe the additional functions available to the single line editor.

Single Line Editor Key Functions

KED Mode

Primary Key Functions (Not prefixed by PF1)	
Key	Function
0	Move cursor to left end of line
1	Move cursor one word in current direction
2	Move to end of line in current direction
3	VT100: Move cursor one char in current direction
4	Set direction forward (left to right)
5	Set direction backward (right to left)
6	VT52: Delete character under cursor
7	Not implemented
8	Not implemented
9	VT52: Delete word under cursor
-	VT100: Delete word under cursor
,	VT100: Delete character under cursor
ENTER	Pass current line to running program

Secondary Functions (Keys Prefixed by PF1)	
Key	Function
0	Delete from cursor to right end of line
1	Change case of char under cursor
2	Delete from cursor to right end of line
3	Not implemented
4	Move cursor to right end of line
5	Move cursor to left end of line
6	VT52: Retrieve last deleted character
7	Not implemented
8	Not implemented
9	VT52: Retrieve last deleted word
-	VT100: Retrieve last deleted word
,	VT100: Retrieve last deleted character
ENTER	Truncate from cursor to end of line and execute

To return the single line editor to the normal mode, issue the command:

```
SET SL NOKED
```

To disable the single line editor altogether, issue the command:

```
SET SL OFF
```

In addition to editing command lines, the single line editor may be used to edit data entry fields during program execution. However, there are some restrictions on such use. If any of the following conditions exist, then the single line editor may NOT be used to edit program data fields:

1. The SET SL OFF command has been issued
2. Bit 4 (EDIT$, mask 20) is set in the Job Status Word (JSW)
3. Bit 12 (TTSPC$, mask 10000) is set in the JSW
4. The program is using high-efficiency terminal mode
5. The program is using escape sequence activation
6. Input is being accepted via the .TTYIN EMT (except as below)

In order to use the single line editor to edit data entry fields within programs which accept input via the .TTYIN EMT, the following command must be issued prior to execution of the program:

```
SET SL TTYIN
```

Since COBOL-Plus programs accept terminal input via the .TTYIN EMT, the following steps must be used to edit data entry fields while executing COBOL-Plus programs:

1. SET SL ON

2. SET SL TTYIN

3. From within the executing program, CALL "ESCAPE-OFF"

The TSX-Plus single line editor is generally compatible with that provided with RT-11, with the following exceptions:

1. The "Help" key (PF2) is not implemented.

2. The SET SL LEARN mode is not implemented.

3. The SET SL ASK option is ignored. (The current TSX-Plus terminal type information is used.)

4. The SET SL SYSGEN option is ignored.

5. The maximum width of a command line or input field that is accepted is 80 characters. The SET SL WIDTH=n option is ignored.

6. The line feed key deletes the word to the left of the cursor. Technically, characters to the left of the cursor are deleted until one of the following delimiters is reached: space, tab, comma, or equal sign.

7. The up arrow key can be used to retrieve either of the last two lines. Pressing the up arrow key cycles between recalling the last input line and the line prior to that.

8. Using the single line editor with .TTYIN input does not force a new line.

9. The single line editor is implemented as a TSX-Plus overlay region and does not require the SL pseudo-device handler.

1.6 User defined terminal keys

It is possible to specify character strings which will be substituted for a character when that character is typed. This feature is most commonly used to associate frequently typed commands with some of the terminal function keys, but it may be used to associate a character string with almost any key.

Key substitutions are performed by the single line editor; hence, substitutions are only done on terminal input processed by the single line editor.

The DEFINE KEY keyboard command is used to specify a key substitution. The form of this command is:

DEFINE KEY[/qualifiers] key "string"

where key is the name of the key that is associated with the string. For example, the following command associates the SHOW TIME command with the PF2 key:

```
DEFINE KEY PF2 "SHOW TIME"
```

The substitution string may be up to 64 bytes long.

Current key definitions may be displayed by the SHOW KEYS command.

If the associated string contains no leading or trailing spaces, no @ symbol, and no control characters, the quotation marks may be omitted. Thus, the command may also be specified as:

```
DEFINE KEY PF2 SHOW TIME
```

If the associated string contains an @ symbol, then the string must be enclosed in quotation marks. For example, the following key definition could be used to cause the PF2 key to invoke a command file:

```
DEFINE KEY PF2 "@DL3:CMDFIL"
```

If the key being defined is a control character, enclose the key in quotation marks and place a caret (^) in front of the letter that is to be converted to a control character. For example, the following command causes control-T to display the current time of day:

```
DEFINE KEY/LETTER/NOECHO "^T" SHOW TIME
```

A key definition is removed by using a DEFINE KEY command with no substitution string. Thus, to remove the PF2 key definition use the following command:

```
DEFINE KEY PF2
```

The following table lists key names which may be used:

Key name	Actual key
The following keys may only be defined in KED mode	
KP0,KP1,...,KP9	digits 0 to 9 on numeric keypad
PERIOD	period key (.) on numeric keypad
COMMA	comma key (,) on numeric keypad
MINUS	minus key (-) on numeric keypad
ENTER	ENTER key on numeric keypad
The following keys are not affected by KED mode	
PF1,PF2,PF3,PF4	PF1,PF2,PF3,PF4
UP	up-arrow key
DOWN	down-arrow key
LEFT	left-arrow key
RIGHT	right-arrow key
FIND	"Find" key on VT200
INSERT	"Insert here" key on VT200
REMOVE	"Remove" key on VT200
SELECT	"Select" key on VT200
PREV	"Prev screen" key on VT200
NEXT	"Next screen" key on VT200
HELP	"Help" key on VT200
DO	"Do" key on VT200
F6,F7,...,F20	Function keys on top row of VT200

Key substitutions may be disabled/enabled with the command:

```
SET SL [NO]SUBSTITUTE
```

The default mode is SUBSTITUTE which enables key substitutions by the single line editor.

If you define substitutions for any of the keys of the numeric keypad other than the PF keys, the single line editor must be in KED mode (SET SL KED).

Note that the PI handler which controls the console terminal on the Professional normally provides VT100 support for the console terminal, not VT200. Thus, the function keys on the top row and the "Do", "Help", etc. keys may not normally be defined. However, it is possible to enable the Pro console for VT200 compatible operation by sending it the control sequence "<ESC>[?39h".

If a defined key appears not to be working, first verify that the definition is correct with the SHOW KEYS command. Then, use the SHOW SL command to verify that key substitution is in effect and that KED mode is enabled for numeric keypad keys.

You may specify a key definition for a key which is normally used to perform some single line editor function (e.g., up arrow). When this is done, the key definition takes precedence over the normal function.

The following qualifiers can be used with the DEFINE KEY command:

/[NO]ECHO — Determines whether the substitution string will be printed at the terminal at the time the substitution takes place. The default mode is /ECHO.

/[NO]TERMINATE — Determines whether a carriage-return and line-feed are appended to the end of the substitution string when it is substituted. Use /NOTERMINATE with a definition that specifies a part of a command. The default mode is /TERMINATE. You may not specify /NOECHO and /NOTERMINATE together. For example, the following definition associates the PF2 key with the word HELP followed by one space, without termination:

```
DEFINE KEY/NOTERMINATE PF2 "HELP "
```

/[NO]GOLD — Determines whether the specified key must be prefixed by the "gold" (PF1) key. If /GOLD is specified then the substitution only takes place if you type the PF1 key followed by the specified key. If /NOGOLD is specified (the default case) then the substitution takes place when the specified key is pressed without being prefixed by the PF1 key. "/GOLD" definitions are not available if the PF1 key itself has been assigned a key definition. The following two definitions associate the SHOW TIME command with the unprefixed PF2 key and the SHOW DATE command with the two key combination PF1 PF2:

```
DEFINE KEY PF2 SHOW TIME
DEFINE KEY/GOLD PF2 SHOW DATE
```

/LETTER — Specifies that the key being defined is not a function key, but is a key such as a letter, digit, or punctuation mark which is part of the typewriter portion of the keyboard. If /LETTER is specified, then key must be a single letter from the non-function-key portion of the keyboard. The /GOLD qualifier may

be used in conjunction with /LETTER to cause the substitution to take place only if the specified letter is prefixed by the PF1 key. The default mode is /NOLETTER. For example, the following commands cause a pound sign (#) to be substituted for the dollar sign ($) and the SHOW JOBS command to be substituted for the "PF1 dollar-sign" combination:

```
DEFINE KEY/LETTER/NOTERMINATE $ #
DEFINE KEY/LETTER/GOLD $ SHOW JOBS
```

Deleting or redefining a substitution for a letter which has already been defined requires that key substitution be turned off first. Otherwise, the defined string is substituted for the letter as the DEFINE KEY command is typed. If you need to delete or redefine a letter substitution, invoke the SET SL NOSUBSTITUTE command to turn off substitutions, then use the DEFINE command, then SET SL SUBSTITUTE.

Control characters may also be included in key substitution strings. To include control characters in a key definition string, enclose the substitution string in quotation marks and type a caret (^) in front of the letter that is to be a control character. For example, the following command defines numeric keypad key 0 (zero) as control-U (SL must be in KED mode):

```
DEFINE KEY/NOTERMINATE KP0 "^U"
```

Control characters count as one character in the string even though two characters are used to specify them. If the DEFINE command is placed within a command file, two caret characters must be specified to denote each control character because command file processing translates two consecutive caret characters into a single caret. Thus, if the previous DEFINE command were placed in a command file, it would be written as:

```
DEFINE KEY/NOTERMINATE KP0 "^^U"
```

It is possible to define a key with a control-W digit sequence to cause a switch to a subprocess. However, this is less powerful than actually typing control-W digit because the switch with a defined key can only be used at a time when the single line editor is accepting input, not when a program is executing. The following key definition defines PF2 to switch to subprocess one:

```
DEFINE KEY/NOTERMINATE PF2 "^W1"
```

Key definitions are inherited from the primary process when subprocesses are initiated.

Key definitions for each job are stored in a local named region with the name "KEYDEF". This region is created when the first key definition is made and is deleted when the last key definition is deleted or the job logs off. The size of the KEYDEF region (in bytes) is equal to KEYMAX*68.

2. KEYBOARD COMMANDS

2.1 Keyboard command interpretation

When a system command line is typed in, TSX-Plus attempts to interpret it by sequentially applying the following rules:

1. If the User Command Interface is in effect, then each time TSX-Plus is ready to accept a keyboard command it passes control to the current UCI program. The UCI program may be selected with the SET KMON UCI[=filnam] command. See the description of SET KMON command and the section in this chapter on the User Command Interface for more information.

2. If the command line begins with an "at-sign" ("@"), TSX-Plus attempts to execute a command file. If no device is specified with the command file name, device "DK:" is assumed. The default extension for command files is "COM". If the SET KMON IND command has been issued, command files will execute under the control of the IND program. Command files may be specified for execution as normal command files, regardless of whether KMON is set IND or NOIND, by starting the command with a dollar-sign (e.g. "$@filnam"). Conversely, command files can be forced to execute under the IND utility, regardless of whether KMON is set IND or NOIND, by typing: "IND filnam".

   See Chapter 3 for further information on the execution of command files by TSX-Plus.

3. If user-defined commands have been allowed during TSX-Plus generation, and if UCL is set FIRST either in TSGEN or subsequently by the keyboard SET UCL FIRST command, then commands are checked at this point to see if they are user-defined commands. However, if the first character on a command line is the underline character ("_") then the command on that line is not checked to see if it is a user-defined command. See the next section for more information on user-defined commands.

4. TSX-Plus next attempts to identify a command as a standard system command such as COPY, RUN, EXECUTE, etc. Commands may be abbreviated to the minimum number of characters that uniquely specify the name. Thus "COP" would be an acceptable abbreviation for COPY, but "CO" would not because it could mean COPY or COMPILE. "COPX" also would not be identified as a system command.

5. If user-defined commands have been allowed during TSX-Plus generation, and if UCL is set MIDDLE either in TSGEN or subsequently by the keyboard SET UCL MIDDLE command, then commands are checked at this point to see if they are user-defined commands. However, if the first character on a command line is the underline character ("_") then the command on that line is not checked to see if it is a user-defined command.

6. If the command has not yet been identified, then TSX-Plus tries to find a command file on device "DK:" that has the same name as the command keyword. If no such command file is found on "DK:", TSX-Plus looks for the command file on device "SY:". In either case, if the SET KMON IND keyboard command has been issued, it will be executed under control of the IND program. When a command file is started in this fashion (rather than explicitly specifying an at-sign before its name), the command file listing is suppressed as if an implied "SET TT QUIET" command was executed during command startup. This implied listing suppression is temporary in effect and applies only to the command file started in this fashion. See Chapter 3 for more information on command files.

7. If a command file cannot be found, TSX-Plus looks for an executable program (SAV file) on device "SY:" that has the same name as the command keyword. If such a program is found, it is executed as if there were an "R" command in front of the program name. Note that while both RT-11 and TSX-Plus allow a line of text input to be passed to a program with the RUN command by specifying it after the program name, TSX-Plus also allows this to be done with the "R" command and with an implied "R" command line when the program name is specified as the command keyword. See example 6 below.

8. If user-defined commands have been allowed during TSX-Plus generation, and if UCL is set LAST either in TSGEN or subsequently by the keyboard SET UCL LAST command, then commands are checked to see if they are user-defined commands at this point. However, if the first character on a command line is the underline character ("_") then the command on that line is not checked to see if it is a user-defined command.

9. If a command has not been identified after all the above steps have been tried, then it is reported as an unrecognizable command. The error message is:

```
?KMON-F-Unrecognizable command
```

The following list summarizes the sequence of events which occur in the processing of keyboard commands. If a command can be recognized at any of these steps, then the appropriate command is executed and the remaining steps are skipped.

```
Call user command interface if one is active.
If command begins with "@", execute command file on DK:.
If UCL FIRST, check for user-defined command.
Check for system command.
If UCL MIDDLE, check for user-defined command.
Check for command file on DK:.
Check for command file on SY:.
Check for SAV file on SY:.
If UCL LAST, check for user-defined command.
Report unrecognizable command.
```

If user-defined command support has not been included in TSGEN, or if the SET UCL NONE command has been issued, or if a command line begins with the underscore character ("_"), then the command interpreter never attempts to interpret a command as a user-defined command. Attempts to issue user-defined commands under these conditions will also be reported as unrecognizable commands.

Examples:

1. Execute the command file "DK:PURGE.COM".

   ```
   @PURGE
   ```

2. Run a program named "DUMP" on device "SY:".

   ```
   R DUMP
   ```

3. Run a program named "PAYROL" on device "DX1:".

   ```
   RUN DX1:PAYROL
   ```

4. List all files on "RK1:"

   ```
   DIR RK1:
   ```

5. Start a command file "SY:LOADIT.COM" and pass it the parameter string "PROG2".

   ```
   LOADIT PROG2
   ```

6. Execute the program "SY:PIP.SAV" and pass it the input line "A.TMP=B.TMP".

```
PIP A.TMP=B.TMP
```

2.2 User-defined Commands

It is possible to define your own keyboard commands in terms of system commands and other keyboard commands. New keyboard commands may be defined according to the following syntax:

name :== string

where name is a 1 to 11 character command keyword which may consist of letters, digits, and the underscore symbol ("_"), and string is a string of up to 80 characters which defines the body of the command.

For example, the following command would define the keyword "NOW" as being equivalent to the TIME command:

```
NOW :== TIME
```

Multiple commands may be included in the body of a command definition by separating them with the backslash character ("\"). For example:

```
NOW :== DATE\TIME
```

An up-arrow character ("^") may be included in the command body to cause all text on the command line following the command keyword to be inserted in the command body at the position of the up-arrow. For example, if a command is defined as follows:

```
NAMES :== DIR/ORDER:NAME ^
```

Then, if this command is invoked by typing:

```
NAMES *.MAC
```

The resulting command will be equivalent to:

```
DIR/ORDER:NAME *.MAC
```

More than one up-arrow character may occur in the command body. The parameter string specified when the command is invoked is substituted for each occurrence of the up-arrow character.

A user defined command may invoke other user-defined commands within its definition provided that the definition does not call on itself and provided that the other commands are defined at the time the command is invoked. For example, the following command definitions would be legal:

```
NOW :== SHOW DATE\SHOW TIME
STATUS :== NOW\SYSTAT
```

However, the following pair of commands would cause an infinite loop:

```
ONE :== TWO
TWO :== ONE
```

It is possible to allow abbreviation of user-defined commands. To do this, place an asterisk character ("*") within the keyword at the point of the minimum length abbreviation. For example, the definition:

```
ST*ATUS :== NOW\SYSTAT
```

Would allow the STATUS command to be abbreviated to "STAT" or "ST" but not to "S". Note that the portion of the command typed must match the definition (except for any asterisk in the definition) up to the last character entered.

You can specify the order in which the TSX-Plus command interpreter checks for user-defined commands by use of the SET UCL command. This command has four forms:

```
SET UCL FIRST
SET UCL MIDDLE     (This is the recommended setting.)
SET UCL LAST
SET UCL NONE
```

If the SET UCL FIRST command is used, user-defined commands will be processed before system commands. This allows user-defined commands to replace system commands but makes the processing of system commands slower. This is the required setting if it is necessary to replace some system commands.

If the SET UCL MIDDLE command is used, user-defined commands are processed after system commands but before checking for command files and SAV files with names that match the command keyword. Using this setting, it is not possible to replace a system command with a user command, but both system commands and user-defined commands are processed relatively quickly. This is the recommended setting unless it is desirable to replace system commands.

If the SET UCL LAST command is used, a command will not be checked to see if it is a user-defined command until after it has been checked to see if it is a system command, the name of a command file on DK, the name of a command file on SY, or the name of a SAV file on SY. Using this setting, it is not possible to replace a system command with a user command and user commands cannot have the same name as command files or SAV files. System commands are processed quickly (the same speed as SET UCL MIDDLE), but the processing of user-defined commands is slow. This is the appropriate setting only if user-defined commands are desired, but command files already exist whose names would conflict with user-defined commands. Existing command files which are short and merely execute system commands should be replaced by user-defined commands.

If the SET UCL NONE command is used, user-defined commands are never interpreted. In this mode, attempts to invoke user-defined commands will result in the error:

```
?KMON-F-Unrecognizable command
```

The following list illustrates where the FIRST/MIDDLE/LAST setting causes the command interpreter to check for and process user-defined commands:

```
FIRST  -->
           See if command is a system command
MIDDLE -->
           Look for command file on DK: with command name
           Look for command file on SY: with command name
           Look for SAV file on SY: with command name
LAST   -->
```

See the beginning of this chapter for further information on the command interpretation process.

If an underscore character ("_") is typed in front of a keyboard command, this is a signal to the system that the command is not to be interpreted as a user-defined command. For example, if the NOW command has been defined as shown above, then the following command will be recognized as a user-defined command and will cause the date and time to be displayed:

```
NOW
```

However, the following command would not be recognized as a user-defined command and would be rejected as an undefined command since there is no NOW command defined by the system (unless there is a command file or SAV file on SY: with the name NOW):

```
_NOW
```

There are two reasons for using the underscore prefix. If UCL has been set FIRST, the underscore prefix can be used to speed up the processing of large numbers of system commands that could be present in frequently executed command files. For example, the NOW command could be defined as follows to cause it to execute faster:

```
NOW :== _DATE\_TIME
```

The second and more important reason for using the underscore prefix is to allow user-defined commands to be defined which replace system commands but which use the system commands in their definitions. (Note that it is necessary to SET UCL FIRST to allow system command replacement.) For example, the following definition replaces the system DIRECTORY command with a user-defined command that has the same name but which always orders the files alphabetically:

```
DIR*ECTORY :== _DIR/ORDER:NAME ^
```

If the body of this command were not preceded with the underscore character, then it would be a circular definition and cause a futile loop.

A user-defined command can cause a command file to be executed. However, the command file invocation must be the last (or only) command defined within the body of the command. For example, the following definition causes all BAK files to be deleted, and a command file named QUIT to be executed when the OFF command is used (the QUIT command file could end with an "_OFF" command to do the actual logoff):

```
OFF :== _DEL *.BAK/NOQ\@QUIT
```

A user-defined command may be replaced at any time by simply entering a new definition for the command. A command may be deleted by entering its name and ":==" without a command body. For example, the following command deletes the definition of the NOW command:

```
NOW :==
```

The SHOW COMMANDS keyboard command may be used to display a list of all current user-defined commands.

Commands defined by one time-sharing user are "local" to that user and do not affect other users. However, when a subprocess is started the subprocess "inherits" the user-defined commands that are in effect for the primary line at the time that the subprocess is started. User-defined commands created for a subprocess are not available from other subprocesses or from the primary line. All user-defined commands for a job are reset (forgotten) when the job logs off.

When defining multiple commands from a command file (especially a start-up command file) it is useful to prevent repeated execution of the TSXUCL program and return to the keyboard monitor. The TSXUCL program automatically determines whether it was called from TSKMON in response to a user-defined command definition or if it was run directly. When run directly, it accepts command definitions until it finds a blank line and then returns to the keyboard monitor. This is significantly faster only when defining multiple commands from within a command file. The following excerpts from a typical start-up command file demonstrate the repeated entry method and the direct definition method which is faster for multiple definitions:

Slower	Faster
!Slower method	R TSXUCL !Faster method
Q :== SPOOL LP,STAT	Q :== SPOOL LP,STAT
WHEN :== SHOW TIME	WHEN :== SHOW TIME
NEW :== DIR ^/D	NEW :== DIR ^/D
!End of command file	!Blank line required

The system manager must enable user-defined commands by setting the U$CL flag in TSGEN and the program TSXUCL.SAV must be on SY: in order to process user-defined commands. The maximum number of commands which can be defined by any job is set by the UCLMNC command in TSGEN. The default order for interpretation of user-defined commands during command processing is determined by the TSGEN parameter UCLORD. This may be overridden by the keyboard command SET UCL {FIRST|MIDDLE|LAST|NONE} for individual jobs.

2.3 User Command Interface

The User Command Interface (UCI) allows a user-provided program to take over the job of command acquisition from the TSX-Plus keyboard monitor. When UCI is enabled, the user-written program will be called by the TSX-Plus keyboard monitor each time it is ready to accept a new command. It is then the responsibility of the user-written program to prompt for a command and accept it from the terminal. The program may then perform the appropriate actions, chain to other programs or pass commands on to the keyboard monitor. This provides a mechanism for such applications as a command menu.

UCI is enabled with the command:

```
SET KMON UCI[=filnam]
```

which may be entered either from the keyboard or in a start-up command file. If the optional filnam is omitted, then the keyboard monitor passes command control to the program SY:UKMON.SAV. This is appropriate when a common command interface is desired for multiple lines. If different command interfaces are desired for different lines, then the file name of the appropriate user-written command interface should be specified.

After UCI is enabled, the TSX-Plus keyboard monitor will run the user-written UCI program each time it needs a new command. The program must prompt the user for a new command, accept the command, process it as desired and may optionally pass the command to the TSX-Plus keyboard monitor by doing a "special chain exit". A special chain exit is performed by issuing the .EXIT request with bit 5 (mask 40) set in the job status word and with R0 cleared. Any commands to be executed by the keyboard monitor are passed through the chain data area. See the RT-11 Programmer's Reference Manual for more information on "special chain exits". Commands passed to the TSX-Plus keyboard monitor in this fashion behave as though the keyboard monitor obtained them from a command file. A command file name may also be passed to the keyboard monitor by passing a command of the form "@name". If a command file name is passed to the keyboard monitor, then it must be the last or only command passed in the chain data area. When a command file name is passed in this manner, then all of the commands included in the command file are executed by the keyboard monitor before returning to the user-written UCI program for another command.

Keyboard command control may be returned to the TSX-Plus keyboard monitor by the command:

```
SET KMON SYSTEM
```

The following program provides a simple example of the techniques for writing a User Command Interface program. This program accepts a command from the keyboard and passes it through to the TSX-Plus keyboard monitor if it is a legal command.

Example:

```
        .TITLE  MYKMON
        .ENABL  LC
;
;  Simple example of User Command Interface
;  Refuses to pass SET KMON SYSTEM, but otherwise does nothing but
;  pass commands thru to KMON.
;
        .MCALL  .PRINT,.EXIT,.GTLIN,.SCCA

JSW     = 44                    ;Job status word address
SPXIT$  = 40                    ;Special exit flag to pass command to KMON
MONPTR  = 54                    ;Pointer to base of RMON
SYSGEN  = 372                   ;Offset into RMON of SYSGEN options word

BEL     = 7                     ;ASCII bell
BS      = 10                    ;ASCII backspace
LF      = 12                    ;ASCII line feed
FF      = 14                    ;ASCII form feed
CR      = 15                    ;ASCII carriage return
ESC     = 33                    ;ASCII escape

        .DSABL  GBL             ;Disable undefined globals
START:  .SCCA   #AREA,#TTSTAT   ;Inhibit control-C abort
        MOV     @#MONPTR,R0     ;Get pointer to base of RMON
        TST     SYSGEN(R0)      ;Are we running under TSX?
        BPL     QUIT            ;Normal exit if not
        MOV     #TTYPE,R0       ;Point to EMT arg block to
        EMT     375             ;Get TSX-Plus terminal type
        ASL     R0              ;Convert to word offset
        CMP     R0,#4           ;Legal types are unknown, VT52 and VT100
        BLOS    1$
        CLR     R0              ;If not VT52 or VT100, make unknown
1$:     MOV     R0,R1           ;Save terminal type
        .PRINT  CLRSCR(R1)      ;Clear the screen
        .PRINT  #MENU           ;Display simple menu
        MOV     #SETRUB,R0      ;Point to EMT arg block to
        EMT     375             ;Set rubout filler character
2$:     .PRINT  CENTER(R1)      ;Move to screen center and clear the line
        .GTLIN  #BUFFER,#PROMPT ;Accept input line
        CALL    MATCH           ;See if it's legal
        BCS     2$              ;Repeat if illegal command
        MOV     #1000,SP        ;Ensure stack pointer safe
        CALL    MOVCMD          ;Move command from buffer to chain data area
        BIS     #SPXIT$,@#JSW   ;Set special chain exit bit in JSW
        CLR     R0              ;Required for special chain exit
QUIT:   .EXIT                   ;And pass command to KMON

;  Simple matching. Easy to defeat by inserting extra spaces!!!
```

```
MATCH:  MOV     #BUFFER,R2      ;Point to beginning of input buffer
        MOV     #ILLCMD,R3      ;Point to beginning of illegal command
1$:     TSTB    (R2)            ;At end of input string?
        BEQ     2$              ;Yes, matched so far, probably illegal
        CMPB    (R2)+,(R3)+     ;No, test through end of illegal string
        BNE     9$              ;No match, not illegal command
        CMP     R3,#ILLEND      ;Past end of illegal command?
        BLO     1$              ;No, keep checking
2$:     SEC                     ;Strings match, signal illegal command
        BR      10$
9$:     CLC                     ;Strings don't match, signal legal command
10$:    RETURN

;  Move command from input buffer to chain data area.

MOVCMD: MOV     #BUFFER,R2      ;Point to beginning of input string
        MOV     #512,R3         ;Point to chain data area
1$:     MOVB    (R2)+,R0        ;Get next char
        BNE     2$              ;Continue if not nul
        CLRB    (R3)+           ;If end of input command
        BR      9$              ; then done
2$:     CMPB    R0,#'\          ;Command separator?
        BNE     3$              ;No, move it
        CLRB    R0              ;Yes, replace with nul
3$:     MOVB    R0,(R3)+        ;Move command into chain data area
        CMP     R2,#BUFEND      ;Don't want to overflow
        BLO     1$              ;Keep moving if characters left
        CLRB    -1(R3)          ;Mark end of command (ensure it is ASCIZ)
9$:     SUB     #512,R3         ;How many bytes did we move?
        MOV     R3,@#510        ;Mark the number for .CHAIN
        RETURN

AREA:   .BLKW   10              ;GP EMT argument area
TTSTAT: .WORD   0               ;Terminal status word for .SCCA
TTYPE:  .BYTE   0,137           ;EMT arg block to get terminal type
SETRUB: .BYTE   0,152           ;EMT arg block to control terminal funtions
        .WORD   'A              ;Function code - set rubout filler
        .WORD   '_              ;Rubout filler = underline
CLRSCR: .WORD   CLRUNK,CLR52,CLR100     ;Terminal specific screen clears
CENTER: .WORD   CNTUNK,CNT52,CNT100     ;Terminal specific move and clear
        .NLIST  BEX
CLRUNK: .BYTE   FF,FF,FF,CR,200         ;Emulate clear screen with 3*(8LFs)
CLR52:  .BYTE   ESC,'H,ESC,'J,200       ;VT52 clear screen sequence
CLR100: .ASCII  <ESC>/[H/<ESC>/[J/<200> ;VT100 clear screen sequence
CNTUNK: .ASCII  <CR><LF><LF><LF>/     /<200>
CNT52:  .ASCII  <ESC>/Y% /              ;Line 6, column 1
        .ASCII  <ESC>/K/                ;Erase to end of line
        .ASCII  /     /<200>            ;Move to column 6
CNT100: .ASCII  <ESC>/[6;6f/            ;Line 6, column 6
```

```
        .ASCII  <ESC>/[2K/<200> ;Erase entire line
MENU:   .ASCII  <LF><LF><LF>/          *****     Simple Menu     *****/<200>
PROMPT: .ASCII  <BEL>/Command: _____________________________________/
        .NLIST
        .REPT   32.
        .BYTE   BS                      ;Backspace to beginning of field
        .ENDR
        .LIST
        .BYTE   <200>                   ;End of string
ILLCMD: .ASCII  /SET KMON SYSTEM/       ;Don't permit UCI disable
ILLEND:
BUFFER: .BLKB   81.                     ;Command line input buffer
BUFEND:
        .END    START
```

2.4 Keyboard Commands

The keyboard commands accepted by TSX-Plus are listed below. Because many commands are identical or very similar to those of RT-11, full descriptions are only provided for TSX-Plus specific commands and for differences between TSX-Plus and RT-11 commands. Users should consult the RT-11 System User's Guide for more information on keyboard commands.

The ACCESS Command

The ACCESS command is used to restrict user access to a particular set of files or devices. It is only valid in start-up command files. Logical device names may be used in lieu of physical device names. Refer to the TSX-Plus System Manager's Guide for further information about this command.

The ALLOCATE Command

The ALLOCATE command is used to temporarily request exclusive access to a device. Use of this command requires ALLOCATE privilege. The form of the ALLOCATE command is:

ALLOCATE ddn[,ddn...] [lnm]

where ddn is the name of an allocatable device and lnm is an optional logical name to be assigned to the first device in the allocation list. Note that more than one device may be allocated with this command, but only the first may also be assigned a logical name in the same command. The device names ddn may also be substituted by previously assigned logical names. If an error occurs on the allocation of one device, an error message is printed and the system will continue to attempt to allocate any other specified devices. The most commonly used form of this command specifies a single device to be allocated and does not include a logical assignment. For example:

ALLOCATE MT0:

If no device names are specified, the command is equivalent to SHOW ALLOCATE.

While a device is allocated by one user, access to that device is restricted exclusively to the user who allocated it; no one else will be allowed to open files on that device, to mount the device for directory caching, or to mount logical subset disks on that device. Conversely, a device cannot be allocated while any other user has that device mounted or a file open on that device. The maximum number of devices which may be simultaneously allocated by all users combined is determined during system generation. All devices allocated by a job are deallocated when that job logs off. See the DEALLOCATE command for more information on device deallocation. The SHOW ALLOCATE command may be used to determine which devices are currently allocated by any user.

All jobs associated with a primary time-sharing line (the primary line and any subprocesses) have access to a device allocated by any other job associated with the same primary line. When a job connected to a primary line allocates a device, it overrides any allocation of the same device by a subprocess associated with that primary line. If two subprocesses associated with the same primary line attempt to allocate the same device, then the first allocation takes precedence.

Devices which are partitioned into multiple units may be allocated on a unit-by-unit basis. For example, allocating DL1 has no effect on use of DL0 by others; similarly, allocating CL0 has no effect on CL1. Only real devices may be allocated (those which are serviced by device handlers and CL). You cannot allocate the system device (SY:), the pseudo-device TT:, or any logical subset disks (LDn:).

Device allocation is useful when performing operations which have no other convenient mechanism for preventing disruptive interaction by multiple users. For example, if CL0 is attached to a communication port, undesirable confusion can arise if two users attempt to use the VTCOM program through CL0 at the same time. This can be overcome by allocating CL0 before running the VTCOM program. Another use for device allocation might be to prevent excessive rewinding delays when copying multiple files from magnetic tape while another user also attempts to access the same tape unit. It might even be desirable to allocate a removable device while it contains sensitive information.

The following example lists a command file which shows how the ALLOCATE command can be used to prevent conflicts in use of a communication line:

```
SET CL0 LINE=6      !Take over time-sharing line
SET CL0 NOLFOUT     !Inhibit line feed transmission
ASS CL0 XL          !Assign for VTCOM
ALLOCATE XL         !Prevent multi-user collisions
R VTCOM             !Part of RT-11 5.01 distribution
DEALLOCATE XL       !Let others use CL0
DEASS XL            !Clean up assignment
SET CL0 LINE=0      !Re-enable time-sharing line
```

The ASSIGN Command

The ASSIGN command is used to associate a logical I/O device name with a physical device. To simply assign a logical device name to a physical device, the form of the ASSIGN command is the same as that under RT-11:

```
ASSIGN ddn lnm
```

or

```
ASSIGN ddn=lnm
```

where ddn is the physical device and unit specification (or another logical name previously assigned to a physical device) and \lnm is a logical name (up to three characters long) by which the physical device may be referenced.

For example, to assign the logical device name "BIN" to physical device "DX1" the command would be:

```
ASSIGN DX1 BIN
```

The following command would assign logical device "BIN" to a file named "PROG1" on the system device:

```
ASSIGN SY:PROG1=BIN
```

It is also possible under TSX-Plus to assign a new logical name to a previously assigned logical name. The effect is to assign the new logical name to the same physical device to which the previous assignment was directed. For example, the following sequence of ASSIGNs result in both logical devices "AA" and "BB" being assigned to "DL1".

```
ASSIGN DL1 AA
ASSIGN AA BB
```

The ASSIGN command is frequently used to assign FORTRAN I/O logical unit numbers to selected devices. To assign FORTRAN I/O logical unit number 1 to the terminal, the command would be:

```
ASSIGN TT 1
```

The TSX-Plus ASSIGN command provides a useful extension. In addition to being able to specify a physical device name, the user may specify a file name, extension, and size. If a file name and optional size are specified in addition to the physical device name, the file name and size follow the device name. For example, the following command assigns FORTRAN I/O logical unit number 1 to a file named "PAYROL" on device "DX0" with a size of 43 blocks:

```
ASSIGN DX0:PAYROL[43]=1
```

A maximum of twenty-five assignments may be in effect at any given time for each user.

The BACKUP Command

The TSX-Plus BACKUP command has the same form and options as the RT-11 BACKUP command. Use of this command requires NFSREAD privilege.

The BOOT Command

The BOOT command attempts to abort TSX-Plus and reboot RT-11. Due to the variations in hardware and bootstrap ROMs, this command is unsupported. The BOOT command may either reboot RT-11 on your system or simply halt depending on your particular hardware configuration. Unlike the RT-11 BOOT command, no device or file name may be specified with the TSX-Plus boot command; BOOT always attempts to reboot from the system (SY) device. OPER privilege is required to use this command. The BOOT command is equivalent to the $STOP command.

The BYE Command

The BYE command is used to log off a time-sharing line. It is equivalent to the OFF command.

The COBOL Command

The COBOL command is used to compile a COBOL source program using the COBOL-Plus compiler. COBOL-Plus, a product of S&H Computer Systems, Inc., is sold separately. The default extension for COBOL source programs is "CBL"; the default extension for COBOL object files is "CBJ". The COMPILE, LINK and EXECUTE commands may also be used to compile and execute COBOL programs. TSX-Plus will implicitly invoke the COBOL-Plus compiler and CBLINK link program if the source program has the extension "CBL" or the object program has the extension "CBJ". Switches that can be used with the COBOL command are listed below.

Switch	Meaning
/ALLOCATE:size	Specify size of list or object file.
/ANSI	Produce warning messages for non-ANSI feature use.
/CARD	Source program is in card sequence format.
/CREF	(Equivalent to /CROSS).
/CROSS	Produce a cross-reference of the source program.
/DCARDS	Compile lines with "D" in the indicator field.
/INFORMATION	Print additional information at compilation end.
/LINENUMBER	Enable source line information in object listing.
/LIST[:name]	Produce a source program listing.
/NARROW	Format the cross-reference for 80 column display.
/OBJECT[:name]	Specify name of object file.
/ONDEBUG	Compile the program for use with the debugger.
/PRODUCTION	Omit line number tracing and subscript checking.
/RM	Compile RM/COBOL(*) programs.
/SEQUENCE	(Equivalent to /CARD).
/SUMMARY	Print only error messages on listing device.
/WARN	Suppress warning messages.

See the COBOL-Plus reference manual for further information about the COBOL command.

* RM/COBOL is a trademark of Ryan-McFarland Corporation.

The COMPILE Command

The COMPILE command invokes the appropriate language processor to compile the specified source file. The TSX-Plus COMPILE command is the same as the RT-11 COMPILE command except that it also recognizes programs with the extension "CBL" as COBOL source programs and calls the COBOL-Plus compiler. When compiling a COBOL program, the switches that are legal with the COBOL command may also be used with the COMPILE command. It is also possible to explicitly specify that the COBOL-Plus compiler is to be called by using the "/COBOL" switch with the COMPILE command. The default compiler for files with the extension "DBL" is DBL; this may be changed with the SET LANGUAGE command.

The COPY Command

The TSX-Plus COPY command has the same form and options as the RT-11 COPY command. Use of this command requires NFSREAD privilege.

The CREATE Command

The TSX-Plus CREATE command has the same form and options as the RT-11 CREATE command. Use of this command requires NFSREAD privilege.

The DATE Command

The TSX-Plus DATE command has the same form and options as the RT-11 DATE command. OPER privilege is required to set the date.

The DEALLOCATE Command

The DEALLOCATE is used to release a temporary exclusive access restriction initiated by an ALLOCATE command for a device. This allows other users to again access the specified device. This command has three forms:

```
DEALLOCATE ddn[,ddn...]

DEALLOCATE              }
                        } (equivalent commands)
DEALLOCATE/ALL          }
```

where ddn is the name of the device to be released. Logical device names may be used in lieu of the physical device names. Individual devices may be deallocated with the first form of the command. Individual devices allocated from the primary line or any other subprocess associated with the same primary line may be deallocated from the primary or any other subprocess associated with the same primary line. The second and third, non-specific, forms of the command are equivalent. All devices allocated by a job may be deallocated with a non-specific form of the command. However, this only affects devices allocated from the same primary or subprocess issuing the DEALLOCATE command. Devices allocated from other lines, even those associated with the same primary line, are not deallocated by non-specific forms of the DEALLOCATE command.

When a subprocess logs off, any devices allocated from that same subprocess are automatically deallocated, while those allocated from the primary line or a different subprocess are not deallocated. When a primary line logs off, any devices allocated from it or any of its associated subprocesses are automatically deallocated.

Logical names assigned to a device by using the ALLOCATE command are not deassigned by the DEALLOCATE command. See also the ALLOCATE and the SHOW ALLOCATE commands.

The DEASSIGN Command

The TSX-Plus DEASSIGN command is equivalent to the RT-11 DEASSIGN command. It is used to dissociate a logical unit assignment.

The DEFINE KEY Command

The DEFINE KEY command is used to specify a terminal key substitution. User defined keys cause a specified string to be substituted for a named key when that key is typed. Key substitutions are performed by the single line editor; hence, substitutions are only done on terminal input processed by the single line editor. Key definitions are inherited from the primary process when a subprocess is initiated. See Chapter 1 for more information on the single line editor and user defined keys.

The form of this command is:

DEFINE KEY[/qualifiers] key "string"

where key is the name of the key that is associated with the string. The substitution string may be up to 64 characters long.

The following table lists key names which may be used:

Key name	Actual key
The following keys may only be defined in KED mode	
KP0,KP1,...,KP9	digits 0 to 9 on numeric keypad
PERIOD	period key (.) on numeric keypad
COMMA	comma key (,) on numeric keypad
MINUS	minus key (-) on numeric keypad
ENTER	ENTER key on numeric keypad
The following keys are not affected by KED mode	
PF1,PF2,PF3,PF4	PF1,PF2,PF3,PF4
UP	up-arrow key
DOWN	down-arrow key
LEFT	left-arrow key
RIGHT	right-arrow key
FIND	"Find" key on VT200
INSERT	"Insert here" key on VT200
REMOVE	"Remove" key on VT200
SELECT	"Select" key on VT200
PREV	"Prev screen" key on VT200
NEXT	"Next screen" key on VT200
HELP	"Help" key on VT200
DO	"Do" key on VT200
F6,F7,...,F20	Function keys on top row of VT200

For example, the following command associates the SHOW TIME command with the PF2 key:

```
DEFINE KEY PF2 "SHOW TIME"
```

If the associated string contains no leading or trailing spaces and no control characters, the quotation marks may be omitted.

The following qualifiers can be used with the DEFINE KEY command:

/[NO]ECHO — Determines whether the substitution string will be printed at the terminal at the time the substitution takes place. The default mode is /ECHO.

/[NO]TERMINATE — Determines whether a carriage-return and line-feed are appended to the end of the substitution string when it is substituted. Use /NOTERMINATE with a definition that specifies a part of a command. The default mode is /TERMINATE. You may not specify /NOECHO and /NOTERMINATE

together. For example, the following definition associates the PF2 key with the word HELP followed by one space, without termination:

```
DEFINE KEY/NOTERMINATE PF2 "HELP "
```

/[NO]GOLD — Determines whether the specified key must be prefixed by the "gold" (PF1) key. If /GOLD is specified then the substitution only takes place if you type the PF1 key followed by the specified key. If /NOGOLD is specified (the default case) then the substitution takes place when the specified key is pressed without being prefixed by the PF1 key. "/GOLD" definitions are not available if the PF1 key itself has been assigned a key definition. The following two definitions associate the SHOW TIME command with the unprefixed PF2 key and the SHOW DATE command with the two key combination PF1 PF2:

```
DEFINE KEY PF2 SHOW TIME
DEFINE KEY/GOLD PF2 SHOW DATE
```

/LETTER — Specifies that the key being defined is not a function key, but is a key such as a letter, digit, or punctuation mark which is part of the typewriter portion of the keyboard. If /LETTER is specified, then key must be a single letter from the non-function-key portion of the keyboard. The /GOLD qualifier may be used in conjunction with /LETTER to cause the substitution to take place only if the specified letter is prefixed by the PF1 key. The default mode is /NOLETTER. For example, the following commands cause a pound sign (#) to be substituted for the dollar sign ($) and the SHOW JOBS command to be substituted for the "PF1 dollar-sign" combination:

```
DEFINE KEY/LETTER/NOTERMINATE $ #
DEFINE KEY/LETTER/GOLD $ SHOW JOBS
```

A key definition is removed by using a DEFINE KEY command with no substitution string. Thus, to remove the PF2 key definition use the following command:

```
DEFINE KEY PF2
```

Deleting or redefining a substitution for a letter which has already been defined requires that key substitution be turned off first. Otherwise, the defined string is substituted for the letter as the DEFINE KEY command is typed. If you need to delete or redefine a letter substitution, issue the SET SL NOSUBSTITUTE command to turn off substitutions, then use the DEFINE command, then SET SL SUBSTITUTE.

If you define substitutions for any of the keys of the numeric keypad other than the PF keys, the single line editor must be in KED mode (SET SL KED).

To include control characters in a key definition string, enclose the substitution string in quotation marks and type a caret (^) in front of the letter that is to be a control character. Control characters in substitution strings only count as one character, even though two characters are required to specify them. For example, the following command defines numeric keypad key 0 (zero) as control-U (SL must be in KED mode):

```
DEFINE KEY/NOTERMINATE KP0 "^U"
```

If the DEFINE KEY command is placed within a command file, two caret characters must be specified to denote each control character because command file processing translates two consecutive caret characters into a single caret. Thus, if the previous DEFINE KEY command were placed in a command file, it would be written as:

```
DEFINE KEY/NOTERMINATE KP0 "^^U"
```

You may specify a key definition for a key which is normally used to perform some single line editor function (e.g., up arrow). When this is done, the key definition takes precedence over the normal function.

It is possible to define a key with a control-W digit sequence to cause a switch to a subprocess. However, this is less powerful than actually typing control-W digit because the switch with a defined key can only be used at a time when the single line editor is accepting input, not when a program is executing. The following key definition defines PF2 to switch to subprocess one:

```
DEFINE KEY/NOTERMINATE PF2 "^W1"
```

If a defined key appears not to be working, first verify that the definition is correct with the SHOW KEYS command. Then, use the SHOW SL command to verify that key substitution is in effect and that KED mode is enabled for numeric keypad keys.

The PI handler which controls the console terminal on a Professional, normally provides VT100 support for the console terminal, not VT200. Thus, the function keys on the top row and the "Do", "Help", etc. keys may not be defined. However, it is possible to enable the Pro console for VT200 compatible operation by sending it the control sequence "<ESC>[?39h". These keys may then be defined.

The DELETE Command

The TSX-Plus DELETE command has the same form and options as the RT-11 DELETE command. Use of this command requires NFSREAD privilege.

The DETACH Command

The DETACH command is used to initiate execution of a command file as a "detached" job, to check the status of a detached job, or to abort a detached job. The system manager may restrict the use of this command. The process which initiates a detached job is known as the "parent" of the detached job; this makes it possible for the detached job to send a message to its "parent" without knowing its line number.

Use of the command to start a detached job requires DETACH privilege. The form of the command used to start a detached job is:

DETACH file [parameters]

where file is the name of a command file which is to be started as a detached job; parameters is any optional text to be passed to the detached command file. See Chapter 3 for more information on passing parameters to command files. The total length of the command beyond the DETACH keyword (including the name of the command file, parameters, and blank space) must not exceed 80 characters. The default command file extension is ".COM". If a free detached-job line is available, the system starts the command file and prints a message indicating the detached job line number used. Detached-job lines must be declared during TSX-Plus system generation.

Detached jobs inherit the full context of the process from which they are started. See Chapter 4 for more information on detached jobs. In addition, programs running as detached jobs may also use the TSX-Plus EMT to acquire a job's file context - see Chapter 7.

In the following example a command file named "SY:CRUNCH.COM" is started as a detached job with the name of a data file passed as a parameter on the command line.

```
DETACH SY:CRUNCH DL2:DATFIL.DAT
```

Terminal output for detached jobs is normally discarded since they are not attached to any terminal. However, it is possible to collect the terminal output from a detached job by sending it to a log file. This can be done by using the SET LOG FILE=filnam command in the detached job command file. See the SET LOG command for more information on terminal output logging.

The DETACH/CHECK command is used to check the status of a specified detached job line. (The SYSTAT command also provide information on detached jobs.) For example, if a detached job is executing on line number 5:

```
DETACH/CHECK 5
```

Use of the command to kill a detached job requires DETACH privilege. Appropriate SAME, GROUP or WORLD privilege is also required to kill an unrelated detached job depending on the project-programmer number of the issuing and target jobs; these are not required for a "parent" to kill a "child" detached job. WORLD privilege is required to kill a detached job started as a result of the DETACH macro declared during system generation. The DETACH/KILL command is used to abort a detached job. (The KILL command may also be used to abort a detached job.) For example:

```
DETACH/KILL 5
```

The DIBOL Command

The DIBOL command is used to compile a DIBOL or DBL source program. The default compiler for programs with the extension "DBL" is DBL. This may be changed with the SET LANGUAGE command. The TSX-Plus DIBOL command has the same form and options as the RT-11 DIBOL command, except that the options /BUFFERING, /LOG, /PAGE and /TABLES are not supported. Because of differences between compiler switch options, DIBOL switches are not supported for use with DBL.

The DIFFERENCES Command

The DIFFERENCES command is used to compare two files. The TSX-Plus DIFFERENCES command has the same form and options as the RT-11 DIFFERENCES command.

The DIRECTORY Command

The TSX-Plus DIRECTORY command has the same form and options as the RT-11 DIRECTORY command. Use of this command requires NFSREAD privilege.

The DISMOUNT Command

The DISMOUNT command has three functions: 1) it tells TSX-Plus to stop directory caching on a particular device; 2) it tells the system to stop doing data caching on a device; 3) it dissociates a logical subset disk from its assigned file. The form of the DISMOUNT command is:

```
DISMOUNT ddn
```

where ddn is the real or logically assigned name of the device.

If the device is a physical device or a logical name for a physical device, then the DISMOUNT command removes the current job's entry from the mount table for that device. If no other jobs have mounted the device, then directory and data caching for that device are stopped. Files on a physical device may still be accessed after it is DISMOUNTed, but access may be slower since the directory is no longer cached. Note however, that if a job accesses a device which it has not mounted, and another user INITIALIZEs or SQUEEZEs that device, then reads will probably return garbage and writes will probably corrupt other files. ALWAYS MOUNT ANY DIRECTORY STRUCTURED DEVICE WHICH YOU INTEND TO USE!

The INITIALIZE and SQUEEZE operations cannot be performed on a device which is mounted by other users. If it is necessary to INITIALIZE or SQUEEZE a device which is mounted by other users, then they must first DISMOUNT that device. Remember that it is still possible for a job which has not mounted a device to access that device. After a device is INITIALIZEd or SQUEEZEd, then the directory and data caches are cleared for that device and if it is still mounted, then caching is resumed. Caching is not resumed if all jobs have DISMOUNTed a device until some job reMOUNTs that device. The following information message is printed if a device is dismounted and the device is still mounted by other users:

```
?KMON-I-Device is still mounted by other users
```

The SHOW MOUNTS command may be used to determine which jobs have devices mounted.

In the case of logical subset disk assignments ("ddn" = LD0-LD7 or logical names assigned to them), the effect of the DISMOUNT command is to stop directory caching on the logical subset disk as described above and to remove the device from the logical subset disk tables. In this case, files on the logical subset disk are no longer accessible until the logical subset disk is re-mounted. This form of the command only affects the logical subset disks belonging to the user who issues the command. If another job has mounted the same logical subset disk, then the rules for physical devices with regard to INITIALIZE and SQUEEZE also apply to the logical subset disk.

The DISPLAY Command

The DISPLAY command is used within a command file or user-defined command to cause a line of text to be displayed on the terminal when the command is executed. This is useful in command files that are not being listed to keep track of progress through the command file. The form of the DISPLAY command is:

DISPLAY comments

where comments can be any text string to be displayed on the terminal. See the section on user-defined commands in this chapter and see Chapter 3 for more information on command files.

The DUMP Command

The TSX-Plus DUMP command has the same form and options as the RT-11 DUMP command.

The EDIT Command

The TSX-Plus EDIT command has the same form and options as the RT-11 EDIT command. The editor which is invoked by this command is selected during system generation or with the SET EDIT command.

The EXECUTE Command

The TSX-Plus EXECUTE command has the same form and options as the RT-11 EXECUTE command. It also recognizes programs with the extension "CBL" as COBOL source programs and automatically invokes the COBOL-Plus compiler and linker. Switches appropriate when using the COBOL-Plus compiler and linker are also valid with EXECUTE. See also the COBOL, COMPILE, DIBOL, FORTRAN, LINK and MACRO commands.

The FORM Command

The FORM command is used to specify the default form name for subsequent files sent to the spooler by the user. The form of the FORM command is:

FORM name

where name is the one to six character default form name to be used for all files sent to the spooler until another FORM command is issued. The form name is converted internally to upper case. The initial default form name is "STD". A form may also be requested within a file sent to the spooler. See Chapter 5 for more information on spooled devices and forms.

In the following example a FORTRAN listing will be generated for printing on a form called "2-PART".

```
FORM 2-PART
COMPILE/LIST TEST.FOR
FORM STD
```

The FORTRAN Command

The TSX-Plus FORTRAN command has the same form and options as the RT-11 FORTRAN command.

The HELP Command

The TSX-Plus HELP command has the same form and options as the RT-11 HELP command.

The INITIALIZE Command

The TSX-Plus INITIALIZE command has the same form and options as the RT-11 INITIALIZE command. However, the system device (booted device when TSX-Plus is started) may not be initialized when running TSX-Plus. If it is necessary to initialize the system device, it must be done under RT-11. The resulting error message is:

```
?KMON-F-This operation not legal with SY (system) device
```

Use of the INITIALIZE command requires NFSWRITE privilege and may also require SPFUN privilege for some devices.

A device cannot be initialized if any other user has allocated the device. Attempts to INITIALIZE a device allocated by another user will result in an error message like:

```
?KMON-F-Device is allocated to job 14
```

The SHOW ALLOCATE command may also be used to determine the job numbers which have allocated any devices. Note that a device allocated from another subprocess started from the same primary line is not protected in this manner.

A device cannot be initialized if any other user has MOUNTed the device. Attempts to INITIALIZE a device which is mounted by another user will result in the error message:

```
?KMON-F-Device is mounted by another user
```

If the device is only mounted by the job which initializes it, then the directory and data caches are cleared after the operation and caching is resumed. The SHOW MOUNTS command may be used to determine which other users have mounted a device. However, remember that is still possible for a job which has not mounted a device to access that device. If such a job has a file open before you initialize, then severe problems can arise. Great circumspection is necessary before initializing a device in a multi-user environment. Do not initialize rashly. As a defensive measure, always MOUNT any disk device which you plan to use.

If terminal output logging is being done (see the SET LOG command) and the log file is open on the device being initialized, then the log file is closed before the device is initialized and the following warning message appears:

```
?KMON-W-Closing log file
```

The INSTALL Command

The INSTALL command is used to enable certain programs to be executed with special characteristics or privilege. It is NOT equivalent to the RT-11 INSTALL command which is used to enter device handler information in system tables. See the TSX-Plus System Manager's Guide for more information on the INSTALL command. Use of the INSTALL command requires SYSPRV privilege.

The KILL Command

The KILL command is used to abort a time-sharing job on another line. This has the effect of aborting the execution of the job and forcing the logoff of the line. SAME, GROUP or WORLD privilege is required to use the KILL command, depending on the project,programmer numbers of the issuing and target jobs. The form of this command is:

```
KILL line-number
```

where line-number is the number of the job to be killed.

The KJOB Command

The KJOB command is used to log off a time-sharing line. It is equivalent to the OFF command.

The LIBRARY Command

The TSX-Plus LIBRARY command has the same form and options as the RT-11 LIBRARY command. It also can be used to build COBOL-Plus object program libraries; see the COBOL-Plus Reference Manual for further information.

The LINK Command

The TSX-Plus LINK command has the same form and options as the RT-11 LINK command. It also recognizes object files with the extension "CBJ" as COBOL-Plus object files and then invokes the COBOL-Plus link program (CBLINK). The COBOL-Plus linker may also be explicitly specified with the "/COBOL" switch. See the COBOL-Plus Reference Manual for further information. Switches which are unique to COBOL-Plus are:

Switch	Meaning
/NOPAGE	Do not swap data segments.
/NOSHARED	Do not use shared COBOL-Plus run-time library.
/SHARED	Always use shared COBOL-Plus run-time library.
/SIZE	Report the size of the largest data segment.
/VM	Use VM for run-time and program segmentation.
/XM	Load entire program and run-time into extended memory.

The LOGOFF Command

The LOGOFF command is used to log off a time-sharing line. It is equivalent to the OFF command.

The MACRO Command

The TSX-Plus MACRO command has the same form and options as the RT-11 MACRO command.

The MAKE Command

The MAKE command is used to create a new file with the TECO editor. It is equivalent to the RT-11 MAKE command.

The MEMORY Command

The MEMORY command is used to control the amount of memory available to a job. When a job initially "logs on" it receives a default memory allocation set by the system manager. The MEMORY command can be used to change the allocation for the job. Use of the MEMORY command to change a job's memory allocation is not valid if the system has been generated to disallow job swapping. The form of the MEMORY command is:

MEMORY nn

Where nn is the number of k-bytes (Kb, 1024. bytes) of memory to be allocated for the job. The maximum memory size that a job may use is set by the system manager, but never exceeds 64 Kb. When a running program performs a .SETTOP EMT the top of memory address corresponds to the size last specified by a MEMORY command. Note that .SETTOP EMT's do not actually affect the amount of memory allocated to a job -- only the MEMORY command and a TSX-Plus EMT described in Chapter 7 do that.

If the MEMORY command is entered without specifying a size, the current and maximum memory allocation for the job is displayed. See also the description of the SHOW MEMORY command.

Programs are only allowed to use more than 56Kb of memory if they are "virtual", meaning they do not directly access the RMON area, although they may still access it indirectly by use of the .GVAL and .PVAL EMT's. Programs may indicate that they are virtual by any of the following techniques:

1. Set bit 10 (mask 2000) in the job status word (location 44) of the SAV file. See Appendix A for information about how the SETSIZ program can be used to do this.

2. Use the /V LINK switch (/XM switch for the LINK keyboard command) which stores the RAD50 value for "VIR" in location 0 of the SAV file.

3. Store a memory allocation size greater than 56Kb in location 56 of the SAV file. See Appendix A for information about how the SETSIZ program can do this.

If none of these conditions is met the program is restricted to 56Kb even if a larger value is specified with the MEMORY command. See Chapter 8 and Appendix A for more information on memory usage and virtual images.

A program may dynamically control the amount of memory allocated for the job by use of the TSX-Plus EMT with function code 141 (described in Chapter 7). See also the description of the SETSIZ program in Appendix A for information about how the amount of memory to be allocated for a particular program can be stored in the SAV file for the program.

The MONITOR Command

The MONITOR command is used to cause TSX-Plus to begin a performance analysis. See Chapter 13 for complete information about the TSX-Plus performance analysis feature. The form of the MONITOR command is:

MONITOR base-address,top-address[,cell-size]/switches

where base-address is the lowest address in the program region being monitored, top-address is the highest address in the region, and cell-size is the number of bytes to group per histogram cell. The only valid switch is "/I" which causes I/O wait time to be included in the analysis.

The MOUNT Command.

The MOUNT command is used to: 1) begin directory caching on a file-structured device; 2) enable data caching on a device; and 3) associate a logical subset disk with a disk file.

Directory caching is a technique that speeds up file "lookups" by keeping information about files in memory so that it is not necessary to access the directory on the device each time a file is opened. Data caching is a technique used to speed up disk reads by keeping memory resident copies of recently used file blocks. Both directory and data caching are enabled during TSX-Plus system generation and activated when a device is MOUNTed. The form of the MOUNT command to activate directory and data caching is:

MOUNT ddn

where ddn is a physical device name such as "DL1:". The effect of this type of MOUNT command is to tell TSX-Plus that it should begin directory and data caching for the device being mounted. The system device is automatically MOUNTed for each user. If caching is not wanted, then no MOUNT should be performed, or the DISMOUNT command should be used to halt caching on a previously mounted disk. If the device being mounted is allocated by another user, then the system will report an error similar to:

?KMON-F-Device is allocated to job 12

The INITIALIZE and SQUEEZE operations cannot be performed on a device which is mounted by other users. If it is necessary to INITIALIZE or SQUEEZE a device which is mounted by other users, then they must first DISMOUNT that device. Remember that it is still possible for a job which has not mounted a device to access that device.

Once a MOUNT command is issued, caching is enabled for all users who access files on the device (including users who have not MOUNTed the device). The system maintains a table of all users who have mounted each device. See also the DISMOUNT and SHOW MOUNTS commands.

Warning: If directory caching is enabled for a device, it is crucially important that the DISMOUNT command be used to dismount the device before a disk is replaced on the same drive. If a new disk pack is inserted in the drive without issuing the DISMOUNT command, TSX-Plus would try to access files on the new pack according to the locations stored in the directory cache for the old pack.

Directory caching causes a dramatic improvement in the speed of file "lookups" but does not speed up file "enters", "deletes" or "renames". This is because TSX-Plus always updates the directory on the device when it is altered. The maximum number of devices whose directories may be cached and the number of file entries that are kept in the directory cache are specified when TSX-Plus is generated.

The second form of the MOUNT command is used to associate a logical subset disk with a disk file. The form of the command is:

MOUNT[/[NO]WRITE] LDn filnam [logical-name]

where LDn is the logical subset disk, and n is in the range 0-7, filnam is the name of a disk file containing the subset directory and files, and logical-name is an optional logical name to be assigned to the logical subset disk. The [NO]WRITE option controls access to the logical subset disk. WRITE allows full access, whereas NOWRITE allows read-only access. WRITE access is allowed by default unless the NOWRITE option is used. The default extension for the disk file to be associated with a logical subset disk is "DSK". File protection is automatically set on the file specified to be a logical subset disk. When a logical subset disk is mounted, directory and data caching are also begun for it. If the device which holds the file to be mounted as a logical subset disk is allocated to another job, then the following error will be reported:

?KMON-F-File not found

Each user may mount up to 8 logical subset disks at any time. The association between a logical subset disk (LD0-LD7) and a file is "local" to each user. For example, one user may associate her LD2 with file DL1:MYDISK.DSK while a different user associates his LD2 with file DL1:YORDSK.DSK.

Logical subset disks may be "nested", allowing one or more subsets to be defined within other subsets. However, if this is done, the MOUNT commands must be executed sequentially from outer-most to inner-most logical subset disk and the unit numbers must be assigned sequentially from LD0 to LD7.

Example:

```
MOUNT LD0 MANUAL MAN
CREATE LD0:SUB.DSK/ALLOCATE:100.
MOUNT/WRITE LD2 MAN:SUB
INIT/NOQ LD2:
```

Other commands which refer to logical subset disks are: DISMOUNT, SET LDn {CLEAN|WRITE|NOWRITE} and SHOW SUBSETS. The ACCESS command may also be used with logical subset disks in start-up command files. The restrictions on INITIALIZE and SQUEEZE operations also apply when another user has mounted the same logical subset disk.

Logical subset disk support is integral to the file management functions of TSX-Plus, and does not require the "LD" pseudo-device handler. See Appendix G for more information on the use of logical subset disks.

The MUNG Command

The MUNG command is used to start a file of TECO commands. The MUNG command is equivalent to the RT-11 MUNG command.

The OFF Command

The OFF command is used to log off a time-sharing line, and to release a subprocess (see the discussion of process windows in Chapter 1). The accumulated connect time and CPU time used during the session are printed during the logoff processing. The BYE, KJOB and LOGOFF commands are synonyms for the OFF command. TSX-Plus automatically logs off dial-up lines if the telephone connection is broken. A special log-off command file may also be designated to execute whenever a job logs off; see the TSX-Plus System Manager's Guide for more information.

Example:

```
.OFF

Connect time=01:43:00  CPU=00:12:03
```

The OPERATOR Command

The OPERATOR command is used to send a message to the operator's console. The OPERATOR command works like the SEND command, but it is not necessary to know the line number of the operator's terminal. This command is equivalent to the SEND,OPERATOR command. Use of this command requires SEND privilege. The form of the OPERATOR command is:

```
OPERATOR message
```

For example, to send a disk mount message to the operator:

```
OPERATOR PLEASE MOUNT PAYROLL MASTER DISK ON RK1
```

The PAUSE Command

The PAUSE command is used within command files (see Chapter 3) to temporarily suspend processing of the file. The form of the PAUSE command is:

PAUSE comments

where comments may be any string of characters. When a PAUSE command is encountered within a command file, the PAUSE command is printed on the terminal followed by ">>". Execution of the command file is suspended until carriage return is pressed. This gives the operator an opportunity to perform manual operations such as mounting disks or tapes.

The PRINT Command

The TSX-Plus PRINT command has the same form and options as the RT-11 PRINT command. Use of this command requires NFSREAD privilege.

The PROTECT Command

The TSX-Plus PROTECT command has the same form and options as the RT-11 PROTECT command.

The R Command

The "R" command is used to start a program. The form of the command is:

R[/switch] filnam [input-data]

If no device name is specified with the program name, TSX-Plus attempts to find the specified program on "SY:". The amount of memory available to a program can be controlled with the MEMORY command, or size information can be included in its disk image. See the description of the SETSIZ program in Appendix A for more information about how the amount of memory allocated for a program may be controlled. See also Chapter 8 for more information on the operating environment for programs under TSX-Plus.

A line of input may be passed to a program by specifying it as part of the "R" command following the program name. If this is done the program will receive the text string as its first line of input and will receive control-C as its second line of input. (See example 2 below.) Note that only programs which accept input with the .GTLIN, .CSISPC, and .CSIGEN requests can accept input in this manner. Single character input (.TTYIN) does not normally accept data from a command line; however, the program can be invoked with a command file and accept all terminal input from the command file - see the section on command file control characters in Chapter 3. Note also that text passed on the command line to be accepted by the program via a .GTLIN request will be

reorganized if it contains multiple words separated by spaces. The first word will be placed as the input to a CSI command string and the remainder of the line will be placed on the output side of the equal sign. (See example 7 below.) The unscrambled input parameters are available in the chain data area as in RT-11.

The valid switches for the R (and RUN) command are:

```
/BYPASN         -- Run program without logical device assignments
/DEBUG          -- Run program under debugger control
/HIGH           -- Run program in high efficiency TTY mode
/IOPAGE         -- Run program with PAR 7 mapped to I/O page
/LOCK           -- Lock program to line
/MEMLOCK        -- Run program in low memory
/NONINTERACTIVE -- Run program in non-interactive mode
/ODT            -- Equivalent to /DEBUG
/SINGLECHAR     -- Run program with single-character activation
/TRANSPARENT    -- Run program in "transparent" terminal mode
```

All switches can be abbreviated to a single character.

Note that the functions of these switches are also available to installed programs. See the TSX-Plus System Manager's Guide for more information on installed programs and the INSTALL command.

The /BYPASN switch causes all logical device references to be ignored while the program is running. This includes any reassignment of SY and DK which will be directed to the system disk (device from which RT-11 was booted). Programs run with the /BYPASN switch must not access any logical device names (other than SY and DK which are directed to the system device). Only physical device names should be used. The following example shows a potential effect of bypassing logical device assignments:

```
.RUN SRT:TEST
*SRT:TEST.SAV
.RUN/BYPASN SRT:TEST
*SRT:TEST.SAV
?CSI-F-Cannot find file
*^C
```

The /DEBUG switch causes the program being started to execute under control of the TSX-Plus program debugging facility. Use of this switch requires DEBUG privilege. Note that the debugger is a system generation option which must be included in order to use the debugging facility (see your System Manager). Since the debugger does not share memory space with the program being debugged, there are no restrictions on the size of program which can be debugged. It is not necessary to link the debugger with the program being debugged, although a link map of the program is essential to make effective use of the debugger. When a program is started under the debugger, the program is loaded and control is passed to the debugger. At this point, the starting address of the program

is loaded into R0 and the debugger is set in such a way that the ";G" command will begin execution of the program. Execution of a program under debugger control may be interrupted as though a break point had been hit by typing a control-D (see the SET CTRLD DEBUG command). If you wish a program to stop at a break-point caused by execution of a BPT instruction included in the program image, then DO NOT run the program with the /DEBUG switch. Debugger commands are similar to those of RT-11 ODT. See Appendix I of this manual for more information on the TSX-Plus program debugger.

The /HIGH switch automatically enables the program to use high efficiency terminal I/O. This disables much of the character testing done during terminal operations and can increase terminal throughput. See the description of the "R" program controlled terminal option in Chapter 6 for more information on high efficiency terminal mode.

The /IOPAGE switch causes PAR 7 for a program (virtual addresses in the range 160000 to 177777) to be mapped to the physical I/O page. Use of this switch requires MEMMAP privilege. Under TSX-Plus a program usually has PAR 7 mapped to a simulated RMON; this allows old programs which directly access RMON fixed offsets to operate without being rewritten. However, when PAR 7 is mapped to a simulated RMON, access to hardware control registers in the I/O page is not allowed without special coding. When a program is started with the /IOPAGE switch, then direct I/O page access is possible without recoding; however, direct RMON access is not available. See Chapter 8 for more information on the TSX-Plus job environment. See Chapter 11 for more information on special system service calls which can be used to control job virtual address mapping, especially RMON vs. I/O page mapping. ###

The /LOCK switch causes the program that is being started to be "locked" to the time-sharing line so that the line is automatically logged off when the program exits. If the "R/LOCK" command occurs within a command file the command file is terminated as the program is started and any additional information in the command file is ignored. The most frequent use of this feature is in start-up command files where a line is to be restricted to executing a particular program. If a locked program chains to another program, the program that was chained to then becomes the locked program.

The /MEMLOCK switch is used to force a program to be loaded into memory below the 256 Kb boundary and locked in memory while it is executing. Use of this switch requires PSWAPM privilege. Forcing the program to be locked in low memory minimizes the memory fragmentation likely to occur if the program were simply locked in the current memory location for the process. This switch should be used for programs which always have an I/O completion pending. This is necessary to prevent the program from hanging if it were swapped. For example, VTCOM is installed with the /MEMLOCK switch. This switch might also be used for a real-time program that needed assured rapid I/O response. Not only is rapid response assisted by always having the program in memory (rather than swapped on disk), but I/O to devices that require the MAPIO facility completes more quickly, as no mapping occurs when the program requesting I/O resides in the low 256K memory region.

The /NONINTERACTIVE switch prevents a program from receiving the priority boost normally given to jobs on the completion of terminal input. This should be used with programs which do heavy terminal I/O but which are not really interactive jobs, such as file transfer programs. A program run with this switch will execute at a lower priority and will not interfere with interactive jobs. The effect of this switch is cleared when a program exits to KMON, but the switch remains in effect if the program chains to another program.

The /SINGLECHAR switch causes a program to execute in "single character activation" mode. (See the discussion of activation characters in Chapter 6.) Normally when programs are run under TSX-Plus they do not receive terminal input until an "activation" character such as carriage-return has been entered. This is true even if the program sets bit 12 in the Job Status Word. Also, TSX-Plus does not normally allow a program to test for terminal input without stalling on the .TTYIN EMT. However, the /SINGLECHAR switch causes TSX-Plus to honor bits 6 and 12 of the Job Status Word, allowing the program to activate on each character and test for terminal input without stalling. A program can also cause TSX-Plus to honor JSW bits 6 and 12 by using the "U" and "S" terminal control commands (see Chapter 6). The example program "STEALS" in the section on requesting exclusive system control in Chapter 11 uses single character activation in this way. KED and K52 are automatically run in single character activation mode.

The /TRANSPARENT switch is used to minimize terminal output character checking by the system during execution of a program. This enables the program to transmit the program controlled terminal option "lead-in" character to the terminal. There is no way to turn off transparent mode from within a program until it exits to the monitor. See Chapter 6 for a discussion of this and other program controlled terminal options.

Examples:

1. Run the program named "DUMP" on device "SY:".

   ```
   R DUMP
   ```

2. Run the program named "PIP" on "SY:" and pass to it the input line "A.TMP=B.TMP. (If no system command, UCL command, or command file name conflicts with a program name, then a program on SY: may be run simply by name. See the beginning of Chapter 2 for more information on command interpretation.)

   ```
   PIP A.TMP=B.TMP
   ```

3. Run the program named "SAMPLE" on "RK2:".

   ```
   R RK2:SAMPLE
   ```

4. Start the execution of BASIC and force logoff on exit.

   R/LOCK BASIC

5. Start a program named PLANE and allow it to use single character activation mode.

   R/SINGLE PLANE

6. Start a program named TRIAL in debug mode so that it will be run under TSODT.

   R/DEBUG TRIAL

   TSX-Plus debugger

   DBG:

7. Start the program SY:GETLIN and pass it some input text.

   R GETLIN INPUT OUTPUT

   A .GTLIN request in the program will receive the following text:

   OUTPUT=INPUT

The REMOVE Command

The TSX-Plus REMOVE command is only partially similar to the RT-11 REMOVE command. Device handlers are permanently loaded under TSX-Plus, so use of the REMOVE command to clear a device name from system tables is not applicable.

The TSX-Plus REMOVE command is used to eliminate a local or global named region. SYSGBL privilege is required to remove named global regions. See Chapter 8 for more information on named regions. The form of the command is:

REMOVE region-name

Region names may be determined from the SHOW REGIONS command.

The RENAME Command

The TSX-Plus RENAME command has the same form and options as the RT-11 RENAME command. Use of this command requires NFSREAD privilege.

The RESET Command

The RESET command is used to reset the system usage statistics that are displayed with the SYSTAT command and the SYSMON utility. Data caching statistics are also reset by the RESET command. This is useful when you want to monitor system performance during a particular part of the day. SYSPRV privilege is required to use the RESET command. The TSX-Plus RESET command is NOT equivalent to the RT-11 RESET command.

The RESUME Command

The RESUME command is used to continue the execution of a process which was suspended with the SUSPEND command. SAME, GROUP or WORLD privilege is required to use this command depending on the project-programmer numbers of the current and target processes. The form of the command is:

```
RESUME job-number
```

where job-number is the number of the process to be resumed. Job numbers can be obtained from the SYSTAT command.

The RUN Command

The RUN command is equivalent to the "R" command except that the default device is "DK:" instead of "SY:". See the description of the "R" command for information about available switches.

The SEND Command

The SEND command is used to send messages between processes and from detached jobs to processes. Use of this command requires SEND privilege. The form of the command is:

```
SEND,line-number message
```

where line-number is the number of the process to which the message is to be sent. One of the following special names may be specified in lieu of a line-number:

Name	Destination
ALL	All logged on lines
OPERATOR	Terminal designated as operator during system generation
PARENT	Process by which sender was started

The special name PARENT is useful when a detached job needs to send a message to the process which started it. A message sent to any primary or subprocess will always be delivered, regardless of which process is currently attached to the terminal. Thus, sending to PARENT from a subprocess will result in the message being delivered to the same terminal which sent the message.

If the receiving process has SET TT GAG and is executing a program other than KMON, then the message will not be delivered. Messages sent to a process which has windowing enabled are not preserved in the window memory for that process. Thus, if the window is refreshed, the message will be lost.

Examples:

1. Send a message to all logged-on users:

```
SEND,ALL Bob, Call me when you get a chance.
```

2. Send a message to line number 2:

```
SEND,2 Will you be on tonight?
```

When a SEND message is printed at a terminal, the message is preceded by the number of the line that originated the message and the user name currently associated with that line. For example, a message from line 1 might be printed as follows:

```
01 (SYSMGR) -- Bob, Call me when you get a chance.
```

Keep in mind that several characters are used to identify the sending line and user, with the result that a long message may be truncated.

The SET Command

The SET command is used to set various options controlling system operation. The general form of the SET command is:

```
SET device option
```

As with RT-11, the TSX-Plus SET command is used to specify options for devices such as line-printers and card-readers as well as setting certain system parameters such as terminal control characteristics. When used to set device options, the SET command has the same form as under RT-11 and may set the same options (they are specified in the device handler). OPER privilege and either SYSPRV or BYPASS privilege is required to set an option in a device handler. The device name may be either the physical device name or a logical name assigned to the physical device. For example:

```
ASSIGN CL1 XX
SET XX LENGTH=66
```

The SET command may use logical names for physical devices and for CL, LD and VM devices, but not for pseudo-devices like TT and SL, nor for system parameters like QUAN1, CACHE or PRIORITY. The SET command causes the copy of the device handler on the disk to be altered so that the effect of the command becomes "permanent" (until another SET changes the parameter back). The SET command also attempts to make the change to the copy of the handler that is in memory with TSX-plus. If the handler is idle when the SET is issued, the change will be made; otherwise, a warning message:

```
?KMON-F-Handler active -- Can't update running copy
```

will be printed and the running copy of the handler is not altered. If a SET is applied to a handler which was not loaded when TSX-Plus was started, then the following warning message also appears:

```
?KMON-W-Handler not installed.  Set applied to handler disk file only.
```

When a SET is done to a device handler, blocks 0 and 1 of the handler are read from the disk, the SET option is applied and then block 1 is written back to the disk and moved over the copy of block 1 that is in memory. If the vector of a device is changed with the SET dd VECTOR=nnn command, TSX-Plus must be restarted to function correctly. See the RT-11 System User's Guide for device handler SET options.

SET CACHE

The SET CACHE command is used to alter the number of blocks which may be held in the generalized data cache. This command does not alter the amount of memory reserved for the data cache, but only controls the number of blocks within the limits allowed by the CACHE parameter selected during system generation. This command is used by the system manager to determine the effect of varying cache sizes on system performance. SYSPRV privilege is necessary to use this command. The form of this command is:

```
SET CACHE blocks
```

where blocks may range from 0 to the number of blocks reserved by the CACHE parameter during system generation.

SET CCL

There are two types of system commands, low level commands such as RUN, SET, ASSIGN and high level commands such as EXECUTE, COPY, DELETE, and DIRECTORY. Low level commands are executed directly by TSX-Plus. High level commands are translated into the appropriate low level commands before execution. The set of high level commands is known as the Concise Command Language (CCL). The "SET CCL" command can be used to observe the low level commands that are produced by translating CCL commands. The form of this command is:

```
SET CCL [NO]TEST
```

When TSX-Plus is in CCL TEST mode, it will display at the terminal the low level commands that are generated by a CCL command, but not execute them. The "SET CCL NOTEST" command turns this mode off and TSX-Plus resumes executing CCL commands. Test mode is very useful if you are having trouble getting some complex CCL command to work and want to examine the low level commands that are being generated.

Example:

```
.SET CCL TEST
.DIR/OUTPUT:DIR.DAT/OCTAL/BLOCKS DL1:
R DIR
DK:DIR.DAT=DL1:*.*/O/B
^C
.SET CCL NOTEST
```

SET CL

The SET CL command is used to control the functions of a CL (Communication Line) pseudo-device. The CL facility is a device handler which may be used to service most serial devices such as printers, plotters and dial-out lines. Up to 16 CL units may be declared during system generation. Units 0 through 7 are referenced as CL0 through CL7 respectively; units 8 through 15 are referenced as C10 through C17 respectively. CL units may either be assigned to dedicated lines which are to be used only as I/O devices or may be assigned to "take over" inactive time-sharing lines on a temporary basis. This might be useful when a particular line is to be used as a "dial in" time-sharing line at some times and as a "dial out" communication device at other times. The CL handler can be used to replace the LS and XL device handlers. The CL handler can serve as a communication interface with virtual terminal or file transfer utilities, such as the RT-11 VTCOM program. CL lines, as well as time-sharing lines, may be connected through DH(V)11, DL(V)11 and DZ(V)11 type interfaces. See the TSX-Plus System Manager's Guide for specific programming information for the CL device handler.

TERMINAL privilege is required to issue SET CL commands.

SET options are issued for each individual CL unit. The number of available CL units is determined during TSX-Plus system generation. CL unit numbers range from zero to one less than the number of CL units defined during system generation. For example: if a system is generated with a total of 5 CL units, then the units would be designated CL0 through CL4. If a system were generated with a total of 9 CL units, they would be designated CL0 through CL7 plus C10 (which would be the ninth unit). The unit CL: is equivalent to CL0:.

SET options for CL units are not permanent; they return to the default parameters and must be reset each time TSX-Plus is restarted. A detached job start-up command file is a convenient way to set CL options each time TSX-Plus is restarted. If an unattached CL unit is assigned to take over a time-sharing line, then that CL unit acquires the default options. The SHOW CL command may be used to determine current settings for any CL unit attached to a line.

The SET CL command has two forms, one for on/off options that accept a NO prefix, and another for options that accept a value. Those which accept a NO prefix are used to toggle between two possible states. Those which accept a value are used to control variable features like page length. Examples of these two forms are:

```
    SET CL0 LINE=6
or
    SET CL1 NOLFOUT
```

A single command may specify multiple parameters and options. If there is more than one qualifier, the qualifiers may be separated by a comma, a space, or a slash. For example:

```
    SET CL2 SPEED=1200,BITS=7,PARITY=EVEN
```

The SHOW CL and SHOW TERMINALS commands and the SYSMON utility may be used to obtain information about the current status of CL units.

A typical use of CL is to redefine a "dial up" time-sharing line for temporary use as a "dial out" communication device using the RT-11 VTCOM utility. A typical command file to do this might be:

```
    SET CL0 LINE=6      !Take over time-sharing line
    ASSIGN CL0 XL       !Assign for VTCOM (use XC on the PR0)
    ALLOCATE XL         !Prevent multi-user collisions
    SET XL NOLFOUT      !Inhibit line feed transmission
    R VTCOM             !Part of RT-11 5.01 distribution
    !Communicate with remote system using VTCOM
    DEALLOCATE XL       !Let others use CL0
    DEASS XL            !Clean up assignment
    SET CL0 LINE=0      !Re-enable time-sharing line
```

A second common use for CL is to drive serial printers, as a replacement for the LS device handler. In some situations with fixed system resources it can be useful to alternate a single interface port between use as a time-sharing line and as a printer port. The printer port on a Professional 350 is one example. A typical command file to make this redefinition is:

```
SET CL2 LINE=2      !Redefine printer port as spooled CL unit
SET CL2 SPEED=1200  !1200 baud printer
SET CL2 LENGTH=66   !Set page length
SET CL2 NOFORM      !Printer does not have form feeds
SET CL2 FORM0       !Start new page for each file
ASS CL2 LP          !Assign so PRINT command works
```

These and all other available SET CL commands are explained in the following table.

SET CLn

Option	Meaning
7BIT	This option is equivalent to NOEIGHTBIT.
[NO]8BIT	This option is equivalent to [NO]EIGHTBIT.
[NO]BININ	This option controls binary input mode. In binary input mode: 8 bit data characters are passed directly to the user's data buffer; and received control characters (such as control-S and control-Q) are treated as normal data characters. BININ overrides the current selection of EIGHTBIT for input. Note that in order to receive 8 bit characters, BITS=8 must also be selected. The default mode is NOBININ.
[NO]BINOUT	This option controls binary output mode. In binary output mode: 8 bit data characters are sent to the CL unit without modification; the CL handler does not send XON or XOFF characters to control the speed of the remote device, but it will respond to XON/XOFF characters received from the remote device unless binary input mode is also in effect. BINOUT overrides the current selection of EIGHTBIT for output. Note that in order to transmit 8 bits characters, BITS=8 must also be selected. The default mode is NOBINOUT.
BITS=n	This option selects the number of data bits to be used by the hardware line controller. If the hardware does not support programmable data bit selection, then this command has no effect. The number of data bits may be 7 or 8. Note that in order to transmit and receive 8 data bits both BITS=8 and EIGHTBIT (or BININ/BINOUT) mode must be selected.

[NO]CR

This option controls transmission of carriage return characters to the output device. If a CL unit is set NOCR, carriage return characters are discarded and not sent to the output device. Carriage return characters received from the CL device are not affected. The default setting is CR.

[NO]CTRL

This option controls transmission of control characters to a CL output device. Control characters are those ASCII characters from NUL to US (octal values 0 to 37; decimal values 0 to 31). When a CL unit is set NOCTRL, control characters are not sent to the output device. This includes the ESC character. Carriage and paper movement characters are exceptions; BS, HT, LF, FF and CR are always transmitted, regardless of the setting of CTRL. (Note, however, that other parameters may affect transmission of these characters, such as the LFOUT and FORM settings.) Characters received from the CL device are not affected by the CTRL setting. The default setting is CTRL.

[NO]DTR

This option causes the Data Terminal Ready (DTR) signal to be asserted on interface devices capable of modem control. NODTR causes the DTR signal to be dropped. The DTR signal is automatically asserted if a read or write operation is directed to a CL unit, even if that unit has been set NODTR. In this case, DTR remains asserted even after the operation has completed until it is specifically turned off. The default (initial) setting is NODTR.

[NO]EIGHTBIT

If the EIGHTBIT option is selected, all eight bits of received characters are passed to programs. This option does not bypass control character checking as do the BININ and BINOUT options. If NOEIGHTBIT is specified, characters are masked to seven bits. Note that in order to transmit or receive 8 data bits, both BITS=8 and EIGHTBIT (or BININ/BINOUT) must be selected.

ENDPAGE=n

This option specifies the number of form-feed characters to be appended to the end of the output file when the channel to the CL unit is closed. This is required by some laser printers to cause the last page buffer to be printed. The default is zero. The ending form feeds are only appended if a write operation has been performed to the CL unit. If both ENDPAGE and ENDSTRING are specified for a CL unit, then the ENDPAGE option is performed first.

ENDSTRING="string" This option specifies a character string to be appended to the end of the output file when the channel to the CL unit is closed. The string may be enclosed in either single (') or double (") quote marks. The string may be up to seven characters in length. The endstring is only appended to the output file if a write operation has been performed to the CL unit. If both ENDPAGE and ENDSTRING are specified for a CL unit, then the ENDPAGE option is performed first. For example, the following command causes "EOF" to be printed, followed by carriage-return, line-feed, control-Z:

```
SET CL2 ENDSTRING="EOF^M^J^Z"
```

Control characters are specified in the string by a caret (^) followed by the character whose ASCII value is 100 (octal, 64 decimal) larger than the control character desired. Each control character counts as one character in the string even though two characters are used to specify it. If the SET CLn ENDSTRING command is included in a command file, then each control character requires a double caret (^^). For example:

```
SET CL2 ENDSTRING="EOF^^M^^J^^Z"
```

[NO]FORM This option controls the transmission of form feed characters to CL output devices. If a device's hardware can utilize form feed characters, the CL unit should be set FORM. If a CL unit is set NOFORM, then form feeds sent to the unit are translated to enough line feed characters to advance to the top of the next form, based on the setting of the LENGTH parameter. The default setting of this parameter for dedicated CL units is determined during TSX-Plus system generation. For extra CL units, the default setting is NOFORM.

[NO]FORM0 This option controls paging at the beginning of print files. More precisely, if a CL unit is set FORM0, then a form feed (or enough line feeds) will be sent each time a write is issued to the device with a block number of 0. The default setting is NOFORM0.

[NO]LC This option controls case conversion of output characters. If a CL unit is set NOLC, then lower case characters (a - z) will be translated to upper case (A - Z) before transmission. Characters received from the CL unit are never converted to upper case. The default setting is LC.

LENGTH=n

This option defines the number of lines per page. This option is used together with the NOFORM option to replace form feed characters with enough line feeds to advance to the top of a page. If LENGTH=0 and NOFORM are selected, no form feed simulation occurs and form feeds are discarded. This option is also used with the SKIP option to define bottom margins. The default setting is LENGTH=66.

[NO]LFIN

This option determines the fate of line feed characters received from a CL unit. If a unit is set NOLFIN, then line feed characters received from the CL device are discarded (except when reading with .SPFUN 203). The default setting is LFIN.

[NO]LFOUT

This option controls the transmission of line feed characters to a CL device. If a unit is set NOLFOUT, then line feed characters sent to the CL device are discarded. When a CL unit is used with the RT-11 VTCOM utility, it should be set NOLFOUT. The default setting is LFOUT.

LINE=n

This option is used to redirect a CL unit to use a time-sharing line or a dedicated CL line. The parameter n must refer to a physical time-sharing line number or to the line number assigned to a dedicated CL line. You may not assign a CL unit to a time-sharing line which is in use or to a dedicated CL line which currently has another CL unit assigned to it. A CL unit may be disassociated from any line by setting it to "LINE=0". Time-sharing lines may be temporarily redefined as output devices or "dial-out" ports by assigning a CL unit to them. They may then be restored as time-sharing lines by disassociating the CL unit from them. A CL unit may not be assigned to a line which is flagged as DEAD. If the CL unit being assigned currently has output pending, then the system will wait up to 20 seconds for pending output to be transmitted before reassigning the line. The SHOW CL and SHOW TERMINALS commands may be used to determine the current assignments of CL units.

PARITY=xxxx

Selects parity control for the terminal hardware line controller to which the CL unit is connected. This option has no effect if the hardware does not support programmable parity control. The valid options are: EVEN, ODD or NONE. The alternate form "NOPARITY" is equivalent to PARITY=NONE.

RESET

This option is used to clear the CL handler. A handler .SPFUN call (201) is also available to clear CL from within a program. It performs three operations: 1) resets the internal "control-S received" flag; 2) transmits control-Q; 3) clears the internal "end-of-file" flag.

SKIP=n — This option is used together with the LENGTH setting to control bottom margins. When only n lines remain on a page, a form feed (or enough line feeds) is issued to advance to the top of the next form. This feature is normally used to skip over page perforations between forms. The default setting is SKIP=0, which does not skip lines at the bottom of a page.

SPEED=n — This option controls the transmit/receive baud rate for a CL unit. Split speeds are not supported. This option can only be used for hardware interfaces which support programmable baud rates, such as DZ11, DZV11, DH11, DHV11, and DLV11-E interfaces and the Professional 350 printer and communication ports. The available speed values are: 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600, and 19200. DEC DZ(V)11 interfaces do not support the 19200 baud rate. DEC DHV11 interfaces do not support 3600 or 7200 baud. DEC DH11 interfaces do not support 2000, 3600 or 7200 baud. The PRO quad SLU does not support 3600 or 7200 baud.

[NO]TAB — This option controls transmission of horizontal tab characters to CL units. If the device can support the tab character, the TAB setting should be used. If the unit is set NOTAB, then tab characters sent to the unit are replaced with enough spaces to advance to the next tab position. (Substituted tabs are at columns 1, 9, 17, 33, 41, ...) The default setting for dedicated CL lines is determined during TSX-Plus system generation. The default setting for extra CL units is NOTAB.

TOP — This option is used to tell the CL handler that the printer is now at the top of form. This is necessary when repositioning forms on a printer which does not support hardware form feeds.

WIDTH=n — This option specifies the maximum line width. Characters sent to a CL unit are discarded if they would exceed the maximum line width. The current column count is cleared after each carriage return. The default setting is WIDTH=0, which allows unlimited line widths.

SET CORTIM

The SET CORTIM command is used to adjust the value of the CORTIM system control parameter. This parameter controls the minimum memory residency time for jobs just swapped into memory. See the TSX-Plus System Managers Guide for further information about the CORTIM parameter. The form of this command is:

SET CORTIM value

where value is the time value specified in 0.1 second units. The current value of the CORTIM parameter may be determined with the SHOW CORTIM command. SYSPRV privilege is required to use this command.

SET CTRLD

The SET CTRLD command is used to enable or disable automatic entry to the TSX-Plus program debugger when control-D is typed. Use of the program debugger and this command requires DEBUG privilege. Any time a program is running under control of the debugger, then control-D may be used to interrupt the program execution and pass control to the debugger as if a breakpoint had been hit at the current location. Normally, this is only possible if the program was started under debugger control (/DEBUG switch to the R or RUN command). However, it is also possible to enable control-D to interrupt programs which were not started under the debugger and pass control to the debugger. To enable this feature, issue the command:

SET CTRLD DEBUG

To disable control-D interruption of programs which were not started under the debugger, issue the command:

SET CTRLD NODEBUG

See the description of the /DEBUG switch to the R command and the description of the debugger in Appendix I for more information.

SET EDIT

The SET EDIT command is used to select which edit program will be invoked when the system EDIT command is used. The form of this command is:

SET EDIT option

where option may be EDIT, TECO, KED or K52. The options KED and K52 are actually synonymous; the KED editor is used if the terminal type has been specified to be a VT100 or VT200 and the K52 editor is used if the terminal type has been specified to be a VT52. VT200 terminals must be set to 7-bit control characters to function with KED. The terminal must be SET TT LC in order to use KED or K52.

SET EMT

The SET EMT command is used to control tracing of EMT calls during the execution of a user program. Use of this command requires DEBUG privilege. The form of the command is:

```
SET EMT [NO]TRACE
```

When SET EMT TRACE is specified, a line of information about the EMT call is displayed at the terminal each time an EMT is executed. The .TTYIN, .TTYOUT and .PRINT EMTs, however, are not included in EMT traces. EMT tracing is disabled with the SET EMT NOTRACE command. Each line of information which is displayed during EMT tracing contains: the virtual address of the EMT call, the EMT code, function code, channel number (or sub-function code), and the first 5 words in the EMT argument block. Only the first two items are defined for all EMTs. The other items are defined only if used for the EMT currently being traced. As an example of EMT tracing, the LNTT program which displays the current line number and terminal type (see Chapter 7) was traced as follows:

```
.SET EMT TRACE
.RUN LNTT

001004  374  004  000  000000  000000  000610  000000  000000

001012  375  110  000  057400  001252  001262  001270  001277

001026  374  005  000  057400  001252  001262  001270  001277
TSX-Plus line number: 2
Terminal type:
001060  375  137  000  001252  001262  001270  001277  001311
VT-100

001072  350  016  010  001270  001262  001270  001277  001311
.SET EMT NOTRACE
```

Note that the .PRINT calls are not traced, since .TTYIN, .TTYOUT and .PRINT EMTs are never traced. Appendix D contains a list of both RT-11 compatible and TSX-Plus specific EMTs.

SET ERROR

The SET ERROR command is used to specify the level of error which will abort command file execution. The form of this command is:

```
SET ERROR option
```

where option may be FATAL, ERROR, WARNING or NONE. Command files being executed under the IND program are not normally aborted if errors occur during execution; the SET IND ABORT command can be used to cause IND command files to

abort according to the same rules as for normal command files. The TSX-Plus SET ERROR command functions in the same fashion as the RT-11 SET ERROR command.

SET HIPRCT

The SET HIPRCT command is used to set the value of the HIPRCT system control parameter. See the TSX-Plus System Manager's Guide for more information on the effect of this parameter. The form of this command is:

```
SET HIPRCT value
```

where value sets the non-interactive job I/O counter. SYSPRV privilege is necessary to use this command. The HIPRCT parameter may be referenced by the SET SIGNAL and SHOW commands. Refer to the TSX-Plus System Manager's Guide for more information on job scheduling and performance optimization.

SET HOST

The SET HOST command is used to cross connect a time-sharing line with a CL (communication line) unit in such a fashion that all characters received from the time-sharing terminal are transmitted directly to the CL unit and all characters received from the CL unit are transmitted directly to the time-sharing terminal. This is useful to allow a time-sharing line on one TSX-Plus system to be connected through a CL line to another system and used as a remote terminal to it.

This function is similar to using RT-11's VTCOM to communicate through a CL line but is more direct and more efficient. On the other hand, this internal cross-connection feature does not provide the file transfer capabilities of VTCOM.

The form of this command is:

```
SET HOST/PORT=ddn
```

where the ddn is the name of the CL unit to which your terminal will be cross connected. For example, the following commands would "take over" terminal line 4 with CL unit 1 at 9600 baud and then cross connect the current terminal with the CL unit (CL1):

```
SET CL1 LINE=4,SPEED=9600
SET HOST/PORT=CL1
```

See the SET CL command for more information on taking over time-sharing lines as CL units.

A logical name assigned to a CL unit may also be used as the port name. For example:

```
SET C11 LINE=21,SPEED=9600
ALLOCATE C11 VAX
SET HOST/PORT=VAX
```

While a cross connection is in effect, the program name assigned to the process is "$HOST$".

TERMINAL privilege is required to use the SET HOST command.

The cross connection can be released at any time by typing control-\ (control backslash). (You should normally log out from the remote system before releasing the connection.) When this is done, the message "Cross connection released" is printed and control returns to the keyboard monitor.

When a cross connection is established, characters typed at your terminal are transmitted to the CL line. Control characters such as control-C, control-W, etc. are not interpreted by the local system. There are only four control characters which are interpreted by the local system:

control-A	Signal special command.
control-Q	Resume terminal output (XON).
control-S	Stop terminal output (XOFF).
control-\	Release connection.

(Different characters may be selected during system generation as the special command and release connection characters.)

Typing control-A signals the cross connection controller that one special character follows. When typed immediately after control-A, the following characters perform the specified functions:

B	Send a 0.5 second break signal.
D	Raise DTR signal.
H	Drop DTR signal (hangup).

If any other character is typed after control-A, then that character is sent to the CL line without interpretation. This provides a way to transmit the control-A and control-\ characters. If you type control-A twice, one control-A character will be transmitted to the CL line. Typing control-A control-\ will cause a control-\ character to be transmitted rather than releasing the cross connection.

SET IND

The SET IND [NO]ABORT command is used to control the execution of command files under the control of the IND program when there is an error. Normally, command files under the control of IND are not aborted when an error occurs, regardless of the current SET ERROR level. However, if the SET IND ABORT command is issued, then command files under the control of the IND program will abort under the same conditions as would normal command files. The SET IND NOABORT command restores the default abort processing under IND control (no abort).

SET INTIOC

The SET INTIOC command is used to set the value of the INTIOC system control parameter. See the TSX-Plus System Manager's Guide for more information on the effect of this parameter. The form of this command is:

SET INTIOC value

where value is the interactive job I/O counter. SYSPRV privilege is necessary to use this command. The INTIOC parameter may be referenced by the SET SIGNAL and SHOW commands. Refer to the TSX-Plus System Manager's Guide for more information on job scheduling and performance optimization.

SET IO

The SET IO [NO]ABORT command is used to select the method of handling I/O abort requests. If the SET IO ABORT command is issued, then an I/O abort request will call device handler abort entry points. If the SET IO NOABORT command is issued, then I/O abort requests will proceed through I/O rundown; that is, all pending I/O will complete before the job is aborted. The initial setting of this parameter is selected during TSX-Plus system generation. SYSPRV privilege is required to use this command. The method selected affects all lines, not just the line from which the command is issued.

SET KMON

The SET KMON command is used to direct the processing of commands from the keyboard and from command files. The form of this command is:

SET KMON option

where the valid options are: [NO]IND, UCI[=filnam] or USER[=filnam], and SYSTEM. The chain of events in command processing by TSX-Plus is described at the beginning of this chapter.

The processing of indirect command files may either be controlled by TSX-Plus or by the IND utility provided with RT-11. To cause command files to be processed by IND, use the command: SET KMON IND. To return to the normal mode

of TSX-Plus command file processing: SET KMON NOIND. Note that command files which result in errors are not normally aborted, regardless of the SET ERROR level, when executed under control of IND. The SET IND [NO]ABORT command can used to control error abort of IND command files. Command files may be forced to the normal TSX-Plus mode of execution regardless of whether KMON is set IND or NOIND by calling them as:

```
$@filnam
```

Conversely, command files may be forced to execute under the IND utility regardless of whether KMON is set IND or NOIND by calling them as:

```
IND filnam
```

See Chapter 3 for more information on command file processing.

The other function of the SET KMON command is to control the user command interface. It is possible for user written programs to accept and pre-process keyboard commands before the TSKMON program. Command control is local to each user. That is, each job may select its own command processing method. The User Command Interface may be enabled by the command:

```
SET KMON UCI[=filnam]
     or
SET KMON USER[=filnam]
```

The option USER is equivalent to UCI. When UCI is in effect, then each time TSKMON is ready to accept a command it passes control to the current UCI program. If the optional "=filnam" has been omitted, then TSKMON passes command acquisition control to the program SY:UKMON.SAV. If a file has been specified, then TSKMON passes control to that program. It is the responsibility of the user-written command interface program to prompt for and accept command input lines. Commands may be further passed on to TSKMON through the chain-data area by doing a special chain exit.

Command processing control is returned to TSKMON by the command:

```
SET KMON SYSTEM
```

See the example program in the section on the User Command Interface earlier in this chapter for more information.

SET LANGUAGE

The SET LANGUAGE command is used to select DBL or DIBOL as the default compiler for programs with the extension DBL. This also affects the COMPILE and EXECUTE commands. The form of the command is:

SET LANGUAGE option

where option is DBL or DIBOL. The default setting of this parameter is DBL.

SET LD

The SET LD command is used to control writing to a logical subset disk and to verify logical subset disk assignments. The form of the command is:

SET LDn option

where LDn is in the range of LD0 to LD7, and option may be CLEAN, EMPTY, FREE, WRITE or NOWRITE.

SET LD

Option	Meaning
CLEAN	is used to verify and correct logical subset disk assignments. An implicit SET LDn CLEAN is done by TSX-Plus whenever the DUP utility program is run (e.g. INIT and SQUEEZE operations).
EMPTY	dismounts ALL logical subset disks for the process and deassigns logical device names assigned to them. The LD unit number is ignored with the EMPTY option.
FREE	dismounts the specified logical subset disk and deassigns any logical name assigned to it.
[NO]WRITE	is used to prevent/enable writing to a logical subset disk. WRITE/NOWRITE control is also an option of the MOUNT command.

See the MOUNT command and Appendix G for further information on the use of logical subset disks.

SET LOG

It is possible to copy terminal output to a log file. When terminal logging is enabled, all output directed to the terminal is also written to the log file. The only exception to this is high-efficiency terminal output which is not logged. To initiate terminal logging issue the following command:

SET LOG FILE=name

where name is the file specification for the log file. The default extension is ".LOG". For example, the following command would copy terminal output to a file named "DK:RUNLST.LOG":

```
SET LOG FILE=RUNLST
```

The following command causes terminal output to be copied to the line printer:

```
SET LOG FILE=LP:
```

Logging of terminal output may be stopped and the log file closed by the command:

```
SET LOG CLOSE
```

The log file is automatically closed when another log file is opened or the job logs off. The log file is also automatically closed if the device containing the log file is initialized or squeezed; the following warning message appears:

```
?KMON-W-Closing log file
```

It may be desirable to suspend and resume terminal output logging during some operations without closing and reopening another log file. To temporarily suspend terminal logging, issue the command:

```
SET LOG NOWRITE
```

To resume terminal logging, issue the command:

```
SET LOG WRITE
```

It may be desirable at some times to reset the terminal log file. To clear the contents of the log file without closing and deleting the file, issue the command:

```
SET LOG CLEAN
```

This command resets the highest block written information for the file.

Terminal logging is especially useful with detached jobs. Terminal output to detached jobs is normally discarded since the job is not attached to any terminal. However, when terminal logging is enabled for a detached job, then the terminal output may be directed to a file or to a printer.

SET LOGOFF

The SET LOGOFF command is used to associate a "log-off" command file with a job. This command is only valid within start-up command files. The form of this command is:

SET LOGOFF FILE=name

where name is the file specification of a command file to be executed when the job logs off. Log-off command files, like start-up command files, cannot be aborted by control-C. See the TSX-Plus System Manager's Guide for further information about log-off command files.

SET MAXPRIORITY

The SET MAXPRIORITY command may be used to reduce the maximum priority allowed to a job. When placed in a start-up command file, this command restricts the maximum available priority for that job. This permits restriction of priority on lines which do not use the LOGON facility. The form of this command is:

SET MAXPRIORITY value

where value is in the range of 0 to 127. If the current maximum job priority is less than 127, then the current maximum priority is the upper limit for the valid range of value. See the TSX-Plus System Manager's Guide for further information about restricting job priority.

SET NUMDC

The SET NUMDC command is used to control the number of buffers used for data caching. The form of this command is

SET NUMDC value

where value is the number of buffers to use. The initial value of the NUMDC parameter is specified when the system is generated. The SET NUMDC command may be used to restrict the number of data cache buffers actually used to a value less than the number of buffers specified when the system was generated, but may not exceed that value. The SET NUMDC command does not alter the memory space allocated for cache buffers, it merely controls the number of buffers actually used. SYSPRV privilege is required to use this command.

The primary use of the SET NUMDC command is to determine the optimum number of data cache buffers to include in a system. To do this, the system can be generated with a large number of data cache buffers and the SET NUMDC command can be used to determine the minimum number which are actually needed to provide effective performance. When using this procedure, all files that are being cached should be closed before the SET NUMDC command is issued. See Chapter 9 for a discussion of shared-file data caching.

SET PRINTWINDOW

The SET PRINTWINDOW command is used to enable the printwindow control character to send an image of the current process window to a printer. The printwindow control character is normally Ctrl-B, but it may be changed during system generation. The printwindow feature is only available if: the process has enabled windows with refresh with the SET WINDOW command; the SET PRINTWINDOW device has been specified; and the WINPRT program is running (usually as a detached job).

The form of this command is:

SET PRINTWINDOW [/DEVICE=ddn] [/TYPE=type]
[/LETTER or /DRAFT] [/[NO]BELL] [/[NO]WIDTH]

/DEVICE=ddn — Specifies the name of the printer device to be used when the printwindow control character is typed. This may be a printer name such as LP or LS, a CL unit such as CL2, or some other device name to which the window image is to be sent. A logical device name may also be used. The output device is usually spooled, but it is not required. The device must be specified at least once in order to enable the printwindow feature, but the SET PRINTWINDOW command may be issued without the device name at a later time to change the current printwindow device characteristics. A disk file may also be specified as the printwindow device. The window contents are written to a file on the specified device with a name of the form "WINjji", where "jj" is the job number and "i" is a letter corresponding to the window ID number (e.g., A=1).

/TYPE=type — Specifies the type of the printer. This enables the system to simulate the actual screen display as closely as possible by taking advantage of special printer character sets and features. type may be: LA12, LA36, LA50, LA100, LA120, LA210, LQP02, LQP03, or LN03. If some other printer is used, specify FOREIGN as the type. The default type is FOREIGN.

/LETTER — Specifies that letter-quality print mode is to be used on those printer which support it. This qualifier is ignored on those types which do not support letter-quality mode.

/DRAFT — Specifies that draft-quality mode is to be used. This is the opposite of /LETTER. /DRAFT is the default.

/BELL — specifies that the bell is to be rung at the terminal that is requesting a printwindow when the WINPRT program has successfully captured the window image. When the bell is rung, a "snapshot" of the window contents has been taken so new data may be displayed without affecting the window image that will be printed. /NOBELL is the default mode.

/WIDTH — specifies that control characters are to be sent to the printer to control character width spacing. This only applies to DEC terminals that support character width settings. /NOWIDTH suppresses character width control. /WIDTH is the default mode.

The SET PRINTWINDOW command applies only to the process issuing the command. Thus, different jobs may select different printwindow devices or modes.

SET PROCESS

The SET PROCESS command is used to alter job characteristics. The form of this command is:

```
SET PROCESS [/PRIORITY=value]
            [/SUSPEND]
            [/RESUME]
            [/IDENTIFICATION=value]
            [/NAME=string]
            [/PRIVILEGES=(privileges)[/AUTHORIZED]]
```

The SET PROCESS command may be used to: change the priority of a job (within its authorized range); suspend or resume the execution of a job; change the user name for a job; or change the privileges of a job.

SET PROCESS

Qualifier	Function
/PRIORITY	The /PRIORITY qualifier is used to specify a new job execution priority for the current job or for another job. The /IDENTIFICATION qualifier may be used with the /PRIORITY qualifier to cause the priority to be set for a job other than the current job. The specified priority value must be in the range authorized for the job. The default priority assigned to a job when not otherwise specified or restricted is 50. The maximum priority allowed to a job may be restricted through the logon mechanism or the SET MAXPRIORITY command. The SHOW PRIORITY command can be used to display the current job priority and the maximum authorized priority. The SYSTAT command also displays current job priorities. Job priorities may also be

assigned from within an executing program with an EMT. See Chapters 7 and 11 for more information on setting job priority from within a program. When a job is disassociated from the terminal by switching to a different subprocess, the job is reduced in priority by an amount determined during system generation (the PRIVIR parameter).

/SUSPEND — Used to suspend the execution of a job. The /IDENTIFICATION qualifier must be used to identify the job which is to be suspended.

/RESUME — Used to resume the execution of a suspended job. The /IDENTIFICATION qualifier must be used to identify the job which was suspended.

/IDENTIFICATION — The identification value is the number of the job whose priority is to be set. This qualifier may only be used with the /PRIORITY, /SUSPEND, and /RESUME qualifiers. SAME, GROUP or WORLD privilege is required, depending on the project and programmer numbers of the target and issuing jobs.

/NAME — The /NAME qualifier can be used to specify a new user name for the job. The user name is displayed by the SYSTAT command. SETNAME privilege is required to change the job name. The name of another job may not be changed.

/PRIVILEGES — The /PRIVILEGES qualifier is used to specify a list of privileges. If more than one privilege is being specified, the privilege keywords are enclosed in parentheses and separated by commas. If only a single privilege keyword is specified, the parentheses may be omitted. The word "NO" may be concatenated with a privilege keyword to cause the privilege to be removed from the job. For example, the following command grants the privilege represented by priv1 and removes the privilege represented by priv2:

```
SET PROCESS/PRIV=(priv1,NOpriv2)
```

Job privileges are grouped into three sets: authorized - those for which the job is authorized; set - those which have been specified with the SET PROCESS command or the EMT to set privileges; and current - those currently in effect for the job, based on the set privileges and program-dependent privileges for installed programs. Unless the job has SETPRV privilege, the set privileges will not exceed the authorized privileges. See the TSX-Plus System Manager's Guide for more information on job privileges.

The /AUTHORIZED qualifier may be used in conjunction with the /PRIVILEGE qualifier to cause the authorized privilege flags to be affected as well as the set and current privileges. If the /AUTHORIZED qualifier is not specified, only the set and current privileges are affected. The following command sets the selected privileges as the authorized, set, and current privileges for the job:

SET PROC/PRIV=(priv1,priv2,...)/AUTHORIZED

The SET PROCESS command can always be used to remove a privilege from the authorized, set, and current privileges for the job. Specific privileges can only be granted for a job if the job is authorized to set those privileges. SETPRV privilege is required to set privileges not specifically included in the authorized set. See the TSX-Plus System Manager's Guide for more information on job privileges. Specific privilege requirements are also described individually for system commands and system service calls.

SET PROMPT

The SET PROMPT command is used to change the keyboard monitor prompt character. The default character is a period (".") . The form of the command is:

SET PROMPT "string"

where string is a quoted string containing from 1 to 8 characters. The quoted string will subsequently be used as the keyboard monitor prompt string. For example, in order to set the monitor prompt to a dollar sign followed by a space, use the following command:

SET PROMPT "$ "

To restore the standard RT-11 prompt string, issue the command:

SET PROMPT "."

SET QUANxx

The SET QUANxx command is used to set the value of the system time-slice control parameters (QUAN0, QUAN1, QUAN1A, QUAN1B, QUAN1C, QUAN2, and QUAN3). See the TSX-Plus System Manager's Guide for information about the effect of the these parameters. The form of this command is:

SET QUANxx value

where value is the time value specified in 0.1 second units. SYSPRV privilege is required to use this command. The value selected takes effect for all jobs on the system, not just the job issuing the command. These parameters may be referenced by the SET SIGNAL and SHOW commands. See the TSX-Plus System Manager's Guide for more information on job scheduling and performance optimization.

SET SIGNAL

The SET SIGNAL command is used as an aid to system performance tuning. The form of the SET SIGNAL command is:

SET SIGNAL [NO]parameter

where parameter may be one of the system scheduling parameters: HIPRCT, INTIOC, QUAN0, QUAN1, QUAN1A, QUAN1B, QUAN1C, QUAN2, or QUAN3. Only one parameter may be selected by each SET SIGNAL command, although with multiple SET SIGNAL commands more than one parameter may be selected for signaling at once. Signaling may be disabled for any individual parameter by prefacing the parameter with "NO". Signaling may be halted for all parameters with the command SET SIGNAL OFF.

When signaling has been enabled for a system tuning parameter, the bell will be rung at the terminal of the job for which signaling has been selected each time the job changes state because it exceeds the value of the selected parameter. The SET SIGNAL command functions on a line-by-line basis and only affects the line from which the command is issued.

The signaling feature is intended as an aid to the system manager in determining appropriate values of the system tuning parameters for a given job. See the TSX-Plus System Manager's Guide for more information on use of the signaling feature.

SET SL

The SET SL command is used to control the ability to edit keyboard input lines. The TSX-Plus SL facility is generally compatible with that provided with the RT-11 "SL" editor. It allows editing of the current input line or field and recall of the previous input line or field. Logical names may not be used in lieu of "SL". See the section on the single line editor in Chapter 1 for information on the use of the single line editor. The form of this SET command is:

SET SL option

where the options are described below.

SET SL Option	Meaning
ASK	This command is ignored. The terminal type is determined from the current TSX-Plus terminal type.
[NO]KED	This command disables/enables "KED"-like extensions to the single line editor. Note that the numeric keypad is reset/set in application mode. SET SL NOKED is equivalent to SET SL RT11. The alternate forms KEX and K52 are also accepted, although the NO forms are not.
[NO]LEARN	This command is ignored. The single line editor LEARN mode is not implemented.
[NO]LET	This command is ignored. The LET utility may not be used with the single line editor.
OFF	This command turns off the single line editor.
ON	This command turns on the single line editor. Note that this places the process in single-character activation mode.
RT11	This command disables the "KED"-like extensions to the single line editor. This command is equivalent to SET SL NOKED.
[NO]SUBSTITUTE	This command disables/enables defined terminal key substitutions. See the DEFINE/KEY command.
SYSGEN	This command is ignored. The single line editor is implemented as a TSX-Plus system overlay region and does not require the SL pseudo-device handler.
[NO]TTYIN	This command either enables (TTYIN) or disables (NOTTYIN) editing of keyboard input being accepted via the .TTYIN EMT from within programs.
WIDTH=n	This command is ignored. The maximum input line width that can be used with the single line editor, either as a command line or in a program data field, is 80 characters.

SET SUBPROCESS

The SET SUBPROCESS command is used to specify a command file to be executed whenever a subprocess is initiated. This command is only valid in start-up command files. See the TSX-Plus System Manager's Guide for more information on the SET SUBPROCESS command.

SET SYSPASSWORD

The SET SYSPASSWORD command is used to temporarily change the system password for those lines which require it prior to the greeting message. The change does not remain in effect if the system is rebooted. See the TSX-Plus System Manager's Guide for more information on the system password. SYSPRV privilege is required to use this command.

SET TERMINAL

The SET TERMINAL command is used to set various terminal parameters. It is equivalent to the SET TT command.

SET TT

The SET TT command is used to set various terminal and job parameters, and is equivalent to the SET TERMINAL command. Logical names may not be used in lieu of "TT". The form of this SET command is:

SET TT [line-number] [NO]option

to turn an option off and on. For example:

SET TT FORMO

Some options require a numeric parameter, in which case they are specified as:

SET TT [line-number] option=value

For example:

SET TT 6 SPEED=9600

A single command may specify multiple parameters and options. If there is more than one qualifier, the qualifiers may be separated by a comma, a space, or a slash. For example:

SET TT SPEED=9600,BITS=8,NOPARITY

The optional line-number parameter refers to the TSX-Plus line number, which is determined by the order in which time-sharing lines were declared during system generation. The hardware interface to which each line is attached may be determined from the SHOW TERMINALS command. Only physical line numbers may be specified with the SET TT command, not detached jobs or subprocesses.

If line-number is omitted from the command, the setting is applied to the terminal from which the command is issued. TERMINAL privilege is required to issue a SET TT command for any line other than your own or to make a permanent SET to your own line.

If line-number is specified, then the setting becomes permanent and will remain in effect until changed or until the system is restarted. If line-number is omitted, then the setting is temporary and will be reset when the line logs off. Terminal SPEED setting is an exception to this rule. Line speed is additionally affected by the AUTOBAUD option. If a line is set AUTOBAUD, then a temporary change reverts to AUTOBAUD when the line logs off, whereas a permanent change clears AUTOBAUD and remains in effect across logoffs. If a line is not set AUTOBAUD, then any SPEED setting, either with or without line-number specified, is permanent and remains in effect across a logoff.

SET TT Option	Meaning
7BIT	This command is equivalent to SET TT NOEIGHTBIT.
[NO]8BIT	This command is equivalent to SET TT [NO]EIGHTBIT.
ADM3A	Tells TSX-Plus that the terminal being used is a Lear Siegler ADM3A and also has the effect of SET TT SCOPE, NOTAB, NOFORM.
[NO]AUTOBAUD	Allows automatic baud rate selection for terminals during log on. This is only functional for lines connected through interface cards which support programmable baud rates. TERMINAL privilege is required to use this command even for your own line. Only the following speeds are supported with automatic baud rate selection: 110, 300, 1200, 2400, 4800, 9600, 19200. Two carriage-returns are necessary to start an AUTOBAUD line if the terminal speed is less than 1200 baud. The NOAUTOBAUD option disallows automatic baud rate selection. Use of the SET TT line-number SPEED command also cancels automatic baud rate detection. Specifying AUTOBAUD also selects 8 bit characters and no parity; terminals should be set accordingly, although character length and parity may be changed after the connection is established. When the connection to an AUTOBAUD line is broken, the line reverts to 8 bits and no parity and the speed becomes indeterminate.
BITS=n	Specifies the number of bits to be used by the hardware line controller for the line. Note that not all line controllers support programmable character lengths; this command has no effect if not supported by the hardware line controller. TERMINAL privilege is required to use this option even for your own line. This option is not the same as the EIGHTBIT option which specifies whether or not the operating system masks characters to seven bits. In order to transmit and

receive eight bit characters, both EIGHTBIT and BITS=8 must be specified.

[NO]DEAD — Disables further logons on the line. An active line cannot be set DEAD. The NODEAD option re-enables logons. A CL unit may not be assigned to a line flagged as DEAD.

DECWRITER — Equivalent to the LA36 option.

[NO]DEFER — TSX-Plus offers two modes of character echoing -- "deferred" and "immediate" (NODEFER). If the user only types input to programs while they are waiting for input, the two modes function identically. However, if the user types input before the program finishes processing the previous line of input, the two modes are different. In immediate (NODEFER) mode the input characters are echoed immediately and may be printed even before the program prints the response to the previous line. In deferred echo mode, the characters that are typed ahead are accepted and held for the program, but are not echoed to the terminal until the program is ready to accept them. Under standard RT-11, EDIT, BASIC, and DIBOL programs run in deferred mode. Most other programs use immediate echoing. Deferred echoing is the preferred mode under TSX-Plus. See Chapter 6 for information about how a program can control deferred echo mode.

DIABLO — Has the effect of SET TT NOSCOPE, FORM, NOTAB, PAGE. The QUME type is equivalent. When doing plotting or printing with proportional spacing, SET TT TAB.

[NO]ECHO — Controls echoing of characters to the terminal. See Chapter 6 for information about how a program can control character echoing.

[NO]EIGHTBIT — Controls 8-bit I/O for a terminal line. When in 8-bit mode, all 8 bits of each character are passed to and from a terminal. The null character (000) may never be received from the terminal. In addition, in EIGHTBIT mode, if VTxxx escape sequences are defined as a terminal input activation condition, then the character 377 (octal) may not be received. In 8-bit mode, terminals should be set for 8-bit characters with no parity. VT2xx terminals should be set to VT200 mode with 7-bit control characters. This option controls operating system masking of characters to seven bits; it is not the same as the BITS=n parameter which selects the number of data bits in the hardware line controller. In order to transmit and receive eight bit characters, both EIGHTBIT and BITS=8 must be specified.

[NO]FORM — Controls conversion of form feed (FF) characters to line feeds. FORM should be set with terminals whose hardware can respond to form feed characters. NOFORM should be used for terminals whose hardware cannot handle form feed characters. When NOFORM is set, form feed characters are replaced by eight line feed characters.

[NO]FORM0 — The FORM0 option causes TSX-Plus to first issue a form-feed when a write is done to the terminal with a block number of zero. This is convenient when producing multiple program listings to cause each listing to begin at the top of a new page. The NOFORM0 option disables special handling of block zero writes.

[NO]GAG — The GAG option inhibits messages sent from another line from being displayed at the terminal. This is only in effect when the job is executing a program. Messages are not inhibited while in the keyboard monitor. The NOGAG option allows messages to be displayed at any time. The GAG option is useful for preventing messages from interrupting jobs on hardcopy terminals, such as printers or plotters, where a message could spoil the format. This command only affects messages sent either with the SEND command or the EMT which sends a message to another job. This does not apply to message communication channels.

HAZELTINE — Tells TSX-Plus that the terminal being used is a Hazeltine brand terminal and also has the effect of SET TT SCOPE, NOTAB, NOFORM.

LA36 — Tells TSX-Plus that the terminal being used is an LA36 and also has the effect of SET TT NOSCOPE, NOTAB, NOFORM.

LA120 — Tells TSX-Plus that the terminal being used is an LA120 and also has the effect of SET TT PAGE, TAB, FORM, NOSCOPE.

[NO]LC — Allows lower case characters to be passed to a program. If LC is set and bit 14 of the job status word is set to 1, input of lower case characters from the terminal will be passed to the running program. If the terminal is set NOLC or the job status word bit 14 is clear, lower case characters are translated to upper case. See Chapter 6 for information about how a program can control lower-case character conversion. Note that in order to use the keypad editors KED and K52 the terminal must be SET TT LC, otherwise some of the keypad functions will not work.

[NO]PAGE — Selects XON/XOFF flow control for the line. This is the only flow control method allowed for use with TSX-Plus. PAGE turns on flow control, and NOPAGE turns it off. PAGE is automatically selected if any of the following terminal types is set: VT100, VT200, VT52, LA120, Diablo, Qume. The SET TT NOPAGE command can be used to override this setting after the terminal initialization has been done. This command only affects the primary line. Attempts to change this mode from a subprocess are ignored.

PARITY=xxxx — Selects parity control for the terminal hardware line controller. This option has no effect if the hardware does not support programmable parity control. TERMINAL privilege is required to use this option even for your own line. The valid options are: EVEN, ODD or NONE. The alternate form "NOPARITY" is equivalent to PARITY=NONE.

[NO]PHONE — Selects modem control. NOPHONE disables modem control, indicating that the line is hardwired to a terminal. See the TSX-Plus System Manager's Guide for more information on modem control under TSX-Plus.

[NO]QUIET — Setting the terminal QUIET suppresses the listing of command files as they are executed. When the terminal is set NOQUIET, command file lines are listed as they are executed. See Chapter 3 for additional information on controlling command file listing.

QUME — Equivalent to the DIABLO type. Has the effect of SET TT NOSCOPE, FORM, NOTAB, PAGE. When doing plotting or printing with proportional spacing, SET TT TAB.

[NO]SCOPE — Tells TSX-Plus whether the terminal is a CRT device. Setting SCOPE causes the DELETE key to echo as a backspace-space-backspace sequence, erasing the previously typed character. See Chapter 6 for information about how a program can specify an alternate "rubout filler" character that will be used to overwrite characters being erased when DELETE is typed. When the terminal is set NOSCOPE, the DELETE key causes preceding characters to be echoed in reverse order as they are removed from the input buffer, and CTRL-U echoes carriage return, line feed. CTRL-R can be used to check the current contents of the input buffer when doing rubout editing. See Chapter 1 for information on other special control characters.

SEVENBIT — This command is equivalent to SET TT NOEIGHTBIT.

[NO]SINGLE — Controls automatic single character activation for programs. If the SET TT SINGLE command has been issued, then programs may control single character activation on terminal input by toggling bit 12 in the job status word. The /SINGLE switch to the R[UN] command and the "S" program controlled terminal option also allow individual programs to control single character activation. The SET TT SINGLE command applies to all programs until the SET TT NOSINGLE command is issued. If the SET TT NOSINGLE command is in effect, then programs may still individually control single character activation with the R[UN]/SINGLE switch or the "S" program controlled terminal option. In all cases, the program must still set bit 12 in the job status word to achieve single character activation. The SET TT SINGLE command differs from the R[UN]/SINGLE switch in that it only affects setting of single character activation (JSW bit 12), not terminal no-wait input (JSW bit 6). The SET TT NOWAIT command may be used to allow no-wait terminal input.

SPEED=n — Specifies the transmit/receive speed for a terminal line. The available speed values are: 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600, and 19200. This command is only functional for those lines connected through interface cards which support programmable baud rates (DLV11-E, DH(V)11, DZ(V)11 and the PRO-350 printer and communications ports and Quad Serial Line multiplexer). TERMINAL privilege is required to set this option even for your own line. DEC DZ(V)11 interfaces do not support 19200 baud. DHV11 interfaces do not support 3600 or 7200 baud. DH11 interfaces do not support 2000, 3600 or 7200 baud. The PRO QSL multiplexer does not support 3600 or 7200 baud. SET TT line-number SPEED cancels automatic baud rate selection, which may be restored with the SET TT AUTOBAUD command.

[NO]SYSPASSWORD — Requires the line to enter the current system password before logging on.

[NO]TAB — Controls conversion of TAB characters to multiple spaces. TAB should be selected with terminals whose hardware can respond to TAB characters. When set NOTAB, TAB characters being sent to the terminal are replaced by an appropriate number of spaces.

[NO]TAPE — Causes TSX-Plus to ignore received line-feed characters. See Chapter 6 for information about how a program can turn tape mode on and off.

VT50 — Equivalent to the VT52 option.

VT52 — Tells TSX-Plus that the terminal being used is a VT52 (or VT100 in VT52 mode) and also has the effect of SET TT SCOPE, TAB, PAGE, NOFORM.

VT100 — Tells TSX-Plus that the terminal being used is a VT100 (which must be operating in VT100 mode -- not VT52 compatible mode) and also has the effect of SET TT SCOPE, TAB, PAGE, NOFORM.

VT200 — Tells TSX-Plus that the terminal being used is in the VT2xx series and also has the effect of SET TT SCOPE, TAB, PAGE, NOFORM, EIGHTBIT. The terminal type may also be specified as VT220, VT240 or VT241, all of which are equivalent to VT200.

[NO]WAIT — Normally, TSX-Plus blocks the execution of a program that does a .TTINR EMT if no activation character has been received. This occurs even if the program sets bit 6 (inhibit terminal wait bit) in the Job Status Word which is supposed to mean that the program can do non-blocking .TTINR character tests. This is done to prevent programs from "burning up" CPU time by constantly looping back to test for terminal input. If the NOWAIT option is specified with the SET TT command, TSX-Plus will honor bit 6 in the Job Status Word and allow the program to do non-blocking .TTINRs if bit 6 is set. The example program "STEALS" in the section on requesting exclusive system control in Chapter 11 demonstrates the program controlled terminal option to allow NOWAIT input.

Most of these terminal options can be given initial settings for each line when the TSX-Plus system is generated. Each time a user logs onto a line, the initial option settings are used. The options may be altered by using the SET command, but when the user logs off, the options revert to their initial setting specified in TSGEN. When a user initiates a subprocess, the initial flag settings for the subprocess are copied from the flag settings for the primary process. Subsequent flag changes for a subprocess do not affect flag settings for the user's other lines. The SYSMON utility may be used to determine the current settings for any time-sharing line.

SET UCL

You can specify the order in which the TSX-Plus command interpreter checks for user-defined commands by use of the SET UCL command. This command has four forms:

```
SET UCL FIRST
SET UCL MIDDLE
SET UCL LAST
SET UCL NONE
```

If the SET UCL FIRST command is used, user-defined commands will be processed before system commands. This allows user-defined commands to replace system commands but makes the processing of system commands slower. This is the required setting only if it is necessary to replace some system commands.

If the SET UCL MIDDLE command is used, user-defined commands are processed after system commands but before checking for command files and SAV files with names that match the command keyword. Using this setting, it is not possible to replace a system command with a user command, but both system commands and user-defined commands are processed relatively quickly. This is the recommended setting unless it is desirable to replace system commands.

If the SET UCL LAST command is used, a command will not be checked to see if it is a user-defined command until after it is checked to see if it is a system command, the name of a command file on DK, the name of a command file on SY, or the name of a SAV file on SY. Using this setting, it is not possible to replace a system command with a user command and user commands cannot have the same name as command files or SAV files. System commands are processed quickly (the same speed as SET UCL MIDDLE), but the processing of user-defined commands is slow. This is the appropriate setting only if user-defined commands are desired, but command files already exist whose names would conflict with user-defined commands. Existing command files which are short and merely execute system commands should be replaced by user-defined commands.

If the SET UCL NONE command is used, user defined commands are never interpreted. In this mode, attempts to invoke user-defined commands will result in the error:

```
?KMON-F-Unrecognizable command
```

The following list illustrates where the FIRST/MIDDLE/LAST setting causes the command interpreter to check for and process user-defined commands:

```
FIRST  -->
            See if command is a system command
MIDDLE -->
            Look for command file on DK: with command name
            Look for command file on SY: with command name
            Look for SAV file on SY: with command name
LAST   -->
```

See the beginning of this chapter for further information on the command interpretation process.

SET [NO]VERIFY

The SET VERIFY command is used to control command file listing. It is the reciprocal of the SET TT QUIET command. SET VERIFY causes command files to be listed as the commands are executed. SET NOVERIFY inhibits command file listing. Also see Chapter 3 for more information on command files. The following commands are equivalent:

```
SET VERIFY    ==  SET TT NOQUIET

SET NOVERIFY  ==  SET TT QUIET
```

SET VM

The SET VM command is used to control the amount of memory available to the VM pseudo-device. The SET VM command is normally not necessary as VM will automatically calculate the correct base address to use, starting just above the last address used by TSX-Plus, and using all physical memory installed above that address. The form of this command is:

```
SET VM BASE=nnnnnn
```

where nnnnnn represents the octal value of bits 6 through 22 of the base memory address which VM is allowed to use. For example, in a system with 1.5 megabyte of memory, to reserve the top 256 Kb of memory for use by VM the value of nnnnnn should be 50000. This corresponds to a base address for VM of 5000000. If this command is issued, then VM will use the higher of the address specified by nnnnnn or the top of TSX-Plus. That is, it is not permitted to set the base of VM to overlap memory regions reserved for use by TSX-Plus.

Normally, VM will calculate the top address to use as the absolute top of physical memory. You may decrease this top address. The form of the command to adjust the top address used by VM is:

```
SET VM TOP=nnnnnn
```

where nnnnnn represents bits 6 through 22 of the top memory address (in octal) which VM is allowed to use. For example, if you wish to set the top address of VM to end at 1280K bytes, then nnnnnn should be 50000 since the memory address is 5000000 (octal). Any time a new top address is defined, VM should be initialized.

SET WILDCARDS

The SET WILDCARDS command is used to control substitution of missing parts of file names. The form of the command is:

SET WILDCARDS option

where option is either IMPLICIT or EXPLICIT. If IMPLICIT is chosen, then file specifications which are incomplete will be treated as though the "*" character had been typed for the missing part of the specification. The only parts of file specifications affected by this substitution are the file name and the extension. The device cannot be specified as a wildcard. Most keyboard commands which accept file names also accept wildcards. The following table demonstrates the interpretation of various file specifications when wildcards have been set IMPLICIT or EXPLICIT.

Command	IMPLICIT	EXPLICIT
cmd TEST.FOR	cmd TEST.FOR	cmd TEST.FOR
cmd TEST.*	cmd TEST.*	cmd TEST.*
cmd TEST	cmd TEST.*	cmd TEST
cmd TEST.	cmd TEST.	cmd TEST.
cmd *.FOR	cmd *.FOR	cmd *.FOR
cmd .FOR	cmd *.FOR	cmd .FOR
cmd *.*	cmd *.*	cmd *.*
cmd *	cmd *.*	cmd *
cmd .*	cmd *.*	cmd .*
cmd	cmd *.*	cmd

where cmd is one of the keyboard commands which accepts wildcards in file specifications, such as: COPY, DIRECTORY, PRINT, PROTECT, etc.

The system-wide default setting for wildcard interpretation may be selected in TSGEN; see the TSX-Plus System Manager's Guide.

SET WINDOW

The SET WINDOW command is used to enable the system to remember entire screens of information when switching among subprocesses. Use of this command requires SYSGBL privilege. When windowing is first enabled, or when switching to a new subprocess, the screen is cleared. Subsequent terminal output or input echoing is remembered by the system independently for the window connected to each subprocess. The entire screen is then refreshed when the terminal is logically connected to a subprocess which has windows enabled. See Chapter 1 for more information on screen windows. Screen windows may only be used with VT200, VT100 and VT52 series terminals. The COLUMNS, DARK, LIGHT, WIDE, and NARROW qualifiers are not valid in VT52 mode. Color is not supported. Note, be sure the terminal type (VT52, VT100, or VT200) declared to TSX-Plus, either during system generation or by use of the SET TERMINAL command, matches the actual terminal type before turning on windows.

The form of the SET WINDOW command is:

```
SET WINDOW [ON] [OFF] [COLUMNS=n] [LIGHT] [DARK]
           [WIDE] [NARROW] [SCROLL[=n]]
```

SYSGBL privilege is required to use windows since they create global memory regions.

The following qualifiers may be used with the SET WINDOW command:

Qualifier	Meaning
COLUMNS=n	specifies the number of columns per line which the window can hold. (VT100 and VT200 only.) The value should not exceed 132.
DARK	specifies that the window is to be in normal (not reverse) video (i.e., light characters on dark background). (VT100 and VT200 only.)
DELETE	is equivalent to OFF.
LIGHT	specifies that the window is to be in reverse video (i.e., dark characters on light background). (VT100 and VT200 only.)
NARROW	specifies the window is to hold 80 columns (the COLUMNS=80 option is implied) and causes the terminal to be placed into 80 column mode. (VT100 and VT200 only.)
OFF	deletes all windows for the job.
ON	creates a new window number 1 for the job. See Chapter 7 for more information on multiple windows for the same job.

SCROLL[=n] specifies the maximum number of lines which are allowed to scroll off the window while you are disconnected from it by switching to a different subprocess. If you specify 0 (zero), then no lines are allowed to scroll off the screen. If you specify a value in the range 1 to 127, the job writing to the window will be suspended, and the bell will ring at your terminal, if more than the specified number of lines are attempted to be scrolled. Values greater than 127 are divided by 128 and the remainder used as the scroll value. If the number of lines is unspecified, then an unlimited number of lines is allowed to scroll off the screen.

WIDE specifies the window is to hold 132 columns (the COLUMNS=132 option is implied) and causes the terminal to be placed into 132 column mode. (VT100 and VT200 only.)

The default qualifiers are: ON, COLUMNS=80, DARK, SCROLL=16. Thus, you can initialize a window with 80 column mode by simply typing:

```
SET WINDOW
```

The SET WINDOW OFF command deletes all windows for the job.

Display windows remember all characters sent to the screen by programs or from echoing of input characters. However, messages sent to the terminal by use of the SEND command (or equivalent EMT) are not processed by the message manager. Consequently, received messages will not appear if a window is redrawn. You can cause the window for the current job to be redrawn without switching to a different subprocess by typing control-W followed by the number that selects your current line. For example, if you are running on your primary line and wish to have the current window redrawn, type control-W 0. Terminal attributes such as line width, reverse/normal video, application keypad mode, etc. are saved along with line attributes (double wide, double high), and character attributes. The character attributes are: blinking, bold, underlined, reverse video, and character set information (ascii, U.K. national, DEC supplemental, or graphics).

The SHOW Command

The SHOW command is used to display information about the state of the system. Each form of the SHOW command is described below.

SHOW

The SHOW command without qualifiers is equivalent to SHOW ASSIGNS.

SHOW ALL

The SHOW ALL command is equivalent to specifying all of: SHOW DEVICES, SHOW ASSIGNS, SHOW ALLOCATE, SHOW JOBS, SHOW TERMINALS, SHOW CL, SHOW MEMORY, SHOW SPOOL, SHOW SUBSETS, SHOW MOUNTS, SHOW RUN-TIMES, SHOW REGIONS, SHOW PRIVILEGE, SHOW SL.

SHOW ALLOCATE

The SHOW ALLOCATE command displays a list of all devices allocated for exclusive use by any job on the system. For example:

```
.SHOW ALLOCATE

Device   Job    User name
------   ---    ------------
 DB5      7     MIMSY
 MT0     15     BOROGROVES
```

SHOW ASSIGNS

The SHOW ASSIGNS command displays information about all logical device assignments that are currently in effect.

Example:

```
.SHOW ASSIGNS
Assignments:
SY  --> DL0:
CBL --> RK0:
TMP --> DL3:
DK  --> LD0:
```

SHOW CACHE

The SHOW CACHE command reports the total number of blocks available in the generalized data cache buffer.

Example:

```
.SHOW CACHE

Number of blocks in data cache = 1000
```

SHOW CL

The SHOW CL command is used to determine the current characteristics and assignments of all CL units included during TSX-Plus system generation. CL units are typically used either to control serial devices like printers and plotters or as communication lines to other computer systems. CL units may either be dedicated only for use as CL ports, or may be generated as extra units that can be used to take over inactive time-sharing lines or dedicated CL lines which do not have any currently assigned CL unit. CL units may also be spooled (see Chapter 5 for more information on device spooling). Several parameters may be set for each individual CL unit and the SHOW CL command is used to determine the current settings for each unit. See the SET CL command for descriptions of the various parameters which may be set for CL units. The SHOW TERMINALS command also indicates which lines are currently assigned as CL units. The "Line" column indicates which TSX-Plus line number each CL unit is assigned to. The "Job" column shows the line number of any job which is either currently using or has allocated each CL unit. CL units are numbered from 0 up to the highest number generated (16 maximum). CL units are numbered CL0 to CL7, followed by C10 to C17 if more than eight units are generated.

Example:

```
.SHOW CL

Unit  Line   Job          Options
----  ----   ----  ----------------------------
 CL0     6     2   [TAB,LC,LFIN,CR,CTRL]
 CL1    10  none   [LC,LFOUT,LFIN,CR,CTRL]
 CL2  none  none   (spooled)
```

SHOW COMMANDS

The SHOW COMMANDS command is used to display the currently available user-defined command definitions. See the beginning of this chapter for more information on declaring and using user-defined commands. Note that escape characters embedded in commands are represented by a dollar sign ("$").

Example:

```
.SHOW COMMANDS
C100     :== _DISPLAY $[H$[J
DEF      :== _ASS ^ DK
EXAM     :== _R KED ^/I
KPAD     :== _DISPLAY $=
NEW      :== _R DIR ^/D
NOKPAD   :== _DISPLAY $>
Q        :== _SPOOL LP,STAT
SUB      :== _SH SUB
TOME     :== _DISMO LD0\_ASS DL2 DK\_SH SUB
WORK     :== _DISMO LD0\_MOU LD0 DL2:WORK DK\_SH SUB
```

SHOW CONFIGURATION

The SHOW CONFIGURATION causes a display of certain hardware and operating system characteristics. It does not invoke the RT-11 RESORC utility, which is unsupported for use with TSX-Plus. SHOW CONFIGURATION is equivalent to SHOW DEVICES and SHOW TERMINALS.

SHOW CORTIM

The SHOW CORTIM command displays the current value of the system parameter CORTIM. See the TSX-Plus System Manager's Guide for more information on the significance of the CORTIM parameter.

Example:

```
.SHOW CORTIM
  2
```

SHOW DEVICES

The SHOW DEVICES command displays information about which devices were specified as being available when TSX-Plus was generated. For each device the following items of information are displayed:

1. Device name
2. Active I/O - Total number of I/O operations for all units queued to the handler but not yet completed
3. Device status word (See the RT-11 Programmer's Reference Manual, .DSTATUS request, for a description of this value.)
4. Device handler virtual base address (load address reported by .DSTAT request; 120000 for mapped handlers)
5. Device handler physical base address (22-bit physical address divided by 100 octal; 0 for unmapped handlers)
6. Device handler size (decimal bytes)
7. Device CSR (Control and Status Register) address
8. Device interrupt vector(s) address

The CSR and vector values are only displayed if the user issuing the SHOW DEVICES command has BYPASS or SYSPRV privilege. Some of this information is not displayed for pseudo-devices such as TT, NL, and LD.

Example:

```
.SHOW DEVICES
        Active                  Handler   Handler   Handler
Device    I/O     Status        V. base   P. base    size      CSR     Vector
------  ------    ------        -------   -------   -------   ------   ------
  TT        0     000004
  LD        0     102446
  CL        0     006057        047102    000000     612
  DL        0     102405        120000    054075    1380     174400   160
  DY        0     102406        100710    000000     746     177170   264
  DM        1     102423        102262    000000    1516     177440   210
  DU        0     102450        105236    000000     846     172150   154
  NL        0     000025        120000    054074      58
  LS        0     020041        120000    054062     624     176510   310 314
```

SHOW HIPRCT

The SHOW HIPRCT command displays the current value of the system parameter HIPRCT. See the TSX-Plus System Manager's Guide for more information on the significance of the HIPRCT parameter.

Example:

```
.SHOW HIPRCT
  40
```

SHOW INSTALL

The SHOW INSTALL command is used to display information on programs which have been installed for execution with certain characteristics or privilege. Use of this command requires SYSPRV privilege. See the TSX-Plus System Manager's Guide for more information on installed programs.

SHOW INTIOC

The SHOW INTIOC command displays the current value of the system parameter INTIOC. See the TSX-Plus System Manager's Guide for more information on the significance of the INTIOC parameter.

Example:

```
.SHOW INTIOC
  30
```

SHOW JOBS

The SHOW JOBS command displays information about jobs that are currently logged onto the system. The information displayed by this command is identical to that displayed by the SYSTAT command.

SHOW KEYS

This command is used to display all current defined key definitions.

Example:

```
.SHOW KEYS
Gold J          R TALK 5
     PF2        HELP
```

SHOW MEMORY

The SHOW MEMORY command displays information about memory usage including the total installed memory on the machine, the size of TSX-Plus and handlers, the memory space available to user jobs and the current job memory allocation and maximum authorized size. It also lists the size of the swappable job context area which is a system table associated with each job.

Example:

```
.SHOW MEMORY
Total installed memory = 1280Kb
Size of unmapped TSX and handlers = 38Kb
Size of mapped TSX system regions = 38Kb
Total size of TSX and mapped data = 80Kb
Size of sharable run-time systems = 0Kb
Size of data cache buffer area = 516Kb
Space available for user jobs = 683Kb
Swappable context area for each job = 4Kb
Current job memory limit = 56Kb
Maximum job memory limit = 64Kb
```

SHOW MOUNTS

The SHOW MOUNTS command displays the names of those devices that have been mounted by use of the MOUNT command and whose directories are being cached. TSX-Plus maintains a list of which jobs have mounted each device. This list is used with the INITIALIZE and SQUEEZE commands to reduce the chance of data destruction by altering a device directory while another job has a file open on the device. For logical subset disks, the name of the file which contains the device is also shown. Note that with nested logical subset disks, the table formatting is relaxed.

Example:

```
.SHOW MOUNTS
  Device          Associated jobs
---------- ------------------------------
DL0:          1  2  6  8  9 10 11
DL1:          1  6  9
DL2:SMADA     8
DL3:          2 11
DL3:WORK     11
DL3:WORK:TEMP 11
DL3:MANUAL    2
```

SHOW NUMDC

The SHOW NUMDC command displays the current value of the system parameter NUMDC. See the TSX-Plus System Manager's Guide for more information on the significance of the NUMDC parameter.

Example:

```
.SHOW NUMDC
  0
```

SHOW PRIORITY

The SHOW PRIORITY command displays the current and maximum priority values for a job. In addition, the range of priority values which are used for high and low fixed priority jobs is shown. See Appendix H for further information about job execution priorities.

Example:

```
.SHOW PRIORITY
Current priority = 50; maximum authorized priority = 127
Low priority range = 0 to 19
High priority range = 80 to 127
```

SHOW PRIVILEGES

The SHOW PRIVILEGES command is used to display both the authorized and current privileges for the job. Current privileges will always be a subset of authorized privileges. See the TSX-Plus System Manager's Guide for more information on job privileges.

Example:

```
.SHOW PRIVILEGES
Authorized privileges: ALLOCATE,DEBUG,DETACH,MESSAGE,NFSREAD,NFSWRITE,
                       SEND,SETNAME,SPFUN,RLOCK,GROUP,SAME,UP1,
                       UP2

Current privileges:    ALLOCATE,DEBUG,DETACH,MESSAGE,NFSREAD,NFSWRITE,
                       SEND,SETNAME,SPFUN,RLOCK,SAME
```

SHOW QUANxx

The SHOW QUANxx command is used to display the current value of various system tuning parameters. The parameters which may be shown are: QUAN0, QUAN1, QUAN1A, QUAN1B, QUAN1C, QUAN2, and QUAN3. Related tuning parameters which may also be shown are: CACHE, CORTIM, HIPRCT, INTIOC, and NUMDC. See the TSX-Plus System Manager's Guide for more information on the significance of the various system tuning parameters.

Example:

```
.SHOW QUAN3
  20
```

SHOW QUEUE

The SHOW QUEUE command displays information about print files in the spool queue. The following information is displayed for each print file in the queue: the id number assigned by the system to each entry; the name of the device for which the file is queued; an asterisk if the file is currently being printed; the name of the file -- if a file name was specified with the .ENTER -- otherwise the name of the program that created the file; the name of the form on which the file is to be printed; the number of blocks in the file remaining to be printed -- this will decrease as the file is printed. For more information on printer spooling, see Chapter 5.

Example:

```
.SHOW QUEUE
 ID   Dev  Job   File    Form    Blocks
----  ---  ---  ------  ------  ------
  12  LP *   1  PLT50   STD        244
  13  LP     5  EXTERN  STD          5
  15  LP     5  PAYROL  FORM3       35
```

SHOW REGIONS

The SHOW REGIONS command shows information about named regions local to the job and about all global named regions.

Example:

```
.SHOW REGIONS
Region    Size     Type    Job  Use  Shared  AGE
------  ------  ------  ---  ---  ------  ---
KEYDEF     0.5  Local     2    0     No     No
WIN01A     3.8  Global    1    1     No     No
WIN02A     3.8  Global    2    1     No     No
WIN10A     3.8  Global   10    1     No     No
```

"Region" specifies the region name; "Size" shows the region size in Kb (and tenths); "Type" indicates whether the region is local or global; "Job" shows the number of the process which created the region; "Use" shows the number of jobs that are currently attached to the region; "Shared" is Yes if the region may be accessed by processes other than the one creating the region and No if the region is reserved for exclusive use (note that local named regions will always be No); "AGE" is Yes if the Automatic Global Elimination option was specified for the region.

See Chapter 8 for more information on named regions.

SHOW RUN-TIMES

The SHOW RUN-TIMES command causes the display of the names of the shared run-time systems that were loaded with the system.

Example:

```
.SHOW RUN-TIMES
CBRTS
RTCOM
```

SHOW SL

The SHOW SL command lists the current status of the single line editor. See Chapter 1 for a description of the single line editor.

Example:

```
.SHOW SL
SL status: ON,KED,NOTTY,SUBSTITUTE
```

The status options may be the following:

ON	Single line editor is in effect.
OFF	Single line editor is not in effect.
KED	Numeric keypad is in alternate keypad mode. KED is mode required for some SL functions and to use numeric keypad keys as defined keys.
NOKED	Numeric keypad is in normal (RT11) mode. KED mode SL functions are not valid and defined key substitutions are not made for keys on the numeric keypad.
TTY	The single line editor can edit input being accepted by programs via the .TTYIN request. (FORTRAN, COBOL and DBL programs accept most terminal input via the .TTYIN request.)
NOTTY	The single line editor cannot be used on input to programs using the .TTYIN request.
SUBSTITUTE	User defined key substitutions are enabled.
NOSUBSTITUTE	User defined keys are disabled.

SHOW SPOOL

The SHOW SPOOL command lists the devices which have been declared as spooled during system generation. See Chapter 5 for more information on device spooling.

Example:

```
.SHOW SPOOL
Spooled devices:  LP   CL2
```

SHOW SUBSETS

The SHOW SUBSETS command is used to obtain information about logical subset disks which have been mounted. Only the logical subset disks which have been mounted by the user are shown; those mounted by other users are not included. The name of the logical subset disk, the file with which it is associated, the file size, and an optional asterisk are displayed. If present, the asterisk indicates that the file associated with the logical subset disk is missing. In order to DISMOUNT a logical subset disk which is associated with a missing file, it is necessary to create or copy the missing file to the appropriate device. See the MOUNT and DISMOUNT commands and Appendix G for more information on logical subset disks.

Example:

```
.SHOW SUBSETS
LD0 --> DL1:MANUAL.DSK[2601]
LD2 --> LD0:SUB.DSK[100] *
```

SHOW SYSPASSWORD

The SHOW SYSPASSWORD displays the current system password. SYSPRV privilege is required to use this command.

Example:

```
.SHOW SYSPASSWORD
TRANSGLUTAMINASE
```

SHOW TERMINALS

The SHOW TERMINALS command gives a display of the parameters of all primary time-sharing terminal lines defined to TSX-Plus during system generation along with some current characteristics.

Example:

```
.SHOW TERM

Line  Type    Vector      CSR     Terminal  Speed     Active  Line Name
----  -----   ----------  ------  --------  --------  ------  ------------
 1    Oper.   DL     060  177560  VT100     9600 8N   Yes     Console
 2*   Local   DH - 0 330  160060  VT100     9600 8N   Yes     Boris
 3    Local   DH - 4 330  160060  VT100     Auto 8N   No      VAX link
 4    Local   DH - 5 330  160060  VT100     9600 8N   No      Natasia
 5    Local   DH - 6 330  160060  LA120     Auto 8N   No      AJ Terminal
 6    Local   DH - 7 330  160060  VT200     9600 8N   Yes     VT220
 7    Phone   DZ - 0 300  160040  VT100     Auto 8N   No      Dial up line
 8    Local   DZ - 6 300  160040  VT100     9600 8N   CLO     PRO Link
```

The line number indicates the number assigned to each line (determined by the order of declaration during system generation). The line which issued the SHOW TERMINALS command is marked with an asterisk. The type of line may be:

Oper. - the line which was declared to be the operator's console during TSX-Plus system generation

Phone - a line which has been declared to use modem control

CL - a line which was declared during system generation to be a dedicated CL line

Local - all other lines

The Vector column identifies the type of interface card to which the line is assigned. DL11 and DLV11 type interfaces are identified as DL, and will only be followed by the vector address for the line. DZ11 and DZV11 type multiplexers will be identified as DZ and followed by the port number assigned to the line as well as the common interrupt vector for the multiplexer. DH11 type multiplexers are identified as DH, DHV11 type multiplexers are identified as DHV, and both are otherwise similar to the information provided for DZ. Special types are provided to identify the ports on a PRO-350: PC - Professional Console; PP - Professional Printer Port; CP - Professional Communications Port; QP - Quad serial line multiplexer. The Vector and CSR addresses are those declared during system generation. The Terminal identification is that which has been declared to TSX-Plus either during system generation or via a later SET TT <type> command. Note that only the type currently specified for the primary line is shown here. If a SET TT <type> command is issued from a subprocess, that setting does not affect the primary line and is not shown by the SHOW TERMINALS command. The terminal type setting for a subprocess may be identified from the SYSMON utility. The Speed column indicates the baud rate specified for lines for which the baud rate is known. The speed should always be known for multiplexer lines. The speed for DL lines is undefined unless the speed has been declared during system generation or a later SET TT n SPEED=speed command. The speed is followed by the number of data bits and

parity control selected for the line. Lines which are currently logged on are marked with a "Yes" in the Active column and the owner is identified in the User column if possible. If a time-sharing line has been "taken over" by a CL unit, then the CL unit currently attached to the line is identified. See also the SHOW CL command.

SHOW USE

The SHOW USE command causes display of the accumulated connect time and CPU usage for the current job since logon. The SHOW USE command is equivalent to the USE command.

Example:

```
.SHOW USE
Connect=00:50:00  CPU=00:00:23
```

The SPOOL Command

The SPOOL Command is used to control the operation of the spooling system. It may only be used if device spooling is enabled when the system is generated. The form of the SPOOL command is:

SPOOL device,function,parameter

where device is the name of a device that was specified to be spooled when the system was generated, function denotes what function is to be performed, and parameter provides additional information for some functions. A logical device name may be used in lieu of the physical device name. All functions except DELETE and STATUS require OPER privilege. The available functions are:

Function	Priv	Meaning
ALIGN	OPER	Print form alignment file
BACKUP	OPER	Skip backward and resume printing
DELETE	none	Delete current or pending file from queue
FORM	OPER	Mount form name
[NO]HOLD	OPER	[Do not] Wait for file closure before printing
LOCK	OPER	Mount and lock form name
MULTIPLE	OPER	Print any file available for current form
SINGLE	OPER	Request form mount for every file
SKIP	OPER	Skip forward and resume printing
STATUS	none	Display status of spooled device

The SPOOL,DELETE command takes a slightly different form:

SPOOL device,DELETE [id-number]

which is used to delete entries from the list to be printed. Note that there is a space between "DELETE" and id-number. When no id-number is specified, then the entry currently being printed on device is deleted. When id-number is specified, then the entry associated with that id-number is deleted and device may be any spooled device. The id-number assigned to an entry may be determined from the SHOW QUEUE or SPOOL device,STAT commands.

See Chapter 5 for further information on the SPOOL command.

The SQUEEZE Command

The TSX-Plus SQUEEZE command has the same form and options as the RT-11 SQUEEZE command. However, the system device (booted device when TSX-Plus is started) may not be squeezed while running TSX-Plus. If it is necessary to squeeze the system device, it must be done from RT-11. The following error message appears:

```
?KMON-F-This operation not legal with SY (system) device
```

The command "SQUEEZE/OUT:ddn SY:" is also restricted, although you may run the DUP program with the appropriate command line.

You must have NFSWRITE privilege to use the SQUEEZE command.

A device which has been allocated by another user cannot be squeezed. An error message will result, similar to:

```
?KMON-F-Device is allocated to job 13
```

A device cannot be squeezed if any other user has MOUNTed the device. Attempts to SQUEEZE a device which is mounted by another user will result in the error message:

```
?KMON-F-Device is mounted by another user
```

The SHOW MOUNTS command may be used to determine which other jobs have the device mounted. If the device is mounted only by the job which squeezes it, then the directory and data caches are cleared after the operation and caching is resumed.

If terminal logging is being done (see the SET LOG command) and a log file is open on the device being squeezed, the log file is automatically closed and the following warning message appears:

```
?KMON-W-Closing log file
```

Warning: It is still possible to write to a device without first mounting it. If one user has a file open on a device while another user squeezes the device, the possibility of severe data corruption exists. If the user with the open file writes to the disk during or after the squeeze operation, the data will be directed to locations on the disk according to the previous directory information. When the disk is squeezed, these locations are no longer appropriate and write operations will probably corrupt other files. Never squeeze a disk to which another user may be writing data. As a defensive measure, always MOUNT any device which you plan to use. You should also ALLOCATE physical devices before squeezing.

Warning: The system checks for device mounts and open files only at the level of the SQUEEZE command. Running the DUP utility directly bypasses system checking and presents a possibility of severe device corruption. Exercise extreme caution whenever squeezing a device.

The SUSPEND Command

The SUSPEND command is used to temporarily suspend the execution of another process. The suspended process may be allowed to continue at a later time with the RESUME command. The form of the command is:

SUSPEND job-number

where job-number is the number of the process to be suspended. Job numbers may be determined with the SYSTAT command. SAME, GROUP or WORLD privilege is required to use this command depending on the project-programmer numbers of the issuing and target jobs.

The SYSTAT Command

The SYSTAT (SYstem STATus) command displays information about the performance of the system and information about each logged-on job. The SHOW JOBS and WHO commands are synonyms for the SYSTAT command. The first line indicates the amount of time since TSX-Plus was started or the RESET command was issued. The second line of the system performance information shows a breakdown of the percent of total time spent running user jobs, waiting for user I/O, waiting for swapping I/O and waiting for something to do (idle time). These percentages should add up to approximately 100%. The third line of system performance information shows the percent of the total time that some user I/O and swapping I/O was being performed. The percentages on this line are not expected to sum to 100 because they simply indicate how much of the time some I/O was taking place without considering whether jobs were running while the I/O was going on. The difference between the I/O percentages on the second line and the I/O wait percentages on the first line is a measure of the amount of overlap of job execution with I/O that took place. The RESET keyboard command may be used to reset these statistics so that the statistics may be gathered over a desired interval of system execution.

The information displayed for running jobs consists of one line per job. The first item is the job number, followed by an asterisk for the line to which you are currently attached. The next item indicates the primary line and subprocess line number for each job. If the job is a primary line, then the line number will correspond to the job number and the number in parentheses will be zero - indicating relative subprocess number 0. If the job is a subprocess, the line number will indicate the primary line from which it was started and the subprocess number relative to the primary line in parentheses. Detached jobs will be marked by "Det.". The next item is the current priority for each job. A two-character state code is printed next, indicating the current state of the job. The state codes and their meanings are as follows:

State	Meaning
HI	High priority non-interactive run state
IN	Interactive run state
IO	Waiting for non-terminal I/O to finish
LO	Fixed-low-priority run state
MI	Waiting for mapped I/O buffer
MS	Waiting for a message
RN	Normal priority non-interactive run state
RT	Fixed-high-priority run state (real-time)
SF	Waiting for access to a shared file
SL	Doing a .TWAIT, .SPND or suspended
SP	Waiting for free spool block or file entry
TI	Waiting for input from the terminal
TO	Waiting for the terminal to print output
US	Waiting for access to file management module

The characters "-Swap" are printed following the state code if the job is currently swapped out of memory. "-Lock" is displayed by the state code if the job has locked itself in memory. The number of K-bytes of memory space used by the job, shown next, includes ordinary job space, extended memory regions and the job context block (currently 6 Kb). This is followed by the connect time and CPU time used so far by the job, and the name of the program being run on the line. The last item indicates the user name except for detached jobs, which are not associated with any particular user or line. The user name may be blank.

Example:

```
.SYSTAT
Uptime: 05:34:29
System use:   Run=10%, I/O-wait=8%, Swap-wait=0%, Idle=81%
I/O Activity: User I/O=10%, Swapping I/O=0%

Job   Line    Pri   State     Size   Connect   CPU time   Program   User name
---   ------  ---   -------   -----  --------  --------   -------   ------------
 1    1(0)    50    TI-Swap   33Kb   05:35:00  00:03:40   KMON      HAIKU
 2    2(0)    40    TI        36Kb   01:53:00  00:01:36   KED       Pacific
 7    7(0)    84    SL-Lock   16Kb   01:00:00  00:03:17   LAB3      SHORE
 8    8(0)    50    RN        34Kb   05:24:00  00:00:33   COBOL     Fast
10    Det.    50    MS-Swap   62Kb   05:35:00  00:00:00   RTSORT
11    Det.    50    SL        30Kb   01:54:00  00:00:00   WINPRT
13*   2(1)    50    IN        38Kb   01:53:00  00:01:00   KMON      Pacific
```

The TECO Command

The TECO command is used to initiate an editing session with the TECO editor. The TSX-Plus TECO command is equivalent to the RT-11 TECO command.

The TIME Command

The TSX-Plus TIME command has the same form and options as the RT-11 TIME command. OPER privilege is required to set the time.

The TYPE Command

The TSX-Plus TYPE command has the same form and options as the RT-11 TYPE command. Use of this command requires NFSREAD privilege.

The UCL Command

The UCL command is equivalent to the SHOW COMMANDS command.

The UNPROTECT Command

The UNPROTECT command is used to clear file protection status. The TSX-Plus UNPROTECT command has the same form and options as the RT-11 UNPROTECT command. Use of this command requires NFSREAD privilege.

The USE Command

The USE command displays the accumulated connect time and CPU usage since log-on.

Example:

```
.USE
Connect=02:25:00  CPU=00:02:19
```

The WHO Command

The WHO command is used to display information about the system status and logged-on jobs. The WHO command is equivalent to the SYSTAT command.

The $STOP Command

The $STOP command is used to halt the execution of TSX-Plus. On some hardware configurations, this may also reboot RT-11. The form of the command is:

```
$STOP
```

The $STOP command forces an immediate logoff of all users before stopping TSX-Plus. OPER privilege is required to use this command. If other users are logged on, the system will request verification before stopping. Any response beginning with "Y" or "y" will halt TSX-Plus; any other response will return to the monitor. For example:

```
.$STOP
Other users are logged on.
Are you sure you want to stop the system?Y

Connect=01:14:22  CPU=00:11:15
```

The $SHUTDOWN Command

The $SHUTDOWN command is similar to the $STOP command in that it is used to stop TSX-Plus and may return control to RT-11. However, it differs from $STOP in the manner in which it stops TSX-Plus. $STOP forces the immediate logoff of all users, $SHUTDOWN does not. Rather, it sets a flag which prevents any new users from logging on and then waits for all logged on users to log off. When the last user logs off, TSX-Plus is stopped and control may return to RT-11. The form of this command is:

```
$SHUTDOWN
```

OPER privilege is required to use this command.

2.5 RT-11 Commands not supported by TSX-Plus

The following RT-11 keyboard commands are not supported by TSX-Plus and are ignored if issued: CLOSE, GT, LOAD, UNLOAD.

The following RT-11 keyboard commands are not supported by TSX-Plus and will result in the "Unrecognizable command" error message: ABORT, B, D, E, FRUN, GET, REENTER, SAVE, SRUN, START.

The following keyboard commands are partially equivalent between RT-11 and TSX-Plus: INSTALL, REMOVE

The following keyboard commands have different effects under RT-11 and TSX-Plus: BOOT, RESET.

The following switches are not supported by TSX-Plus with the DIBOL, COMPILE/DIBOL or EXECUTE/DIBOL commands: /BUFFERING, /LOG, /PAGE, or /TABLES.

The following SET options are not supported by TSX-Plus: EL, EXIT, or USR. The following SET TT options are not supported by TSX-Plus: CONSOL, [NO]CRLF, [NO]FB, or WIDTH.

3. COMMAND FILES

Certain series of keyboard commands may be executed together regularly, or may be so complex that it is desirable to edit and proofread them before execution. These needs are met by the facility known as indirect command files. These are files containing a set of keyboard commands to be executed together. Command files are invoked by providing the file name preceded by an "@" symbol in response to the keyboard monitor prompt. Command files may also be invoked without the "@" if their names do not conflict with system commands. See the description of keyboard command interpretation in Chapter 2 for more information on how command files may be initiated.

TSX-Plus allows the specification of parameter strings to be inserted in a command file. The parameters are stored by TSX-Plus and inserted in the text of the command file at selected points as the command file is processed. TSX-Plus also allows program data as well as system commands to be placed in a command file. Under TSX-Plus it is possible to set up a command file so that any request for data from device "TT" comes from the command file. This allows EDIT and TECO (but not KED) commands to be placed in a command file.

Command files may be executed either using normal TSX-Plus interpretation or under the control of the IND utility. Either type of control may be specified either implicitly or explicitly. The keyboard command SET KMON [NO]IND selects the desired implicit control of command files. If KMON is set IND, then command files will normally execute under the control of the IND program. If KMON is set NOIND, then command files will normally execute under TSX-Plus control. Regardless of the setting of KMON, a file may be executed under control of IND by typing:

IND file

Regardless of the setting of KMON, a file may be started as a normal command file (not under the control of IND) by typing:

$@ file

A program may determine whether it is running from an indirect command file by testing bits in the fixed offset location 366 (octal) in the simulated RMON. If the program is being run from a command file, then bits 8, 12, and 15 (mask 110400) will be set in RMON fixed offset 366. If the program is not running from a command file, then these three bits will be clear (0).

Examples:

1. Execute the command file DK:DAILY.COM under control of the IND utility regardless of the setting of KMON:

   IND DAILY

2. Execute the command file DL1:WEEKLY.COM under normal TSX-Plus control regardless of the setting of KMON:

   $@DL1:WEEKLY

3.1 Invoking command files

A command file is invoked by typing:

@filename [param1 [param2 ... [param6]]]]]]

where "filename" is the name of the command file and "param1", "param2", etc. are optional parameter string arguments to the command file. The default extension for a command file is "COM".

When the name of a command file does not conflict with a system command, the command file may be invoked by typing:

filename [param1,...param6]

That is, the "@" may be left out. With or without the "@" sign, if no device is specified device "DK" is first searched for the command file. Then, only without the "@" sign, if the named file is not found, then TSX-Plus attempts to locate the command file on device "SY". See Chapter 2 for a description of the steps used by TSX-Plus to interpret keyboard commands. Listing control for command files differs whether the "@" sign is used or not. If the "@" is used, then listing is controlled by the current value of the SET TT [NO]QUIET option. If no "@" is used, then listing is disabled -- as if a SET TT QUIET had been issued. In either case, the command file itself can control its own listing status with a SET TT [NO]QUIET command or with the control characters described later in this chapter.

3.2 Parameter strings

Parameter strings are normally delimited by spaces. Thus in the command:

@TSTRUN ABC 123.45 2/3

the string "ABC" is parameter 1, "123.45" is parameter 2 and "2/3" is parameter 3. In some cases it may be desirable to include spaces as part of a parameter string. If this is to be done, the first parameter must begin with the character "\" (backslash), and the backslash must be used as the parameter delimiter rather than spaces. For example, in the command line:

```
@TSTRUN \A STRING\OF PEARLS
```

parameter 1 is "A STRING" and parameter 2 is "OF PEARLS".

Up to six parameter strings may be specified when the command file is started. The total number of characters in the combined parameter strings may not exceed 60.

Parameter strings are inserted into the command file during execution at locations specified by an up-arrow (^). The parameter to be inserted is designated by a digit (1 to 6) immediately following the "^". During execution of the command file, the "up-arrow-digit" sequence is replaced by the parameter string passed to the command file in the position specified by the digit. If a parameter string is called for that was not specified when the command file was invoked, the up-arrow-digit will be ignored and no characters will be inserted in their place. For example, consider the following command file named TEST.COM:

```
R ^1
^3=^2
```

When this command file is invoked with the following command:

```
@TEST FORTRAN PROG
```

the command file is executed as if it contained the commands:

```
R FORTRAN
=PROG
```

Command files may be nested. That is, one command file may call another command file. When such a call occurs, the parameter strings for the outer level (calling) command file are stored on a stack in TSX-Plus and then the parameter strings for the called command file are set up. When the called command file finishes, the parameters for the calling command file are restored. The maximum depth of nesting is governed by the size of the parameter string stack and the length of the actual parameter strings. A nesting depth of 3 can be reached even with very long parameter strings. If no parameters are specified, the nesting depth may go to about 7 levels.

The command file listing status (SET TT [NO]QUIET) is also stacked as command files are nested. This means that an inner nested command file may have its listing turned on or off. When its execution is completed and control returns to the next outer level command file, the listing control is restored to the state in effect when the inner command file was called. This is not done for the outer-most command file, however, so the SET TT [NO]QUIET state in effect on completion of the outer level command file remains in effect when control is returned to the keyboard monitor.

3.3 Comments in command files

Comments may be included in command files following an exclamation point (!). Anything on a line in a command file following an exclamation point will be treated as comment. For example, in a command file containing the lines:

```
DISPLAY Watch out!  Files may be destroyed.
PAUSE Hit RETURN to proceed   !Requires operator response
```

the resulting output would be:

```
Watch out
PAUSE Hit RETURN to proceed
>>
```

When an exclamation mark (!) is used in a command file line to be input as data to a program, then the exclamation mark and all text following it on the input line are not passed to the program.

3.4 Command file control characters

Several combinations of characters take on special meaning when they are found within a command file. The up-arrow character (^) followed by a letter is replaced by the control character corresponding to the letter specified. Thus "^C" becomes control-C. The escape character may be represented by up-arrow, dollar sign (^$). The up-arrow character itself may be represented in the command file by preceding it with another up-arrow (^^).

Several character combinations act as special commands to influence the execution of the command file. These commands take effect at the point of their occurrence in the command file. The characters in these special sequences are not passed to programs.

Command Sequence	Function
^(	Stop listing command file. This has the same effect as SET TT QUIET, except that it only applies to the current command file.
^)	Start listing command file. This has the same effect as SET TT NOQUIET except that it only applies to the current command file.
^!	Suppress all terminal output. Both the command file listing and any program terminal output are suppressed. The "^(" and "^)" command sequences restart program generated output.

^> Accept all terminal input from the command file. Command file data is normally only passed to programs which request lines of input (using the EMT calls: .GTLIN, .CSISPC and .CSIGEN). RT-11 handles command file data in this manner. Programs called by a command file which request terminal input with the EMT calls .TTYIN or .READ normally still expect to get this from the terminal and cannot use command file data as input to these requests. The "^>" command sequence causes all subsequent requests for terminal input to come from the command file regardless of which EMT is used. This allows data for application programs to be placed in a command file. It also allows commands for TECO and EDIT to be placed in a command file. This command only affects input requests that occur after TSX-Plus reads the "^>" sequence. See also the description in Chapter 6 of the "N" and "O" program controlled terminal options that affect command file input.

^< Return to standard data mode. Subsequent command file data will only be passed to programs which do .GTLIN, .CSISPC or .CSIGEN EMTs (standard RT-11 mode).

^Z Control-Z is translated to control-C in command files.

3.5 PAUSE Command

The PAUSE command is provided to suspend the execution of a command file while the operator performs some manual operation. The form of the PAUSE command is:

PAUSE comments

where "comments" may be any string of characters. When a PAUSE command is executed, the PAUSE command is displayed at the terminal followed by ">>". Execution of the command file is then suspended until carriage return is typed.

3.6 DISPLAY Command

The DISPLAY command causes a line of text to be displayed at the terminal. The form of the DISPLAY command is:

DISPLAY comments

where "comments" may be any line of text to be printed at the terminal. This is useful to mark progress through command files running in "quiet" mode (not being listed).

4. DETACHED JOBS

The TSX-Plus Detached job facility is similar to subprocesses created by the process window facility (see Chapter 1): they both allow a time-sharing user to execute several jobs simultaneously. The major difference between detached jobs and subprocesses is that you may switch back and forth among subprocesses, but once a detached job is started it is dissociated from any terminal. Detached jobs operate more like a "batch" facility. ALL terminal input for a detached job must come from a command file. Any terminal output generated by a detached job is discarded. However, terminal logging may be enabled for detached jobs to accept their terminal output; see the SET LOG command.

The differences between subprocesses and detached jobs are summarized below.

1. Terminal communication may be switched among several subprocesses. A detached job must receive all its terminal input from a command file and any terminal output it generates is discarded (unless terminal logging directs the output to a log file). If a detached job requests terminal input and is unable to obtain it from a command file, the job is terminated.

2. Subprocesses are "owned" by a physical line. When the physical line logs off, the subprocesses also log off. Detached jobs are not associated with any physical line. Once started, any or all time-sharing users may log off without affecting detached jobs.

3. Detached jobs may be started automatically when TSX-Plus is initiated. Subprocesses must be started by time-sharing users after TSX-Plus is running.

4. When a detached job reaches the end of its command file and asks for more terminal input, the job is aborted and the detached job slot is freed. Subprocesses wait for more input.

There are three ways to start detached jobs: 1) during system generation specify a command file to be started as a detached job whenever TSX-Plus is started; 2) use the keyboard DETACH command; 3) use the TSX-Plus EMT to start a detached job from a running program. Detached jobs that are initiated automatically when the system is started run with ALL privilege. Detached jobs initiated by use of the DETACH command or the EMT inherit the characteristics of the (sub)process starting them.

4.1 The DETACH command.

The DETACH command is used to start a detached job, check its status and abort the job. The system manager may restrict the use of the DETACH command. The process which starts a detached job is known as the "parent" of the detached job.

4.1.1 Starting a detached job:

The form of the DETACH command used to start a detached job is:

DETACH file-spec [parameters]

where "file-spec" is the name of a command file to be executed as a detached job. The default device is "DK:" and the default extension is "COM". Use of the DETACH command requires DETACH privilege. "Parameters" is a string of parameters to be passed to the detached job command file just as if you were passing parameters to an ordinary command file. The ^n mechanism is used within the detached job command file to accept the parameters.

A detached job inherits characteristics (such as job name, device assignments, privileges, etc.) from its parent in the same way as subprocesses do, except that detached jobs inherit their characteristics from the (sub)process starting them, rather than always from the primary process as subprocesses do. See Chapter 1 for a list of the job characteristics which are inherited by subprocesses and detached jobs when they are started.

When a request is made to start a detached job, TSX-Plus searches for a free detached job slot. The total number of such job slots is established when TSX-Plus is generated. If a free slot is found, the job is started and a message is printed saying which job slot was used. This number may be used later to reference the detached job. The SYSTAT command also indicates detached job numbers and flags detached jobs with "Det.". If "file-spec" is preceded by the symbol "@", then the first line of the command file will be used by the detached job, but any remaining commands in the file will be associated with the job currently connected to the terminal.

Examples:

1. Start a command file "PURGE.COM" as a detached job.

```
DETACH PURGE
```

2. Start a command file named "RK1:STATS.NEW".

```
DETACH RK1:STATS.NEW
```

3. Start the command file PURGIT as a detached job and pass the string "OLDFIL" as a parameter.

```
DETACH PURGIT OLDFIL
```

The system manager determines the number of slots available for detached jobs and who may use detached jobs. The job numbers assigned to detached jobs start after the slots reserved for primary time-sharing lines. Subprocesses are assigned line numbers above any slots reserved for detached jobs.

4.1.2 Checking the status of a detached job:
The form of the DETACH command used to check the status of a detached job is:

DETACH/CHECK line-number

where "line-number" is the job slot number listed when the job was started. TSX-Plus displays the status (active or free) of the detached job.

Examples:

1. Check the status of the job on line #4.

```
DETACH/CHECK 4
Line is active
```

2. Check the status of the job on line #5.

```
DETACH/CHECK 5
Line is free
```

4.1.3 Aborting a detached job:
The form of the DETACH command used to abort a running detached job is:

DETACH/KILL line-number

where "line-number" is the job slot number listed when the job was started. Use of the DETACH/KILL command requires DETACH privilege. GROUP privilege is required to kill a detached job with a different programmer number than your own. WORLD privilege is required if the detached job has a different project number or if the detached job was started automatically by being specified as a system detached job during system generation. For example, to kill the detached job on line #4:

```
.DETACH/KILL 4
Job aborted
```

4.2 Detached job control EMTs.

TSX-Plus provides a set of EMTs that can be used to control the operation of detached jobs. Using these EMTs it is possible to start a detached job, kill a detached job and check the status of a detached job.

4.2.1 Starting A Detached Job:

This EMT can be used to start the execution of a detached job. Use of this EMT requires DETACH privilege. The process which issues this EMT is known as the "parent" of the detached job it starts. The form of the EMT is:

```
        EMT     375
```

with R0 pointing to the following argument block:

```
        .BYTE   0,132
        .WORD   name-address
```

where "name-address" is the address of an area containing the name of the command file to be started as a detached job. The command file name must be stored in ASCIZ form and may contain an extension. If a free detached job line is available, the specified command file is initiated as a detached job and the number of the detached job line is returned in R0. A detached job started by use of this EMT inherits the characteristics of the (sub)process that is executing the EMT. If there are no free detached job lines, the carry bit will be set on return.

Example:

```
        .TITLE  STRTDJ
        .ENABL  LC

;Start a job on a TSX-Plus detached line

CR      = 15
LF      = 12
ERRBYT  = 52

        .MCALL  .ENTER,.WRITW,.CLOSE,.PRINT,.EXIT

START:  CLR     R1              ;Channel number
;No .FETCH is necessary under TSX-Plus, handlers are always resident.
1$:     .ENTER  #AREA,R1,#FILR50,#1     ;Open a one block file
                                        ;on first free channel.
        BCC     2$              ;Branch on successful .ENTER
        TSTB    @#ERRBYT        ;Why didn't .ENTER work?
        BNE     NOROOM          ;Error = 1 :not enough room for file
        INC     R1              ;Try next higher channel
        CMP     R1,#17          ;Last channel? .CDFN not supported by
                                ;TSX-Plus, so legal channels are 0-15.
        BLE     1$              ;OK, retry on next channel
        .PRINT  #NCA            ;Ran out of channels
        BR      DONE

2$:     .WRITW  #AREA,R1,#COMNDS,#<<CMDEND-COMNDS+1>/2>,#0
        BCS     WRTERR          ;Bad write?
```

```
        .CLOSE  R1              ;Close the file
        MOV     #STRTDJ,R0      ;Point to EMT arguments to
        EMT     375             ;Start the detached job
        BCS     DTCHER          ;Bad start of detached job?
        BR      DONE

NOROOM: .PRINT  #NER            ;Not enough room error
        BR      DONE
WRTERR: .PRINT  #BADWRT         ;.WRITW error
        .CLOSE  R1
        BR      DONE
DTCHER: .PRINT  #BADDET         ;STRTDJ error
DONE:   .EXIT

AREA:   .BLKW   5               ;EMT Argument area
STRTDJ: .BYTE   0,132           ;EMT arguments to start a detached job
        .WORD   FILNAM          ;Pointer to name of command file
        .NLIST  BEX
FILR50: .RAD50  /SY CKSTATCOM/  ;RAD50 name of command file to be detached
FILNAM: .ASCIZ  /SY:CKSTAT.COM/ ;ASCII name of command file to be detached
COMNDS: .ASCIZ  /R CKSTAT/<15><12> ;Start a monitoring program
CMDEND:
NER:    .ASCIZ  /?STRTDJ-F-Not enough room for command file./<7>
NCA:    .ASCIZ  /?STRTDJ-F-No channels available for command file./<7>
BADWRT: .ASCIZ  /?STRTDJ-F-Error writing command file./<7>
BADDET: .ASCIZ  /?STRTDJ-F-Error starting detached job./<7>

        .END    START
```

4.2.2 Aborting a detached job:

This EMT may be used to abort a detached job. Use of this EMT requires DETACH privilege. The form of the EMT is:

```
        EMT     375
```

with R0 pointing to the following argument block:

```
        .BYTE   2,132
        .WORD   job-number
```

where "job-number" is the job number of the detached job to be killed. If the job number is not valid for detached jobs, the carry flag will be set on return and the EMT error byte will be set to 1.

Example:

```
        .TITLE  CKABDJ
        .ENABL  LC

; Check status of a detached job and abort it if running

        .MCALL  .EXIT,.PRINT

START:  MOV     #STATDJ,R0      ;Point to EMT arg block to
        EMT     375             ;Check status of a detached job
        BCC     1$              ;If still on, kill it
        .PRINT  #NOTON          ;Else, say it isn't active
        .EXIT

1$:     MOV     #ABRTDJ,R0      ;Point to EMT arg block to
        EMT     375             ;Abort detached job
        BCS     ABERR           ;Since we checked, should never err
        .PRINT  #KILLED         ;Say we killed it
        .EXIT

ABERR:  .PRINT  #ABERMS
        .EXIT

STATDJ: .BYTE   1,132           ;EMT arg value to check detached job status
        .WORD   9.              ;Line number of detached job to be checked
ABRTDJ: .BYTE   2,132           ;EMT arg value to abort a detached job
        .WORD   9.              ;Line number of detached job to be killed
        .NLIST  BEX
ABERMS: .ASCIZ  /?CKABDJ-F-Invalid detached job number/<7>
NOTON:  .ASCIZ  /?CKABDJ-I-No detached job on line #9/<7>
KILLED: .ASCIZ  /Detached job on line #9 killed./

        .END    START
```

4.2.3 Checking the status of a detached job:

This EMT may be used to check the status of a detached job. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   1,132
.WORD   job-number
```

where "job-number" is the number of the detached job to be checked. If the detached job is still active the EMT returns with the carry-flag cleared. If the detached job has terminated and the detached job line is free, the EMT returns with the carry-flag set.

Example:

See the example program CKABDJ in the previous section.

5. DEVICE SPOOLING

5.1 The concept of device spooling

Device spooling is a technique that provides more efficient use of slow peripheral devices. Data sent to spooled devices is automatically redirected to a high speed disk file for temporary storage and passed on when the slow device is ready to accept it. This allows a program generating data for the spooled device to continue processing without being slowed down by the peripheral. TSX-Plus optionally provides automatic spooling to output devices such as printers, card punches and plotters. More than one device may be spooled.

When a program directs output to a spooled device, the output is diverted by TSX-Plus to a disk spool file. An entry is made in a spool file table indicating that a spool file is ready for the spooled device. When the spooled device becomes free, the spool file is copied by TSX-Plus to the device. All of the processing is automatic and the user does not have to be concerned with its operation. In fact, a user can run programs without waiting for their output to be printed. Devices to be spooled must be declared when the system is generated.

Spooled device handlers such as LP must be set to the "HANG" mode of operation to work properly with the TSX-Plus spooler. This can be done with the SET command. For example:

```
SET LP HANG
```

Since the SET command actually stores this information permanently in the disk copy of the device handler, it need only be issued once.

5.2 Directing output to spooled devices

Output is sent to a spooled device in exactly the same way as it would be directed to the device if it were not spooled. For example, if the line printer (LP) were spooled, the following commands would send a FORTRAN listing to the printer:

```
.R FORTRA
*TEST,LP:=TEST
```

or

```
PRINT TEST.LST
```

The name of a spooled device may be used in a MACRO .ENTER command just as a non-spooled device would.

Any number of users may simultaneously write to a spooled device without conflict. TSX-Plus separates the output from each user and prints it in an orderly fashion. A user may direct output through several I/O channels to the same or different spooled devices.

5.3 Operation of the spooler

The spooling system consists of a memory resident spool file control table which contains information concerning the user's spool file and a single, system-managed spool data disk file which contains the user's intercepted output. Every time a user opens an output channel to a spooled device, a new entry is created in the spool file control table. Output records directed through separate channels to the same device have separate entries in the spool file control table. Placement in this table is governed by the processing of the user's open request for the spooled device.

The total number of spooled files that may be in existence is specified when TSX-Plus is generated. A spooled file is created when an I/O channel is opened to a spooled device; the file remains in existence until all of the output is processed by the spooled device. If a program opens a channel to a spooled device and the spool file control table already contains the maximum number of spooled files, the program is suspended until a slot becomes available in the spool file control table.

All output directed to spooled devices is stored in a common disk data file. The total file space that is available for spooled data is specified when the TSX-Plus system is generated. Space within this disk file is dynamically allocated as needed on a block by block basis. Each block contains 508 bytes of user's output data. Therefore, write requests smaller than 508 bytes will be combined into one spool data block. A write request larger than 508 bytes will be split into more than one spool data blocks. If the spool data file is totally filled, programs writing to the spooled device will be suspended until space becomes available.

Actual output to the spooled devices is processed on a sequential first-in/first-out basis. Since output is actually coming from the disk file, each I/O request to the device handler is the size of the spool data block (508 bytes). While spooled files are being printed, TSX-Plus maintains a list of the blocks most recently printed. The length of this list is specified by the number of backup blocks declared during system generation. When the list becomes full, the oldest block is deallocated and the new block is added. When the entire spooled file has been successfully written, the entire list is deallocated.

Read requests from a spooled device (.READ and .SPFUN requests) bypass the spooling system and connect directly with the device handler.

5.4 The SPOOL Command

The SPOOL command is used to control the operation of the spooling system. The form of the SPOOL command is:

SPOOL device,function,parameter

where device is the name of a spooled device, function indicates the operation to be performed, and parameter is only used with some functions.

A second form of the SPOOL command is used to delete current or pending files in the spooler queue. The form of this command is:

SPOOL device,DELETE [id-number]

where the optional id-number is assigned by the system and can be determined from the SHOW QUEUE or SPOOL device,STAT commands.

The device name may refer to either the physical name of a spooled device (such as LP, LS, or CL2) or a logical name assigned to a spooled device. For example:

ASSIGN CL2 LP

The two following commands are then equivalent:

SPOOL CL2,STAT
SPOOL LP,STAT

A device specified without a unit number is equivalent to unit 0 (e.g., CL = CL0).

The FORM and LOCK Functions

The FORM and LOCK functions are used to specify the name of the currently mounted form. Use of the FORM and LOCK functions requires OPER privilege. The form name is specified in the parameter field of the command. The FORM function allows TSX-Plus to request a form mount when a different form is needed. The LOCK function specifies that the form is to be locked on the printer and disables form mount request messages.

Examples:

SPOOL LP,FORM,BILLS
SPOOL LP,LOCK,BILLS
SPOOL LP,FORM,STD

Note the difference between the FORM keyboard command and the SPOOL command with the FORM or LOCK functions. The FORM command is used by the TSX-Plus user to specify the default form name to be used for subsequent spool files. The SPOOL FORM/LOCK commands are used by the TSX-Plus operator to tell the spooling system which form is currently mounted.

The ALIGN Function

The ALIGN function is used to print a form alignment file on a spooled device. Use of the ALIGN function requires OPER privilege. The name of the alignment file is specified in the parameter field of the command. The default file extension for form alignment files is "ALN".

Examples:

```
SPOOL  LP,ALIGN,BILLS
SPOOL  LP,ALIGN,RK1:PAYROL.DAT
SPOOL  LP,ALIGN,DX:RPORT2
```

The DELETE Function

The DELETE function is used to remove a file from the list of files to be printed by the spooler. Use of the DELETE function does not require any special privilege. This form of the SPOOL command is:

```
SPOOL device,DELETE [id-number]
```

If the id-number is omitted, then the file currently being printed on the specified device is aborted. If the file is open, the file is marked to be deleted but is not actually deleted until it is closed and the spooler begins to process it. If the file is currently being printed when the delete command is issued, the spooler deletes blocks as they become available and the spooled device is tied up until the file deletion is completed.

When an id-number is specified, that number is used to identify the file to be deleted. In this case, device may be the name of any spooled device and does not have to match the device on which the file is actually being printed.

A spooled file id-number may be determined from either the SHOW QUEUE command or the SPOOL device,STAT command. For example:

```
SHOW QUEUE
 ID   Dev  Job   File    Form   Blocks
----  ---  ---  ------  ------  ------
 37  LP *   1   PAYROL  STD      135
 39  LP     1   GL      STD       25
 41  LP     1   AR      STD       86
```

Examples:

To delete the file "PAYROL" currently being printed on LP:,

```
SPOOL LP,DELETE
```

To delete the file "AR" which has not yet started printing,

```
SPOOL LP,DELETE 41
```

The SKIP Function

The SKIP function causes the spooler to skip over the next n blocks in the spool file that is currently being printed, where n is specified in the parameter field of the instruction. Use of the SKIP function requires OPER privilege. Each block in the spool data file contains 508. characters. Printing of the file continues after the indicated number of blocks have been skipped.

Examples:

```
SPOOL  LP,SKIP,10
SPOOL  LP,SKIP,100
```

The BACK Function

The BACK function causes the spooler to skip backward in the spool file a number of blocks and then resume printing at that point. Use of the BACK function requires OPER privilege. The number of blocks involved is specified when TSX-Plus is generated. Each block in the spool data file contains 508. characters. This function is particularly useful for recovering from paper tears or remounts. The spooler will finish printing the current block before backing up.

Examples:

```
SPOOL  LP,BACK
SPOOL  LS,BACK
```

The STAT Function

The STAT function is used to determine the status of a spooled device. Use of the STAT function does not require any special privilege. Information returned includes: the condition of the spooler (active, idle, or waiting for a form mount); the name of the currently mounted form; and information about files waiting to be printed on the device. The SHOW QUEUE command may also be used to display information about files in the spooler queue.

Example:

```
SPOOL  LP,STAT
Spooler idle
Currently mounted form = STD
No files in queue
```

The SING and MULT Functions

The SING and MULT functions control how the spooler will handle multiple files queued for the same form. Use of the SING and MULT functions requires OPER privilege. In "MULT" mode (the initial setting) no form mount request message is generated if a spool file is found that needs the currently mounted form. Processing of the file begins automatically.

In "SING" mode a form mount request is generated for every file even if the file needs the currently mounted form. This is useful where equipment setup or form alignment is needed for every file.

Examples:

```
SPOOL  LP,SING
SPOOL  LP,MULT
```

The HOLD and NOHOLD Functions

A spooled device that is in the HOLD mode will not begin to process a spool file until the file is completely created and the I/O channel associated with the file is closed. A spooled device that is in NOHOLD mode will begin to process a spool file as the file is being created. In NOHOLD mode, the spooler will begin to process a file sooner; however, if the file is being created slowly, the spooled device will remain busy (and unavailable to other users) for as long as it takes to finish generating the file. If the spool storage file is completely filled, the spooler will attempt to free space by beginning to process open spool files even if HOLD is in effect.

Use of the HOLD and NOHOLD functions requires OPER privilege. The default mode is established when the TSX-Plus system is generated. A [NO]HOLD command remains in effect until another [NO]HOLD command is issued or the system is restarted.

Examples:

```
SPOOL  LP,NOHOLD
SPOOL  LP,HOLD
```

It is also possible to dynamically request that a file being printed through the spooler be either held until the file is closed or begin printing as data is made available from the program. This could be used in a situation where NOHOLD is the normal condition, but a program which uses the printer generates data slowly. If data were passed to the printer as soon as available, then printer output from all other jobs would be delayed until the slow job closes the output. This can be avoided by the having the slow program select hold mode for its output. Then, other jobs can proceed to use the printer without being delayed by the slow job. The form of the EMT to select hold or nohold mode on an individual file basis is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   chan,151
.WORD   0
.WORD   flag
```

where "chan" is the channel number which has been used to open the print file and "flag" indicates whether the file is to be printed as it is generated or held until the file is closed. If "flag"=0, the output is printed as generated (equivalent to NOHOLD); if "flag"=1, then the output is not printed until the file is closed. This EMT must be issued after a channel has been opened to the printer (through the spooler), but before any data has been written to it. If the channel is open to any non-spooled device, then the EMT is ignored.

Example:

```
        .TITLE  SPHOLD
        .ENABL  LC
;
; Demonstrate the EMT to hold spooler output until the file is closed
;
        .MCALL  .CSISPC,.LOOKUP,.READW,.WRITW,.CLOSE,.EXIT
ERRBYT  = 52                            ;EMT error code byte location
START:  .CSISPC #OUTSPC,#DEFEXT,#0      ;Get name of file to copy
        BCS     START                   ;Proceed unless error
        MOV     #INSPC,R1               ;Point to first input filspc
OPNFIL: .LOOKUP #AREA,#0,R1             ;Try to open input file
        BCS     START                   ;Get a new command on error
        MOV     #OUTSPC,R2              ;Point to output filspc
        MOV     #^RLP ,(R2)+            ;Put LP: in output filspc
        ADD     #2,R1                   ;Point to input filspc filename
        MOV     (R1)+,(R2)+             ;Move file name into LP filspc
        MOV     (R1)+,(R2)+             ; (not necessary, but convenient)
        TST     (R1)+                   ;Skip over file extension
        .LOOKUP #AREA,#1,#OUTSPC        ;Open channel to printer (spooled)
        BCC     NOHOLD                  ;Proceed unless error
GIVEUP: .CLOSE  #0                      ;Close input file
        .EXIT                           ;And give up
;
; Tell spooler to hold file until it is closed
; (must be issued before any writes to file)
;
NOHOLD: MOV     #SPHOLD,R0              ;Point to EMT arg block to
        EMT     375                     ;Hold output until close
        CLR     R2                      ;Initialize block pointer
6$:     .READW  #AREA,#0,#BUFFER,#256.,R2 ;Copy a block from the file
        BCS     NXTFIL                  ;Try next file on error
        .WRITW  #AREA,#1,#BUFFER,#256.,R2 ;Copy the file block to LP
        BCC     8$                      ;Error?
        .CLOSE  #1                      ;Close print file
        BR      GIVEUP                  ;Forget it
8$:     INC     R2                      ;Point to next block
        BR      6$                      ;And get next block
NXTFIL: .CLOSE  #0                      ;Close input file
        .CLOSE  #1                      ;and print file
        TST     2(R1)                   ;Any input file?
        BNE     OPNFIL                  ;Repeat if so
        BR      START                   ;Else ask for more files

AREA:   .BLKW   10                      ;General EMT arg block area
SPHOLD: .BYTE   1,151                   ;EMT arg block to hold spool output
        .WORD   0                       ;on channel 1 until file is closed
HNH:    .WORD   1                       ;HNH=0 immed; HNH=1 hold til close
OUTSPC: .BLKW   15.                     ;Output file specs
```

```
INSPC:  .BLKW   24.             ;Input file specs
DEFEXT: .WORD   0,0,0,0         ;No default file types
BUFFER: .BLKW   256.            ;I/O buffer area
        .END    START
```

5.5 Use of special forms with spooled devices

Output files directed to spooled devices are queued and held until the spooled device becomes free. Because of this, a special procedure is required to synchronize the mounting of a special form with the printing of a file that requires the form.

If the first character in a file directed to a spooled device is a right square bracket (]), TSX-Plus will interpret the following one to six characters in the file as the name of the form on which the file should be printed. Form names may be from one to six characters in length and must be specified immediately following the initial square bracket character. The form name must be terminated with a carriage return, line feed. Square bracket characters are not significant to the spooler in any position other than the first character of the file.

If a spooled file does not begin with a right square bracket character, TSX-Plus uses the form name that was last specified by the user with a FORM command (see Chapter 2). If no FORM command has been issued by the user, TSX-Plus uses the form name "STD" for the file.

Each time TSX-Plus selects a file to be printed on a spooled device, it first looks for a waiting file that requires the form currently mounted on the spooled device. If several such files are available, the oldest one is started. If no file can be found that requires the currently mounted form, TSX-Plus selects the oldest file requiring a different form and issues a form mount request. The message appears on the operator's terminal as:

"Mount 'xxxxxx' form on ddn"

where xxxxxx represents the form name; dd is the spooled device name; and n indicates the device unit number. The terminal to which the message is directed is the one declared as the operator's console when the TSX-Plus system was generated.

Once the form mount request message is sent, the spooler for the device requiring the new form is suspended. In order to restart the spooler the operator must issue a SPOOL-FORM or SPOOL-LOCK command. These commands tell the spooler that a particular form has been mounted and is ready for use. The operator does not have to mount the form called for in the form mount request, but may mount any form desired, in which case TSX-Plus will search for a spool file that needs the form actually mounted.

The SPOOL-FORM and SPOOL-LOCK commands are both used by the operator to indicate which form has been mounted; however, there is a difference in the effect of the two commands. After processing all files that need the currently mounted form, TSX-Plus checks for files requiring a different form. If there are any, it checks to see if the current form was mounted using a SPOOL-FORM or SPOOL-LOCK command. If a SPOOL-FORM command was used, TSX-Plus issues a form mount request message. If a SPOOL-LOCK command was used, TSX-Plus considers the current form to be locked on the printer and does not issue a form mount message; rather, it waits for new spool files to be created that need the currently mounted form.

5.6 Form alignment procedure

When mounting a new form it is usually necessary to verify the correct positioning of the form before starting production printing on the form. The SPOOL-ALIGN command provides this facility.

The SPOOL-ALIGN command allows the TSX-Plus operator to specify a form alignment file to be printed on the indicated spooled device. Form alignment files are printed immediately without regard to the name of the currently mounted form. The SPOOL-ALIGN command may be issued repeatedly if several attempts are required to mount a form.

Alignment files are created by the user and may contain any desired information. Typically they contain a short sample output file that matches a particular form. Alignment files should not contain a form name specification. The normal sequence of operations involving a form mount is as follows:

1. TSX-Plus issues a form-mount request message and suspends the spooler.

2. The operator mounts the desired form and issues one or more SPOOL-ALIGN commands to verify its positioning.

3. Once the form is correctly positioned, the operator issues a SPOOL-FORM or SPOOL-LOCK command to tell TSX-Plus which form has been mounted.

4. TSX-Plus begins printing the oldest file that needs the currently mounted form.

The SPOOL-ALIGN command may be issued at any time, but it is typically used between a form-mount message and a SPOOL-FORM or SPOOL-LOCK command.

6. PROGRAM CONTROLLED TERMINAL OPTIONS

6.1 Terminal input/output handling

The terminal keyboard and screen provide the principal interface between a time-sharing user and the TSX-Plus operating system. TSX-Plus accepts characters from the keyboard, echoes them to the screen, and stores them in a separate buffer for each time-sharing user. When a program (either a user written program, a utility, or the operating system keyboard monitor) requests input from the terminal, characters are removed from the internal buffer and passed to the program.

6.1.1 Activation characters

The low-level requests for input from a program can call for a single character (.TTYIN), for an entire line (.GTLIN, .CSIGEN, .CSISPC), or for a whole block of characters (.READ). Since the requests for a whole line of input are most common, TSX-Plus improves overall efficiency for many users by retaining characters typed at the keyboard in an internal buffer until a special character is typed which indicates that the line of input is complete. This special character, which indicates that keyboard input is ready, is called an activation character. The standard activation characters are carriage return and line feed. Several control keys will also cause immediate system response. For example, control-C is used to abort the execution of a running program. If the program is waiting for input, one control-C will cause an immediate abort. If the program is not waiting for input, it is necessary to type two control-C's to get the system's attention to abort a program.

When a program requests terminal input, TSX-Plus puts the program in a suspended state until an activation character is typed. This state, in which a program is waiting for input but no activation character has been typed, is identified as the TI state by the SYSTAT command. When characters are typed at the terminal, TSX-Plus responds quickly and stores them in the terminal input buffer for that line, then returns to process other jobs which need its attention. Thus, the amount of time the CPU spends processing input characters is kept to a minimum, and the amount of CPU time used by a program in the TI state is also very small. Some programs request single characters with the .TTYIN request. Normally, these programs are treated by TSX-Plus in the same way as those requesting lines of input (e.g., .GTLIN requests). That is, the job is suspended, input characters are stored in the terminal input buffer, and characters are only passed to the program after an activation character is typed. If a program requests a character with a single .TTYIN, the user can type as many characters as the terminal input buffer will hold (allocated during system generation), but the program will remain suspended and no characters are passed to the program. Then, when an activation is typed, the program is restored to an active state, the first character in the input buffer is passed to the program and processing continues. If the program requested no more characters, then on program exit the remainder of the input buffer, including the activation character, would be passed to the next program (usually the keyboard monitor) which would try to interpret them. This may result in an invalid command error message.

6.1.2 Single character activation

TSX-Plus gives the programmer a wide variety of ways to influence the normal input scheme outlined above. One of the most common methods is the use of "single character activation". With this technique, all characters are regarded as activation characters. If a program requests a single character with a .TTYIN, then as soon as a character is typed and becomes available in the input buffer, it is passed to the program and the program resumes execution.

The standard way to request single character activation under RT-11 is by setting bit 12 in the user's Job Status Word (JSW). Under TSX-Plus, this is not by itself sufficient to cause single character activation. The reason is that quite a few programs designed for a single user environment use this method in a way that causes constant looping back and consequently "burns up" a large amount of processor time. In a single user environment this is of minor importance since no other jobs are trying to use the processor at the same time. In a multi-user system, this is wasteful and should be avoided. Therefore, under TSX-Plus, setting bit 12 in the JSW is not by itself sufficient to initiate single character activation. It is necessary BOTH to set bit 12 and to issue a special command to TSX-Plus indicating that single character activation is actually desired. This may be done in any of the following ways:

1. Specify the /SINGLECHAR switch with the RUN or R command that starts the program.

2. Issue a SET TERMINAL SINGLE command.

3. Use the INSTALL command to install the program with the SINGLECHAR attribute (the description of the INSTALL command is in the TSX-Plus System Manager's Guide).

4. Use the "S" program controlled terminal option described in this chapter.

Note that when a program is in "single character activation" mode, the system does not echo terminal input, it is the program's responsibility to do so.

6.1.3 Non-blocking .TTINR

The situation in which a program requests single characters but none are available in the input buffer also receives special treatment. The single character input request is eventually coded as EMT 340. The .TTYIN request repeats this request until a character is finally obtained, whereas the .TTINR request supposedly permits processing to continue if no character is available. In fact, the EMT 340 call will suspend the job until a character is available from the input buffer. This is referred to as "stalling" on a .TTYIN. The purpose is to avoid the unnecessary looping back to get a character. Under RT-11, if the programmer decides not to wait for a character to become available, but rather proceed with execution, it is only necessary to set bit 6 (100 octal) in the Job Status Word. Some programs abuse this technique and would waste the system resources in a time-sharing environment. TSX-Plus

requires confirmation that the user is aware of the extra system load that could be caused by the constant looping back to check for a character. If you wish to have TSX-Plus return from the EMT 340 with the carry flag set if a character is not available, you must set bit 6 in the Job Status Word and also do one of the following things:

1. Specify the /SINGLECHAR switch with the RUN or R command that starts the program.

2. Issue a SET TERMINAL NOWAIT command.

3. Use the INSTALL command to install the program with the NOWAIT attribute (the description of the INSTALL command is in the TSX-Plus System Manager's Guide).

4. Use the "U" program controlled terminal option described in this chapter.

6.1.4 Non-blocking .TTOUTR

Normally when a program sends output to the terminal using a .WRITE, .PRINT, .TTYOUT, or .TTOUTR EMT, if the terminal output buffer is full, TSX-Plus suspends the program until space becomes available in the output buffer. If you wish to use the .TTOUTR EMT to send output to the terminal and have TSX-Plus return from the EMT with the carry flag set if the output buffer is full, you must do the following things:

1. Use the .TTOUTR EMT rather than .TTYOUT.

2. Set bit 6 in the Job Status Word.

3. The instruction following the .TTOUTR EMT must not be [BCS .-2].

4. The program must be run with no-wait mode by performing one of the following actions:

   a) Specify the /SINGLECHAR qualifier with the RUN or R command that starts the program.

   b) Issue a SET TERMINAL NOWAIT command.

   c) Use the INSTALL command to install the program with the NOWAIT attribute.

   d) Use the "U" program controlled terminal option described in this chapter.

TSX-Plus allows many other ways of modifying terminal input and output for special circumstances. These are provided to allow maximum versatility in the system while still maintaining the high efficiency needed in a multi-user

environment. The programmer communicates the need for special terminal handling to the system through the use of special "program controlled terminal options". These are described individually in the next section.

6.2 Program controlled terminal options

The following table lists the functions which may be used during program execution.

Function Character	Meaning
A	Set rubout filler character.
B	Enable VT52 & VT100 escape-letter activation.
C	Disable VT52 & VT100 escape-letter activation.
D	Define new activation character.
E	Turn on character echoing.
F	Turn off character echoing.
H	Disable subprocesses.
I	Enable lower case input.
J	Disable lower case input.
K	Enable deferred character echo mode.
L	Disable deferred character echo mode.
M	Set transparency mode for output.
N	Suspend command file input.
O	Restart command file input.
P	Reset activation character.
Q	Set activation on field width.
R	Turn on high-efficiency TTY mode.
S	Turn on single-character activation mode.
T	Turn off single-character activation mode.
U	Enable no-wait TT input test.
V	Set field width limit.
W	Turn tape mode on
X	Turn tape mode off
Y	Disable echo of line-feed after carriage-return
Z	Enable echo of line-feed after carriage-return

These functions have a temporary effect and are automatically reset to their normal values when a program exits to the keyboard monitor. They are not reset if the program chains to another program until control is finally returned to the monitor. Some terminal options (notably high-efficiency and single-character modes) are incompatible with, and override, some other terminal options.

TSX-Plus provides two methods for a running program to dynamically alter some of the parameter settings relating to the user's timesharing line. The preferred method of selecting these functions is to use the TSX-Plus EMT for that purpose. This is readily available from MACRO programs and an appropriate MACRO subroutine should be linked into jobs written in other languages. The form of the EMT to select program controlled terminal options is:

```
        EMT     375
```

with R0 pointing to the following argument block:

```
        .BYTE   0,152
        .WORD   function-code
        .WORD   argument-value
```

where "function-code" is the character from the table above which selects the terminal option, and "argument-value" may be a third value used only with some of the functions. An advantage of the EMT method of selecting program controlled terminal options is that they may be used even when the terminal is in high-efficiency mode.

Example:

```
        .TITLE  EMTMTH
        .ENABL  LC
;
;  Demonstrate TSX-Plus program controlled terminal options using
;  the EMT method.
;
        .MCALL  .GVAL,.PRINT,.EXIT,.TTYIN
        .GLOBL  PRTDEC
;
;  Determine and display current lead-in char
;  Default = 35, but don't count on it
;
START:  .GVAL   #AREA,#-4.      ;Determine current leadin character
        MOV     R0,R1           ;Save it
        .PRINT  #LEADIS         ;"Current lead-in is"
        MOV     R1,R0           ;Retrieve lead-in char value
        CALL    PRTDEC          ;Display it
        .PRINT  #LEADND
;
;  Set rubout filler character
;
        MOV     #SETRUB,R0      ;Point to EMT arg block to
        EMT     375             ;Set rubout filler character
;
;  Now demonstrate the current rubout filler character
;  Back space is the default, which we changed to underline
;
```

```
        .PRINT  #TRYIT          ;"Enter some and delete them"
        MOV     #BUFFER,R1      ;Point to input buffer
1$:     .TTYIN                  ;Get next char into input buffer
        CMPB    R0,#12          ;End of input (CR/LF pair)?
        BEQ     2$              ;Yes, terminate input
        CMP     R1,#BUFEND      ;Buffer overflow?
        BLO     1$              ;Get more if not
;
2$:     .PRINT  #THANKS
        .EXIT

AREA:   .BLKW   10              ;General EMT arg block
SETRUB: .BYTE   0,152           ;EMT arg block to
        .WORD   'A              ;Set rubout filler character
        .WORD   '_              ; to underline
TRYIT:  .ASCII  /Enter some characters at the prompt and then /
        .ASCII  /erase them with/<15><12>/DELETE or Control-U./
        .ASCII  / They should be replaced with underlines./<15><12>/*/<200>
LEADIS: .ASCII  /We don't care that the current lead-in char is /<200>
LEADND: .ASCIZ  /./
THANKS: .ASCIZ  <15><12>/STOP -- Thank you./
BUFFER: .BLKB   81.
BUFEND:
        .END    START
```

When it is not practical to incorporate the EMT method of selecting program controlled terminal options into a program, an alternate method using a "lead-in" character may be used. This is conveniently done by sending a sequence of characters to the terminal using the normal terminal output operations of the language. Examples are the FORTRAN TYPE, COBOL-Plus DISPLAY, BASIC PRINT, and Pascal WRITE statements. Program controlled terminal options are selected by having the running program send the lead-in character immediately followed by the function character and, for some functions, a third character defining the argument value for the function. TSX-Plus intercepts the lead-in character and the one or two following characters and sets the appropriate terminal option. It does not pass these intercepted characters through to the terminal. The default value for the lead-in character is the ASCII GS character (octal value 35; decimal value 29). However, the lead-in character may be redefined during system generation when the value conflicts with other uses of the system. For example, some graphics terminals use the GS character as either a command or parameter value. The lead-in character function may be disabled during program execution with the M and R functions described below. Programmers should not rely on the default value of the lead-in character, but may obtain the current value of the lead-in character from the .GVAL request with an offset of -4. Note that when in high-efficiency mode (set with either the RUN/HIGH switch or the "R" program controlled terminal option) output character checking is disabled and the lead-in character method of selecting program controlled terminal options is disabled; in this case, the lead-in character, function-code character, and argument value character are passed through to the terminal. When in high-efficiency

mode, the EMT method of selecting program controlled terminal options is still functional. See Chapter 7 for information on turning high-efficiency terminal mode off by means of an EMT.

Example:

```
        PROGRAM LEADIN
C
C  Demonstrate TSX-Plus program controlled terminal options using
C  the "lead-in" character method.
C
        BYTE    LEADIN(2)
        INTEGER ILEAD
        EQUIVALENCE (ILEAD,LEADIN(1))
C
C  Determine and display current lead-in char
C  Default = 29, but don't count on it
C
        ILEAD = ISPY(-4)        !.GVAL with offset = -4.
        TYPE 820,LEADIN(1)      !Display the current lead-in char value
C
C  Set rubout filler character
C
        TYPE 800,LEADIN(1),'A','_'
C
C  Now demonstrate the current rubout filler character
C  Back space is the default, which we changed to underline
C
        TYPE 810                !Ask for something to be erased
        ACCEPT 830              !Wait for input before exiting
C
        STOP 'Thank you.'

800     FORMAT(1H+,A1,$)
810     FORMAT(1H0,'Enter some characters at the prompt and then ',
     1  'erase them with'/' DELETE or Control-U.',
     1  ' They should be replaced with underlines.'/' *',$)
820     FORMAT(' The current value of the lead-in character is ',I3,'.')
830     FORMAT(40H                                        )
        END
```

The following paragraphs explain the uses of each of the program controlled terminal option function-codes. Any of these options may be selected by either the EMT method or by the lead-in character method.

6.2.1 "A" function--Set rubout filler character.

When a scope type terminal is being used, the normal response of TSX-Plus to a DELETE character is to echo backspace-space-backspace which replaces the last character typed with a space. TSX-Plus responds to a CTRL-U character in a similar fashion, echoing a series of backspaces and spaces. Some programs that display forms use underscores or periods to indicate the fields where the user may enter values. In this case it is desirable for TSX-Plus to echo backspace-character-backspace for DELETE and CTRL-U where "character" may be period or underscore as used in the form. The character to use as a rubout filler is specified by the argument-value with the EMT method or by the third character with the lead-in character method.

6.2.2 "B" & "C" functions--Set VT52, VT100 and VT200 escape-letter activation.

VT52, VT100 and VT200 terminals are equipped with a set of special function keys marked with arrows and other symbols. When pressed, they transmit two or three character escape sequences. The "B" function tells TSX-Plus to consider these as activation sequences. The escape character and the letter are not echoed to the terminal, but are passed to the user program. The "C" function disables this processing and causes escape to be treated as a normal character (initial setting).

6.2.3 "D" function--Define new activation character.

Under normal circumstances TSX-Plus only schedules a job for execution and passes it a line of input when an "activation" character such as carriage return is received. The "D" function provides the user with the ability to define a set of activation characters in addition to carriage return.

The new activation character is specified by the argument-value with the EMT method or by the third character with the lead-in character method. The maximum number of activation characters that a program may define is specified when the TSX-Plus system is generated.

Using this technique, any character may be defined as an activation character, including such characters as letters, DELETE, CTRL-U, and CTRL-C. When a user-defined activation character is received, it is not echoed but is placed in the user's input buffer which is then passed to the running program.

By specifying CTRL-C as an activation character, a program may lock itself to a terminal in such a fashion that the user may not break out of the program in an uncontrolled manner.

If carriage return is specified as a user activation character, neither it nor a following line feed will be echoed to the terminal. TSX-Plus will also not add a line feed to the input passed to the program.

6.2.4 "E" and "F" functions--Control character echoing.

The "E" and "F" functions are used to turn on and off character echoing. The "E" function turns it on, and the "F" function turns it off. An example of a possible use is to turn off echoing while a password is being entered.

6.2.5 "H" function--Disable subprocess use.
The "H" function disables the subprocess window facility for the time-sharing line.

6.2.6 "I" and "J" functions--Control lower case input.
The "I" function allows lower case characters to be passed to the running program. The "J" function causes TSX-Plus to translate lower case letters to upper case letters. The SET TT [NO]LC keyboard command also performs these functions.

6.2.7 "K" and "L" functions--Control character echoing.
The "K" function causes TSX-Plus to enter "deferred" character echo mode. The "L" function causes TSX-Plus to enter immediate character echo mode. Any characters in the input buffer which have not been echoed when the "L" function is selected will be immediately echoed. See the description of the SET TT [NO]DEFER command for an explanation of deferred echo mode.

6.2.8 "M" function--Set transparency mode of output.
If transparency mode is set, TSX-Plus will pass each transmitted character through to the program without performing any special checking or processing. Transparency mode allows the user's program to send any character to the terminal. Note that once transparency mode is set on, TSX-Plus will no longer recognize the lead-in character (octal 35, which means a program control function follows). The only way to turn off transparency mode is to exit to KMON.

6.2.9 "N" and "O" Functions--Control command file input.
When a command file is being used to run programs (see Chapter 3), input which would normally come from the user's terminal is instead drawn from the command file. Occasionally, it is desirable to allow a program running from a command file to accept input from the user's terminal rather than the command file. The "N" function suspends input from the command file so that subsequent input operations will be diverted to the terminal. The "O" function redirects input to the command file. These functions are ignored by TSX-Plus if the program is not being run from a command file.

6.2.10 "P" function--Reset activation character.
The "P" function performs the complement operation to the "D" function. The "P" function is used to remove an activation character that was previously defined by the "D" function. The character to be removed from the activation character list is specified by the argument-value with the EMT method or by the third character with the lead-in character method.

Only activation characters that were previously defined by the "D" function may be removed by the "P" function.

6.2.11 "Q" function--Set activation on field width.

The "Q" function allows the user to define the width of an input field so that activation will occur if the user types in as many characters as the field width, even if no activation character is entered. The field width is specified by the ASCII code value of the argument-value with the EMT method or of the third character with the lead-in character method. If an activation character is entered before the field is filled, the program will be activated as usual. Each time activation occurs the field width is reset and must be set again for the next field by reissuing the "Q" function. For example, the following sequence of characters could be sent to TSX-Plus to establish a field width of 43 characters: "<lead-in>Q+". Note that the character "+" has the ASCII code of 053 (octal) which is 43 decimal.

6.2.12 "R" function--Turn on high-efficiency terminal mode.

The "R" function causes TSX-Plus to place the line in "high efficiency" terminal mode. The effect is to disable most of the character testing overhead that is done by TSX-Plus as characters are transmitted and received by the line. Before entering high-efficiency mode the program must declare a user-defined activation character that will signal the end of an input record. Once a program has entered high-efficiency mode, characters sent to the terminal are processed with minimum system overhead. For example, tab characters are not expanded to spaces. Also, TSX-Plus does not check to see if the character being sent is the TSX-Plus terminal control "leadin" character. This means that the lead-in character method may not be used to control terminal options until the program exits or the EMT to turn off high efficiency mode is used (see Chapter 7). Characters received from the terminal are passed to the program with minimum processing: they are not echoed; and control characters such as DELETE, control-U, control-C, control-W and carriage-return are all treated as ordinary characters and passed directly to the program. High-efficiency mode terminal I/O is designed to facilitate machine-to-machine communication; it is also useful for dealing with buffered terminals that transmit a page of information at a time.

6.2.13 "S" function--Turn on single-character activation mode.

The "S" function causes TSX-Plus to allow a program to do single-character activation by setting bit 12 in the Job Status Word. Normally TSX-Plus stores characters received from the terminal and only activates the program and passes the characters to it when an activation character, such as carriage-return, is received. It does this even if bit 12 is set in the Job Status Word, which under RT-11 causes the program to be passed characters one-by-one as they are received from the terminal. The "S" function can be used to cause TSX-Plus to honor bit 12 in the Job Status Word. If JSW bit 12 is set and the program is in single-character activation mode, TSX-Plus passes characters one-by-one to the program as they are received and does not echo the characters to the terminal. The /SINGLECHAR switch for the R[UN] command and the SET TT SINGLE command can also be used to cause TSX-Plus to honor JSW bit 12. Since the high-efficiency mode implies certain terminal characteristics (such as buffered input and no echo), it is not possible to override these inherent modes by using other function codes.

6.2.14 "T" function--Turn off single-character activation mode.

The "T" function is the complement of the "S" function. It turns off single-character activation mode.

6.2.15 "U" function--Enable non-wait TT I/O testing.

The "U" function causes TSX-Plus to allow a program to do a .TTINR EMT that will return with the carry bit set if no terminal input is pending or a .TTOUTR EMT that will return with the carry bit set if the terminal output buffer is full. Normally TSX-Plus suspends the execution of a program if it attempts to obtain a terminal character by doing a .TTINR EMT and no input characters are available. Or if it does a .TTYOUT or .TTOUTR EMT and there is no free space in the terminal output buffer. It does this even if bit 6 of the Job Status Word is set, which under RT-11 would enable non-blocking .TTINR's. This is done to prevent programs from burning up CPU time by constantly looping back to see if terminal input is available. The "U" function causes TSX-Plus to honor bit 6 in the Job Status Word and allows a program to do a .TTINR to check for pending TT input or a .TTOUTR EMT to check for space in the output buffer without blocking if none is available. The SET TT NOWAIT command and the /SINGLECHAR switch for the R[UN] command also perform this function. Because the single character terminal option determines several terminal operating modes (such as no echo and transparent input), it is incompatible with other terminal functions which would conflict with the implied single-character operation. See the description of special terminal mode in the RT-11 Programmer's Reference Manual.

6.2.16 "V" function--Set field width limit.

The "V" function is used to set a limit on the number of characters that can be entered in the next terminal input field. Once the "V" function is used to set a field limit, if the user types in more characters to the field than the specified limit, the excess characters are discarded and the bell is rung rather than echoing the characters. An activation character still must be entered to complete the input. The field width is specified by the ASCII code value of the argument-value with the EMT method or of the third character with the lead-in character method. The field size limit is automatically reset after each field is accepted and must be re-specified for each field to which a limit is to be applied. Note the difference between the "Q" and "V" functions. The "Q" function sets a field size which causes automatic activation when the field is filled; the "V" function sets a field size which causes characters to be discarded if they exceed the field size.

6.2.17 "W" and "X" functions--Control tape mode.

The "W" function turns on "tape" mode and the "X" function turns it off. Turning on "tape" mode causes the system to ignore line-feed characters received from the terminal or external device. The SET TT [NO]TAPE keyboard command may also be used to control tape mode.

6.2.18 "Y" and "Z" functions--Control line-feed echo.

The "Y" function is used to disable the echoing of a line-feed character when a carriage-return is received. Normally, when TSX-Plus receives a carriage-return character, it echoes carriage-return and line-feed characters to the terminal and passes carriage-return and line-feed characters to the program. The "Y" function alters this behavior so that it only echoes carriage-return but still passes both carriage-return and line-feed to the program. This function can be used to advantage with programs that do cursor positioning and which do not want line-feed echoed because it might cause the screen display to scroll up a line. The "Z" function restores the line-feed echoing to its normal mode.

7. TSX-Plus EMT'S

TSX-Plus provides several system service calls (EMTs) in addition to those compatible with RT-11. In order to take advantage of the special features of TSX-Plus, programs written to run under both TSX-Plus and RT-11 should check to see if they are under TSX-Plus. This chapter describes the preferred method of checking and goes on to describe several of the special EMTs provided by TSX-Plus. EMTs which relate specifically to features described elsewhere in this manual are included in the appropriate chapters.

7.1 Obtaining TSX-Plus system values (.GVAL)

The .GVAL EMT that is normally used to obtain RT-11 system values can also be used to obtain TSX-Plus system values. Although a simulated RMON is normally mapped into each job so that it may directly access fixed offsets into RMON, the .GVAL function is the preferred method for obtaining system values. Under TSX-Plus, the simulated RMON need not be mapped into a job's virtual address space (see Chapter 8). The .GVAL EMT will still function correctly even if RMON is not mapped into the job. In addition to the positive offset values which are documented for use with RT-11, the following negative offset values may be used to obtain TSX-Plus system values:

Offset	Value
-2.	Job number
-4.	"Lead-in" character used for terminal control options
-6.	1 if job has SYSPRV privilege; 0 if job does not have SYSPRV
-8.	1 if PAR 7 mapped to I/O page; 0 otherwise
-10.	Project number job is logged on under
-12.	Programmer number job is logged on under
-14.	TSX-Plus incremental license number
-16.	Current job priority
-18.	Maximum allowed job priority
-20.	Number of blocks per job in SY:TSXUCL.TSX
-22.	Job number of primary process (0 if primary process now)
-24.	Name of system device (RAD50) (device on which RT-11 was booted when TSX-Plus was started; may not correspond to current SY assignment)
-26.	Minimum fixed-low-priority value
-28.	Maximum fixed-high-priority value
-30.	Job number of parent process (0 for primary process)

As with the standard .GVAL function, the system values are returned in R0.

Example:

```
        .TITLE  TSGVAL
        .ENABL  LC

;Demonstrate usage of .GVAL with both positive (RT-11)
; and negative (TSX-Plus) offsets

        .MCALL  .GVAL,.PRINT,.EXIT
```

```
        .GLOBL  PRTDEC          ;Subroutine to print a word in decimal
        .GLOBL  PRTR50          ;Subroutine to print a RAD50 word

SYSGEN  = 372                   ;RMON offset to sysgen options word

START:  .GVAL   #AREA,#SYSGEN   ;Examine system options word
        TST     R0              ;See if we are running TSX-Plus
        BPL     9$              ;Exit if not
        .PRINT  #LICENS         ;"License # is"
        .GVAL   #AREA,#-14.     ;Obtain last 4 digits of license #
        CALL    PRTDEC          ;And display it
        .PRINT  #SYSTEM         ;"Started from"
        .GVAL   #AREA,#-24.     ;Get system device
        CALL    PRTR50          ;And display it
        .PRINT  #JOBNUM         ;"Job # is"
        .GVAL   #AREA,#-2       ;Get TSX-Plus job number
        CALL    PRTDEC          ;Display the job number
        .GVAL   #AREA,#-22.     ;See if this is the primary line
        TST     R0              ;0 if primary
        BEQ     9$              ;Done if so
        .PRINT  #VIRT           ;Else say subprocess
9$:     .EXIT

AREA:   .BLKW   2               ;2 word EMT arg area
        .NLIST  BEX
LICENS: .ASCII  /TSX-Plus license number /<200>
SYSTEM: .ASCII  <15><12>/TSX-Plus started from /<200>
JOBNUM: .ASCII  /:/<15><12>/TSX-Plus line number /<200>
VIRT:   .ASCII  / (This is a subprocess)/<200>

        .END    START
```

7.2 Determining number of free blocks in spool file

The following EMT will return in R0 the number of free blocks in the spool file. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   0,107
```

Example:

```
        .TITLE  SPLFRE
        .ENABL  LC

;Demonstrate EMT to determine number of free spool blocks

        .MCALL  .PRINT,.EXIT
        .GLOBL  PRTDEC

START:  .PRINT  #NUMFRE         ;Preface number message
        MOV     #SPLFRE,R0      ;Point to EMT arg block to
        EMT     375             ;Determine number of free spool blocks
                                ;Number is returned in R0
        CALL    PRTDEC          ;Display the number
        .PRINT  #BLOKS          ;End of message
        .EXIT
        .NLIST  BEX
SPLFRE: .BYTE   0,107           ;EMT arg to get # free spool blocks
NUMFRE: .ASCII  /The spool file has /<200>
BLOKS:  .ASCIZ  / free blocks./
        .EVEN

        .END    START
```

7.3 Determining if a job is running under TSX-Plus

In cooperation with Digital Equipment Corporation, a bit has been allocated in the RT-11 sysgen options word at fixed offset 372 into the RMON. The high order bit (bit 15; mask 100000) of this word will be set (1) if the current monitor is TSX-Plus version 5.0 or later. This bit will be clear if the monitor is any version of RT-11. Testing this bit is the preferred method of determining if a job is running under TSX-Plus. However, if a program is expected to also be used under older versions of TSX-Plus, then an alternative method is necessary. For older versions of TSX-Plus, first issue the .SERR request to trap invalid EMT requests and then issue the TSX-Plus EMT to determine the time-sharing line number. If the job is running under RT-11, this EMT will be invalid and the carry bit (indicating an error) will be set on return. If the job is running under TSX-Plus, then the EMT will return without error and the line number will be in R0.

Example:

```
        .TITLE  TSXENV
        .ENABL  LC
;
; Demonstrate preferred method of determining whether job is
; running under TSX-Plus or RT-11
;
        .MCALL  .PRINT,.EXIT,.SERR,.HERR
```

```
JSW     = 44                    ;Job Status Word address
RMON    = 54                    ;Pointer to base of RMON
SYSGEN  = 372                   ;Index into RMON for sysgen features

START:  .PRINT  #UNDER          ;"Running under"
;
; This is the preferred method, but will not work prior to
; TSX-Plus version 5.0
;
        MOV     RMON,R1         ;Point to base of RMON
        TST     SYSGEN(R1)      ;See if running under TSX-Plus
        BPL     RT11            ;Branch if running under RT-11
;
; This is the old method, but will work correctly with
; all versions of TSX-Plus
;
;       .SERR                   ;Trap invalid EMT error
;       MOV     #TSXLN,R0       ;Point to EMT arg block to
;       EMT     375             ;Determine TSX-Plus line number
;       BCS     RT11            ;Branch if running under RT-11
;
        .PRINT  #TSXPLS         ;"TSX-Plus"
        .EXIT

RT11:   .HERR                   ;Reset SERR trap
        .PRINT  #NOTPLS         ;"RT-11"
        .EXIT

TSXLN:  .BYTE   0,110           ;EMT arg block to get line number
        .NLIST  BEX
UNDER:  .ASCII  /Monitor is /<200>
TSXPLS: .ASCIZ  /TSX-Plus./
NOTPLS: .ASCIZ  /RT-11./

        .END    START
```

7.4 Determining the TSX-Plus line number

The following EMT will return in R0 the number of the line to which the job is attached. Physical lines are numbered consecutively starting at 1 in the same order as specified when TSX-Plus is generated. Detached job lines occur next and subprocesses are numbered last.

The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
        .BYTE   0,110
```

Example:

```
        .TITLE LNTT
        .ENABL  LC

; What TSX line number is this terminal attached to?
; And what type terminal does TSX-Plus think it is?

        .MCALL  .PRINT,.EXIT,.TTYOUT,.SERR,.HERR
        .GLOBL  PRTDEC          ;Subroutine to print a word in decimal

                                ;Are we under TSX-Plus?
START:  .SERR                   ;Stop error aborts
        MOV     #TSXLN,R0       ;Set up EMT request to
        EMT     375             ;Get TSX-Plus line number
        BCS     NOTTSX          ;If error, not under TSX-Plus
        MOV     R0,LINE         ;Save it
        .HERR                   ;Enable error aborts
        .PRINT  #LINMSG         ;Display line number message
        MOV     LINE,R0         ;Recall line number
        CALL    PRTDEC          ;Display line number

        .PRINT  #TRMMSG         ;Display term type message
        MOV     #TTYPE,R0       ;Set up EMT request to
        EMT     375             ;Get terminal type from TSX-Plus
                                ;Returns into R0
        ASL     R0              ;Convert to word offset
        .PRINT  TYPE(R0)        ;Print type from index into table
        .EXIT                   ;All done

NOTTSX: .PRINT  #TSXERR         ;Say we are not under TSX-Plus
        .EXIT

LINE:   .WORD   0               ;Storage for TSX line number
TERM:   .WORD   0               ;Storage for TSX term type code
TSXLN:  .BYTE   0,110           ;TSX line number EMT parameters
TTYPE:  .BYTE   0,137           ;TSX term type EMT parameters

; Table of pointers to TSX term type names
        .EVEN
TYPE:   .WORD   UNK,VT52,VT100,HAZEL,ADM3A,LA36,LA120,DIABLO,QUME
        .NLIST  BEX
LINMSG: .ASCII  /TSX-Plus line number: /<200>
TRMMSG: .ASCII  <15><12>/Terminal type: /<200>
TSXERR: .ASCIZ  /?LNTT-F-Not running under TSX-Plus/
UNK:    .ASCIZ  /Unknown/
```

```
VT52:   .ASCIZ  /VT-52/
VT100:  .ASCIZ  /VT-100/
HAZEL:  .ASCIZ  /Hazeltine/
ADM3A:  .ASCIZ  /ADM3A/
LA36:   .ASCIZ  /LA36/
LA120:  .ASCIZ  /LA120/
DIABLO: .ASCIZ  /Diablo/        ;Diablo and Qume are equivalent
QUME:   .ASCIZ  /Qume/          ;Diablo and Qume are equivalent

        .END    START
```

7.5 Set/Reset ODT activation mode

The following EMT can be used to set TSX-Plus to activate on characters that are appropriate to ODT. In this mode TSX-Plus considers all characters to be activation characters except digits, ',', '$', and ';'. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   code,111
```

where "code" = 1 to turn on ODT activation mode, and "code" = 0 to reset to normal mode.

Example:

```
        .TITLE  ACTODT
        .ENABL  LC

;Demonstrate EMT which sets ODT activation mode

        .MCALL  .PRINT,.EXIT

START:  .PRINT  #ODTTYP         ;Say we are entering ODT activation mode
        MOV     #ACTODT,R0      ;Point to EMT arg block to
        EMT     375             ;Set ODT activation mode
1$:     CALL    GETLIN          ;Get some terminal input
        CMPB    BUFFER,#'Q      ;Back to regular mode?
        BNE     1$              ;No, get more lines
        .PRINT  #REGTYP         ;Say we are going back to regular activation
        CLRB    ACTODT          ;Make arg block into RESET mode request
        MOV     #ACTODT,R0      ;Point to EMT arg block to
        EMT     375             ;Reset ODT activation mode
2$:     CALL    GETLIN          ;Get more input
        CMPB    BUFFER,#'Q      ;Want to quit?
        BNE     2$              ;No, repeat
```

```
        .EXIT

GETLIN: .PRINT  #PROMPT         ;Request some input
        MOV     #TTIBLK,R0      ;Point to EMT arg block to
        EMT     375             ;Accept a block of characters
        CLRB    BUFFER(R0)      ;Make input string ASCIZ
        .PRINT  #BUFFER         ;And echo same string back
        RETURN

ACTODT: .BYTE   1,111           ;EMT arg block to SET/RESET ODT act'n mode
TTIBLK: .BYTE   0,115           ;EMT arg block to get block input from term
        .WORD   BUFFER          ;Pointer to input buffer
        .WORD   79.             ;Number of input chars requested
        .NLIST  BEX
ODTTYP: .ASCIZ  /Starting ODT activation mode./
REGTYP: .ASCIZ  /Restoring regular activation mode./
PROMPT: .ASCII  /?/<200>
        .EVEN
BUFFER: .BLKB   79.             ;TTIBLK input buffer
        .BYTE   0               ;CLRB could go here on full buffer
        .END    START
```

7.6 Sending a block of characters to the terminal

The following EMT can be used to efficiently send a block of characters to the terminal. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   0,114
.WORD   buffer
.WORD   count
```

where "buffer" is the address of the buffer containing the characters to be sent and "count" is a count of the number of characters to be sent. This EMT is much more efficient to use than a series of .TTYOUT EMT's -- it has the same efficiency as a .PRINT EMT but it uses a count of the number of characters to send rather than having the character string in ASCIZ form.

Example:

```
        .TITLE  TTOBLK
        .ENABL  LC

;Demonstration of the use of the TSX-Plus EMT to send a block of
;characters to the terminal.

        .MCALL  .EXIT
```

```
START:  MOV     #TTOBLK,R0      ;Point to EMT arg block to
        EMT     375             ;Send a block of chars to the terminal
        .EXIT

TTOBLK: .BYTE   0,114           ;EMT arg block to send a block of chars
        .WORD   BUFFER          ;Pointer to character buffer
        .WORD   <BUFEND-BUFFER> ;Count of characters to be output
        .NLIST  BEX
BUFFER: .ASCII  /This EMT is used to send a block of characters /
        .ASCII  /to the terminal./<15><12>
        .ASCII  /It is similar to .PRINT, except that it uses /
        .ASCII  /a count of characters/<15><12>
        .ASCII  /rather than a special terminating character /
        .ASCII  /(<0> or <200>)./<15><12>
BUFEND:

        .END    START
```

7.7 Accepting a block of characters from the terminal

The following EMT can be used to accept all characters from the terminal input buffer up to and including the last activation character entered. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   0,115
.WORD   buffer
.WORD   size
```

where "buffer" is the address of the buffer where the characters are to be stored and "size" is the size of the buffer (number of bytes). This EMT causes a program to wait until an activation character is entered and then returns all characters received up to and including the last activation character. On return R0 contains a count of the number of characters received. If the specified buffer overflows, the carry flag is set on return. This EMT is substantially more efficient than doing a series of .TTYIN EMTs; it is particularly well suited for accepting input from page buffered terminals.

Example:

```
        .TITLE  TTIBLK
        .ENABL  LC

;Demonstrates the use of TSX-Plus EMT to accept a block of characters
;from a terminal.
```

```
        .MCALL  .EXIT,.PRINT,.TTYIN

START:  .PRINT  #PROMPT         ;Request input
        MOV     #TTIBLK,R0      ;Point to EMT arg block to
        EMT     375             ;Accept a block of chars from the terminal
        MOV     R0,R1           ;Save input character count
;Char count includes activation char (and LF after CR)
        BCC     1$              ;Buffer overflow on input?
        .PRINT  #OVFLOW         ;Yes, warn user
1$:     ADD     #BUFFER,R1      ;Point past last char in buffer
        CLRB    (R1)            ;Make the input ASCIZ
        .PRINT  #BUFFER         ;Reproduce the input
        .EXIT

TTIBLK: .BYTE   0,115           ;EMT arg block to accept block from terminal
        .WORD   BUFFER          ;Start of input buffer
        .WORD   <BUFEND-BUFFER> ;Length of buffer in chars (May not exceed
                                ;input buffer size declared in TSGEN.)
        .NLIST  BEX
PROMPT: .ASCIZ  /70 character input buffer ready./
OVFLOW: .ASCIZ  /?TTIBLK-F-Buffer overflow/
BUFFER: .ASCII  /XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX/   ;35 chars
        .ASCII  /XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX/   ;35 chars
BUFEND: .ASCII  /??/            ;TTIBLK will never write over these

        .END    START
```

7.8 Checking for terminal input errors

The following EMT can be used to determine if any terminal input errors have occurred. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   0,116
```

On return from the EMT, the carry flag is set if an input error has occurred since the line logged on or since the last time a check was made for input errors. The two types of errors that are monitored by this EMT are hardware reported errors (parity, silo overflow, etc.) and characters lost due to TSX-Plus input buffer overflow.

Example:

```
        .TITLE CKTTIE
        .ENABL  LC

;Check for terminal input errors

        .MCALL  .PRINT,.TTYIN,.EXIT

START:  .PRINT  #PROMPT         ;Ask to overflow buffer
        MOV     #100.,R1        ;Set up counter for input loop
        MOV     #SETTTO,R0      ;Point to EMT arg block to
        EMT     375             ;Set terminal time out for 0.5 secs
;Note that this is reset after every activation character!!!
;Start requesting characters.  Input characters are stacked in the user
;input buffer until an activation character is seen (e.g. carriage return).
;So, all we have to do to overflow is enter more than the input buffer
;size (defined in TSGEN either by DINSPC or with the BUFSIZ macro)
;and type in too many before activating.
;Use a time out so we don't have to hit return.
1$:     .TTYIN                  ;Get a character from the terminal
        CMPB    R0,#37          ;Was it time-out activation char?
        BEQ     TIMOUT          ;Yes, exit loop
        SOB     R1,1$           ;Repeat for 100. characters
;For a system with input buffer size=100. in TSGEN, we should be
;able to overflow the buffer before we see an activation char
TIMOUT: MOV     #CKTTIE,R0      ;Point to EMT arg block to
        EMT     375             ;Check for terminal input errors
        BCS     HADERR          ;Say we had errors
        .PRINT  #NOERR          ;Say we had no errors
        .EXIT

HADERR: .PRINT  #YESERR         ;Error message
        CMP     R1,#3           ;Did we fill the buffer?
;Note that last two chars of input buffer are reserved
;for activation chars.  Any excess input is discarded.
        BLE     TOOMNY          ;Yes, buffer overflow
        .PRINT  #HDWERR         ;No, hardware error message
        .EXIT
TOOMNY: .PRINT  #OVFERR         ;Buffer overflow message
        .EXIT

SETTTO: .BYTE   0,117           ;EMT arg block to set terminal time out
        .WORD   20.             ;to 10 seconds (20 half sec units)
        .WORD   37              ;Passed as activation char on time-out
CKTTIE: .BYTE   0,116           ;EMT arg block to check for input errors
        .NLIST  BEX
YESERR: .ASCIZ  <15><12>/There were errors during terminal input./<7>
OVFERR: .ASCIZ  /(Probably input buffer overflow.)/
HDWERR: .ASCIZ  /(Probably hardware error ... parity, stop bits, data bits)/
```

```
NOERR:  .ASCIZ  <15><12>/There were no terminal input errors./
PROMPT: .ASCIZ  /Please enter more than 100 input characters and wait. . ./

        .END    START
```

7.9 Set terminal read time-out value

This EMT can be used to specify a time-out value that is to be applied to the next terminal input operation. This EMT allows you to specify the maximum time that will be allowed to pass between the time that you issue a command to get input from the terminal and the time that an activation character is received to terminate the input field. You also specify with this EMT a special activation character that is returned as the terminating character for the field if the input operation times out without receiving an activation character from the terminal. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   0,117
.WORD   time-value
.WORD   activation-character
```

where "time-value" is the time-out value specified in 0.5 second units and "activation-character" is a single character value that is to be returned as the last character of the field if a time-out occurs. The time value specified with this EMT only applies to the next terminal input field. The time value is reset when the next field is received from the terminal or the time-out occurs. A new time-out value must be specified for each input field that is to be time controlled.

Example:

```
        .TITLE  DUNJUN

; Demonstrate use of terminal input time-out testing

        .MCALL  .TTYOUT,.TTYIN,.EXIT,.PRINT

START:  .TTYOUT #'?

1$:     MOV     #SETTTO,R0      ;Point to EMT arg block to
        EMT     375             ;Set terminal input time-out
        .TTYIN                  ;Get a character from the terminal
        CMP     R0,#<15>        ;Skip over carriage returns
        BEQ     1$
        CMP     R0,#<12>        ;and line feeds
        BEQ     START           ;prompt for next char
        CMP     R0,#'Q          ;Should we quit?
```

```
        BNE     1$              ;No, get next char
        .PRINT  #DONE           ;Quit or time-out

        .EXIT                   ;Bye

SETTTO: .BYTE   0,117           ;EMT arg block
        .WORD   6*60.*2         ;6.min * 60.sec/min * 2.half-sec-units/sec
        .WORD   ^Q              ;Activation character on time-out

        .NLIST  BEX
DONE:   .ASCIZ  /STOP - /

        .END    START
```

See also the example program CKTTIE in the section on checking for terminal input errors.

7.10 Turning high-efficiency terminal mode on and off

TSX-Plus offers a "high-efficiency" mode of terminal operation that eliminates a substantial amount of system overhead for terminal character processing by reducing the amount of processing that is done on each character. When in high-efficiency mode, characters are sent directly to the terminal with minimum handling by TSX-Plus; operations such as expanding tabs to spaces and form-feeds to line-feeds are omitted as well as input processing such as echoing characters and recognizing control characters such as DELETE, control-U and control-C. The only characters treated specially on input are user-defined activation characters and the user-specified break character. At least one user specified activation character must be declared if high-efficiency mode is to be used. This form of terminal I/O is designed to facilitate high-speed machine-to-machine communication. It can also be used effectively to communicate with buffered mode terminals. The form of the EMT used to control high-efficiency mode is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   code,120
```

where "code" is 1 to turn high-efficiency mode on and 0 to turn it off.

Example:

```
        .TITLE  HIEFF
        .ENABL  LC

;Demonstrate the use of TSX-Plus Hi-efficiency terminal mode

        .MCALL  .EXIT,.PRINT
```

```
START:  .PRINT  #DCLCC          ;Make ^C an activation char
        .PRINT  #PROMPT         ;Ask for input
        MOV     #HIEFF,R0       ;Point to EMT arg block to
        EMT     375             ;Turn on hi-efficiency mode
        MOV     #TTIBLK,R0      ;Point to EMT arg block to
        EMT     375             ;Accept a block of characters
                                ;Actual character count returned in R0
; . . .                          Do something useful with the input?
        MOVB    #15,<BUFFER-1>(R0) ;Replace the activation char with
        MOVB    #12,BUFFER(R0)  ;Carriage return, line feed
        INC     R0              ;Count LF for output
        MOV     R0,<TTOBLK+4>   ;Set up count for output
        MOV     #TTOBLK,R0      ;Point to EMT arg block to
        EMT     375             ;Display a block of characters
        CLRB    HIEFF           ;Get ready to turn hi-eff off
        MOV     #HIEFF,R0       ;Point to EMT arg block to
        EMT     375             ;Turn off hi-efficiency mode

        .EXIT

HIEFF:  .BYTE   1,120           ;EMT arg block to turn hi-eff mode on (off)
TTIBLK: .BYTE   0,115           ;EMT arg block to accept a block of chars
        .WORD   BUFFER          ;Pointer to input buffer
        .WORD   BUFSIZ          ;Number of chars to input
TTOBLK: .BYTE   0,114           ;EMT arg block to display a block of chars
        .WORD   BUFFER          ;Pointer to buffer for output
        .WORD   BUFSIZ          ;Size of buffer to output
BUFFER: .BLKB   82.             ;I/O buffer - Cannot exceed line's I/O
BUFSIZ = . - BUFFER             ;       buffer sizes declared in TSGEN
        .WORD   0               ;Spacer in case of buffer overfill
        .NLIST  BEX
DCLCC:  .ASCII  <35><'D><3><200> ;Declare ^C as special activation char
PROMPT: .ASCII  /Please enter 1 line of characters (^C ends)./<15><12>
        .ASCIZ  /No special processing or echoing will be done./

        .END    START
```

7.11 Checking for activation characters

The following EMT can be used to determine if any activation characters have been received by the line but not yet accepted by the program. The form of the EMT is:

```
        EMT     375
```

with R0 pointing to the following argument block:

```
        .BYTE   0,123
```

If there are pending activation characters, the carry flag is cleared on return from the EMT; if there are no pending activation characters, the carry flag is set on return from the EMT.

Example:

```
        .TITLE  CKACT
        .ENABL  LC

;Demonstrate use of check for activation characters

LEADIN  =       35              ;TSX-Plus program controlled terminal
                                ;option lead-in character
        .MCALL  .PRINT,.EXIT,.GTLIN,.TWAIT,.TTYOUT

START:  .PRINT  #PROMPT         ;Request some characters
                                ;And disallow deferred echoing
;Do some processing.  Simulated here by .TWAIT
        MOV     #80.,R1         ;Line length counter
1$:     .TTYOUT #'.             ;Tick, tock
        DEC     R1              ;End of line?
        BNE     2$              ;No, go on
        .TTYOUT #<15>           ;New line
        .TTYOUT #<12>
        MOV     #80.,R1         ;Reset line length counter
2$:     .TWAIT  #AREA,#TIME     ;Wait 1 second here
; . . .                          Processing . . .
        MOV     #CKACT,R0       ;Point to EMT arg block to
        EMT     375             ;Check for pending activation characters
        BCS     1$              ;Continue if input not complete

        .GTLIN  #BUFFER         ;Collect the pending input
; . . .                          Do something with it
        CMP     BUFFER,EX       ;Exit command?
        BNE     1$              ;No, continue processing
        .PRINT  #BYE
        .EXIT

AREA:   .BLKW   10.             ;EMT arg block
TIME:   .WORD   0,1.*60.        ;1.sec * 60.tics/sec
CKACT:  .BYTE   0,123           ;EMT arg block for activation char check
BUFFER: .BLKB   81.             ;Local input buffer

        .NLIST  BEX
```

```
        .EVEN
EX:     .ASCII  /EX/
PROMPT: .ASCII  <LEADIN>/L/     ;Disallow deferred echoing
        .ASCIZ  /Please enter up to 80 characters, then RETURN:/
BYE:    .ASCIZ  /Thank you./

        .END    START
```

7.12 Sending a message to another line

The following EMT can be used to cause a message to display on another line's terminal. (This feature is not equivalent to message communication channels.) The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   0,127
.WORD   line-number
.WORD   message-address
```

where "line-number" is the number of the line to which the message is to be sent and "message-address" is the address of the start of the message text that must be in ASCIZ form. The message length must be less than 88 bytes. Note that if the target screen is only 80 characters wide, characters past column 80 will be overwritten. Use of this EMT requires SEND privilege. Note that information sent to a line with this EMT is not processed by the window manager for the target line. Thus, if the window is refreshed the message sent will disappear.

Error:

Code	Meaning
0	Job does not have SEND privilege.
1	Line has SET TT GAG and is executing a program.

Example:

See the example program CKSTAT in the section on determining job status information.

7.13 Establishing break sentinel control

The following EMT can be used to declare a completion routine that will be triggered when the "Break" key is pressed. The form of the EMT is

```
        EMT     375
```

with R0 pointing to the following argument block:

```
        .BYTE   0,133
        .WORD   brkchr
        .WORD   cplrtn
```

where "brkchr" is a user defined character that is to be declared the "Break" character and "cplrtn" is the address of the completion routine that is to be called when the break character is received from the terminal.

The specified completion routine will be called if the user presses either the key labeled "BREAK" (which transmits a long space) or types the character that is declared as the user-specified break character (brkchr). If no user-specified break character is wanted, specify the value 0 (zero) for "brkchr" in the argument block and only the real "BREAK" key will be activated. Note that on some systems the console terminal "BREAK" key causes entry to the hardware ODT module and for this reason cannot be used with this TSX-Plus function. Only one break routine may be specified at a time for each user. If a break routine was previously specified, it is cancelled when a new routine is declared. If an address of 0 (zero) is specified as the address of the completion routine (cplrtn), any previously specified break routine is cancelled and the break key connection is cancelled. On return from the EMT, R0 contains the address of any completion routine previously connected to the break sentinel character. If none was previously connected, then R0 will contain zero.

The specified break completion routine request only remains in effect for one break character. If you wish to be notified about additional break characters, you must reestablish the break connection each time a break character is received. This can be done from within the break completion routine.

A break routine can be used to signal an asynchronous request for service to a running program. A good example of this use would be to trigger entry to an interactive debugging program.

Example:

```
        .TITLE  BRKSNT

;Demo use of break sentinel control

        .MCALL  .PRINT,.TWAIT,.EXIT
        .ENABL  LC

START:  MOV     #BRKSNT,R0      ;Point to argument area to
        EMT     375             ;Establish break sentinel control

        .PRINT  #MESSAG         ;Prompt for key
```

```
        .TWAIT  #AREA,#TIME     ;Give the user 2 seconds to hit the break key

        TST     YES             ;Ever see a break?
        BNE     DONE            ;Yes, all done
        .PRINT  #NOBRK          ;No, never saw it

DONE:   .EXIT

CMPRTN: .PRINT  #GOTBRK         ;Say we caught the break
        MOV     #1,YES          ;Remember it
        RETURN                  ;And continue
                                ;Completion routines are ALWAYS exited with
                                ;RTS PC  under TSX-Plus, NEVER via RTI

BRKSNT: .BYTE   0,133           ;EMT arg value block to break sentinel control
        .WORD   0               ;Declare only 'BREAK' key as break char
        .WORD   CMPRTN          ;Address of completion routine to be called
                                ;when system notices break

YES:    .WORD   0               ;Flag for break seen

AREA:   .BLKW   2               ;2 word arg area for .TWAIT

TIME:   .WORD   0               ;high word of time
        .WORD   2.*60.          ;2 sec * 60.tics/sec

        .NLIST  BEX
MESSAG: .ASCIZ  /You have 2 seconds to hit the break key./
GOTBRK: .ASCIZ  <15><12>/Break key pressed./
NOBRK:  .ASCIZ  /Never saw the break key./

        .END    START
```

7.14 Terminal input completion routine

The following EMT can be used to specify a completion routine which will be triggered when the next character is entered at the terminal. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   1,133
.WORD   completion-routine
```

where "completion-routine" is the address of the completion routine to be entered when the next character is typed.

On entry to the completion routine, the received character is in R0. The EMT to connect the completion routine must be rescheduled before returning if it is desired to continue accepting characters via the completion routine. The program should be running with single character activation and bit 12 set in the job status word.

Example:

```
        .TITLE  TTICPL
;
;  Demonstrate terminal character input completion routine.
;
        .ENABL  LC
        .DSABL  GBL
        .GLOBL  PRTDEC
        .MCALL  .TTYOUT,.SPND,.PRINT
;
JSW     = 44                    ;Job Status Word address
TTSPC$  = 10000                 ;TT special mode (single char input)
SPACE   = 40                    ;ASCII Space
;
START:  BIS     #TTSPC$,@#JSW   ;Set single character mode
        MOV     #TTICPL,R0      ;Point to EMT arg block to
        EMT     375             ;Schedule TT input char compl routine
        .SPND                   ;Suspend main-line (forever in example)
;
CPLRTN: MOV     R0,-(SP)        ;Save input char carried in R0
        .TTYOUT                 ;Echo the char
        .TTYOUT #SPACE
        MOV     (SP)+,R0        ;Retrieve char
        CALL    PRTDEC          ;Display its ASCII value
        .PRINT  #CRLF
        MOV     #TTICPL,R0      ;Point to EMT arg block to
        EMT     375             ;Schedule TT input char compl routine
        RETURN
;
TTICPL: .BYTE   1,133           ;EMT arg block for TT input compl routine
        .WORD   CPLRTN          ;Completion routine to run
CRLF:   .ASCIZ  //
;
        .END    START
```

7.15 Mount a file structure

This EMT is used to tell TSX-Plus that a file structure is being mounted and that TSX-Plus should begin caching the file directory for the device. The effect of this EMT is the same as doing a system MOUNT keyboard command to enable caching. It cannot be used to mount a logical subset disk. The form of the EMT is:

```
        EMT     375
```

with R0 pointing to the following argument block:

```
        .BYTE   0,134
        .WORD   device-spec-address
        .WORD   0
```

where "device-spec-address" is the address of a word containing the RAD50 form of the name of the device on which the file structure is being mounted. If there is no room left in the table of mounted devices, the carry bit is set on return and the error code returned is 1.

Example:

```
        .TITLE  MOUNT
        .ENABL  LC

; Demonstrate TSX-Plus EMT to "MOUNT" (do directory caching on) a device

        .GLOBL  IRAD50          ;SYSLIB RAD50 conversion subroutine
BS      = 10                    ;ASCII Backspace
        .MCALL  .PRINT,.GTLIN,.EXIT

START:  .GTLIN  #BUFFER,#PROMPT ;Ask for name of device
        MOV     #R50BLK,R5      ;Point to arg block for next call
        CALL    IRAD50          ;Convert ASCII device name to RAD50
        MOV     #MOUNT,R0       ;Point to EMT arg block to
        EMT     375             ;Mount a file structure (directory caching)
        BCC     START           ;Ask for more if OK

        .PRINT  #NOGOOD         ;Say it was not good
        .EXIT

        .NLIST  BEX
MOUNT:  .BYTE   0,134           ;EMT arg block to mount a file structure
        .WORD   DEVNAM          ;Pointer to RAD50 name of device
        .WORD   0               ;Required 0 argument
R50BLK: .WORD   3               ;Number of args for IRAD50 call
        .WORD   THREE           ;Pointer to number of chars to convert
        .WORD   BUFFER          ;Pointer to chars to convert
        .WORD   DEVNAM          ;Pointer to RAD50 name of device
THREE:  .WORD   3               ;Number of chars to convert
DEVNAM: .WORD   0               ;RAD50 representation of device name
BUFFER: .BLKB   80.             ;GTLIN input buffer
PROMPT: .ASCII  /Name of device to be mounted:   :/<BS><BS><BS><BS><200>
NOGOOD: .ASCIZ  /Attempt to MOUNT too many devices./<7>
        .END    START
```

7.16 Dismount a file structure

This EMT can be used to tell TSX-Plus to stop doing directory caching on a particular drive. The effect of this EMT is the same as a DISMOUNT keyboard command to disable caching. The form of the EMT is:

```
EMT     375
```

with R0 pointing to an argument block of the following form:

```
.BYTE   0,135
.WORD   device-spec-address
.WORD   0
```

where "device-spec-address" is the address of a word containing the RAD50 name of the device to be dismounted.

Example:

```
        .TITLE  DISMNT
        .ENABL  LC

; Demonstrate TSX-Plus EMT to "DISMOUNT" (stop caching on) a device

        .GLOBL  IRAD50          ;SYSLIB RAD50 conversion subroutine
BS      = 10                    ;ASCII Backspace
        .MCALL  .GTLIN

START:  .GTLIN  #BUFFER,#PROMPT ;Ask for name of device
        MOV     #R50BLK,R5      ;Point to arg block for next call
        CALL    IRAD50          ;Convert ASCII device name to RAD50
        MOV     #DISMNT,R0      ;Point to EMT arg block to
        EMT     375             ;dismount a file structure (stop caching)
        BR      START           ;Repeat (no errors returned)

        .NLIST  BEX
DISMNT: .BYTE   0,135           ;EMT arg block to dismount a file structure
        .WORD   DEVNAM          ;Pointer to RAD50 name of device
        .WORD   0               ;Required 0 argument
R50BLK: .WORD   3               ;Number of args for IRAD50 call
        .WORD   THREE           ;Pointer to number of chars to convert
        .WORD   BUFFER          ;Pointer to chars to convert
        .WORD   DEVNAM          ;Pointer to RAD50 name of device
THREE:  .WORD   3               ;Number of chars to convert
DEVNAM: .WORD   0               ;RAD50 representation of device name
BUFFER: .BLKB   80.             ;GTLIN input buffer
PROMPT: .ASCII  /Name of device to be dismounted:   :/<BS><BS><BS><BS><200>

        .END    START
```

7.17 Determining the terminal type

The following EMT will return in R0 a value that indicates what type of time-sharing terminal is being used with the line. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   0,137
```

The terminal type is specified either when the TSX-Plus system is generated or by use of the SET TT command (e.g., SET TT VT100). The terminal type codes which are currently defined are listed below. The types Diablo and Qume are functionally equivalent.

Terminal-type	Code
(Unknown)	0
VT52	1
VT100	2
Hazeltine	3
ADM3A	4
LA36	5
LA120	6
Diablo & Qume	7
VT200	9

A type code of 0 (zero) is returned if the terminal type is unknown.

Example:

See the example program LNTT in the section on determining the TSX-Plus line number.

7.18 Controlling the size of a job

Under RT-11, the .SETTOP EMT is used to set the top address of a job. The TSX-Plus .SETTOP EMT does not actually alter the memory space allocated to a job but simply checks to see if the requested top of memory is within the region actually allocated to the job and if not returns the address of the top of the allocated job region. The TSX-Plus .SETTOP EMT was implemented this way because many programs written for RT-11 routinely request all of memory when they start regardless of how much space they actually need.

The memory space actually allocated for a job can be controlled by use of the "MEMORY" keyboard command or by use of the EMT described below. The memory size specified by the most recently executed MEMORY keyboard command is considered to be the "normal" size of the job. The EMT described here can be used to alter the memory space allocated to a job but the job size reverts to the normal size when the job exits or chains to another program.

The form of the EMT used to change a job's size is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   0,141
.WORD   top-address
```

where "top-address" is the requested top address for the job. If this address is larger than the allowed size of a job, the job will be expanded to the largest possible size. On return from the EMT, R0 contains the address of the highest available word in the program space.

A program is not allowed to change its size if it was started by use of the "RUN/DEBUG" command or the system was generated without allowing program swapping. In either of these cases the EMT operates exactly like a .SETTOP request (i.e., the requested program top address will not be allowed to exceed the normal program size).

See also the description of the SETSIZ program in Appendix A for information about how the default memory allocation for a program can be built into the SAV file for the program.

Example:

See the example program CKSTAT in the section on determining job status information.

7.19 Determining job status information

The information about various jobs on the system which is displayed by the SYSTAT command may also be obtained by application programs. An EMT is provided with several subfunctions to obtain the desired job status information. This EMT may obtain information about any job on the system, not only itself. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   0,144
.BYTE   line-#,sub-function
.WORD   buf-address
```

where "line-#" is the number of the time-sharing line about which information is to be returned. Line numbers are in the range 1 up to the highest valid line number for the system. "Sub-function" is a function code which indicates the type of information to be returned by the EMT (see below). "buf-address" is the address of the first word of a 2 word buffer area into which the

returned value is stored. Note: some of the functions only return a single word value in which case the value is returned into the first word of the buffer area.

If an error occurs during the execution of the EMT, the carry-flag is set on return and the following error codes indicate the type of error:

Errors:

Code	Meaning
0	Indicated line number is not currently logged on.
1	Invalid sub-function code.
2	Invalid line number (0 or higher than largest valid line number).

Each of the sub-functions is described below:

Subfunction # 0 -- Check status of line.
The value returned contains bit flags that indicate the status of the job. The following bit flags are defined:

000001 = This is a subprocess.
000002 = This is a detached job line.
000100 = Job has locked itself in memory.
000200 = Job has SYSPRV privilege.

Subfunction # 1 -- Get job's execution state.
This subfunction returns a code that indicates a job's current execution state. The following code values are defined:

1 = Non-interactive high priority run state.
2 = Normal priority run state.
3 = Fixed-low-priority run state.
4 = Waiting on input from the terminal.
5 = Waiting for output to be written to terminal.
6 = Doing a timed wait.
7 = Suspended because .SPND EMT done.
8 = Waiting for access to a shared file.
9 = Waiting for a inter-job message.
10 = Waiting for access to USR (file management) module.
11 = Waiting for non-terminal I/O to finish.
12 = Waiting for access to spool file.
13 = Interactive high priority run state.
14 = Fixed-high-priority run state.
15 = Waiting for memory expansion.

Subfunction # 2 -- Determine amount of memory used by job.
This function returns the number of 256-word blocks of memory that are currently being used by the job, including PLAS regions.

Subfunction # 3 -- Determine connect time for job.
This function returns the number of minutes that a job has been logged onto the system.

Subfunction # 4 -- Determine position of job in memory.
This function returns the 256-word block number of the start of the memory area allocated to the job.

Subfunction # 5 -- Get name of program being run by job.
This function returns a 2 word value. The two words contain the RAD50 value for the name of the program currently being run by the job.

Subfunction # 6 -- Get project and programmer number for job.
This function returns a two word value. The first word contains the project number that the job is logged on under; the second word contains the programmer number.

Subfunction # 7 -- Get CPU time used by job.
This function returns a two word value that contains the number of clock-ticks of CPU time used by the job. The first word contains the high-order 16-bits of the value, the second word contains the low-order 16-bits.

Subfunction # 8 -- Get current job execution priority.
This function returns one word that contains the current job execution priority level (0-127).

Example:

```
        .TITLE  CKSTAT
        .ENABL  LC

; Demonstration of MEMTOP, JSTAT and SNDMSG EMTs of TSX-Plus

ERRBYT  = 52                    ;EMT error code location
PRGNAM  = 5                     ;JSTAT subfunction code to get prog. name

        .MCALL  .TWAIT,.EXIT

START:  MOV     #MEMTOP,R0      ;Point to EMT arg block to
        EMT     375             ;Set job size
;Only works in swapping environment, otherwise behaves like .SETTOP
        CMP     R0,#HILIM       ;See if we got what we wanted
        BHIS    AGAIN           ;Go on if so
        .EXIT                   ;else quit (can't disp err msg from det line)

AGAIN:  MOVB    #1,LINE         ;Check all lines starting with #1
```

```
CHECK:  MOV     #JSTAT,R0           ;Point to EMT arg block
        EMT     375                 ;Get name of job being run
        BCS     ERRTYP              ;Go find out what kind of error
        CMP     BUFADD,DUNJUN       ;Is this line goofing off?
        BNE     NEXT                ;No, proceed
        CMP     BUFADD+2,DUNJUN+2   ;May be, check for sure
        BNE     NEXT                ;No, proceed
;Send a message to the offending line
;(Each message must be < 88. bytes)
        MOVB    LINE,YOOHOO         ;Who is the guilty party?
        MOV     #MESAG1,MSGADD      ;Prepare part one of message
        MOV     #SEND,R0            ;Point to EMT arg block to
        EMT     375                 ;Send a message to that line
        MOV     #MESAG2,MSGADD      ;Prepare for part two of the message
        MOV     #SEND,R0            ;Point to EMT arg block to
        EMT     375                 ;Send part 2 of message
        MOV     #MESAG3,MSGADD      ;Prepare for part three of the message
        MOV     #SEND,R0            ;Point to EMT arg block to
        EMT     375                 ;Send part 3 of message
        MOV     #MESAG4,MSGADD      ;Prepare for part four of the message
        MOV     #SEND,R0            ;Point to EMT arg block to
        EMT     375                 ;Send part 4 of message
NEXT:   INCB    LINE                ;Try next line
        CMPB    LINE,MAXLIN         ;Have we checked them all?
        BGT     SLEEP               ;Yes, wait awhile
        BR      CHECK               ;Go check the rest of the lines
SLEEP:  .TWAIT  #AREA,#TIME         ;Come back in 5 minutes
        BR      AGAIN               ;And try again
ERRTYP: CMPB    @#ERRBYT,#1         ;Which error is it
        BLT     NEXT                ;0 --> line not logged on, try next line
        BEQ     2$                  ;1 --> invalid sub-function code, give up
        MOVB    LINE,MAXLIN         ;2 --> line > last valid line
        DECB    MAXLIN              ;Largest valid line number
        BR      SLEEP               ;should only happen first time

2$:     .EXIT                       ;Invalid code should never happen
                                    ;Might as well kill job
MEMTOP: .BYTE   0,141               ;Argument block for MEMTOP EMT
        .WORD   HILIM               ;Upper address limit
JSTAT:  .BYTE   0,144               ;Argument for JSTAT EMT
LINE:   .BYTE   0                   ;TSX-Plus line number to be checked
SUBFUN: .BYTE   PRGNAM              ;EMT subfunction
        .WORD   BUFADD              ;Address of 2-word buffer for returned value
BUFADD: .BLKW   2                   ;2 word buffer to hold stat result
MAXLIN: .BYTE   30.                 ;Maximum number of lines under TSX-Plus
        .EVEN                       ;Will be altered to max valid line #
SEND:   .BYTE   0,127               ;EMT arg block to send a message
YOOHOO: .WORD   0                   ;Destination line number
MSGADD: .WORD   MESAG1              ;Message to be sent
AREA:   .BLKW   2                   ;.TWAIT arg area
```

```
TIME:   .WORD   0               ;time high word
        .WORD   5*60.*60.       ;5min * 60.sec/min * 60.ticks/sec
        .NLIST  BEX
DUNJUN: .RAD50  /DUNJUN/        ;Name of illicit program
MESAG1: .ASCII  <7><15><12>
        .ASCII  /*********************************/<15><12>
        .ASCIZ  /*                                 */<15><12>
MESAG2: .ASCII  /*  Continued use of this system  */<15><12>
        .ASCIZ  /*  for game playing will result  */<15><12>
MESAG3: .ASCII  /*  in loss of user privileges!!  */<15><12>
        .ASCIZ  /*                                 */<15><12>
MESAG4: .ASCIZ  /*********************************/<15><12><7>

HILIM:  .END    START
```

7.20 Determining file directory information

This EMT returns directory information about a file. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   chan,145
.WORD   dblk
.WORD   rblk
```

where "chan" is a channel number in the range 0-16 (octal) that is currently not in use, "dblk" is the address of a 4-word block containing the RAD50 file specification (device, file name, extension), and "rblk" is the address of a 7-word block that will receive the information about the file. The information returned in "rblk" is:

```
Word 1:  Size of the file (number of blocks).
Word 2:  0-->File not protected; 1-->File is protected.
Word 3:  File creation date (standard RT-11 date format).
Word 4:  File creation time (number of 3-second units).
Word 5:  Starting block number of file.
Word 6:  Unused (reserved)
Word 7:  Unused (reserved)
```

Errors:

Code	Meaning
0	Channel is currently in use.
1	Unable to locate specified file.
2	Specified device is not file structured.

Example:

```
        .TITLE  FILINF
        .ENABL  LC

; Demonstrate TSX-Plus EMT to return information about a file

        .MCALL  .PRINT,.EXIT,.CSISPC,.TTYOUT
        .GLOBL  DSPDAT,DSPTI3,PRTDEC

ERRBYT  = 52                    ;EMT error code location

START:  .CSISPC #OUTSPC,#DEFLT,#0,#BUFFER       ;Get file name
        MOV     #FILINF,R0      ;Point to EMT arg block to
        EMT     375             ;Get information about a file
        BCC     5$              ;No error?
        MOVB    @#ERRBYT,R1     ;What error
        ASL     R1              ;Convert to word index
        .PRINT  FIERR(R1)       ;Explain it
        .EXIT

5$:     MOV     #BUFFER,R0      ;Find the end of the file spec.
10$:    TSTB    (R0)+           ;End?
        BNE     10$             ;No, keep looking
        MOVB    #200,-(R0)      ;No CR,LF at end
        .PRINT  #BUFFER         ;File name
        .TTYOUT #'[
        MOV     FILSIZ,R0       ;File size
        CALL    PRTDEC
        TST     PRTCTD          ;Was file protected?
        BEQ     15$
        .TTYOUT #'P
15$:    .TTYOUT #']
        .PRINT  #SPACE2
        MOV     FILDAT,R0       ;File creation date
        CALL    DSPDAT          ;Display date
        .PRINT  #SPACE2
        MOV     FILTIM,R0       ;File creation time (3 sec resolution)
        CALL    DSPTI3          ;Display special 3-sec time
        .PRINT  #SPACE2
        MOV     FILLOC,R0       ;File starting block #
        CALL    PRTDEC
        .EXIT

        .NLIST  BEX
FILINF: .BYTE   0,145           ;EMT arg block to get file info.
        .WORD   INSPC           ;Pointer to RAD50 file name
        .WORD   FILSIZ          ;Pointer to 7 word result buffer
FILSIZ: .WORD   0               ;File size
PRTCTD: .WORD   0               ;Protected=1, unprotected=0
```

```
FILDAT: .WORD   0               ;File date (standard format)
FILTIM: .WORD   0               ;File time (special 3-sec format)
FILLOC: .WORD   0               ;File starting block number
        .WORD   0,0             ;Pad for 2 reserved words
OUTSPC: .BLKW   15.             ;Output file specifications
INSPC:  .BLKW   24.             ;Input file specifications
DEFLT:  .WORD   0,0,0,0         ;No default extensions
FIERR:  .WORD   CINUSE          ;EMT error message table
        .WORD   NOFILE
        .WORD   BADDEV
BUFFER: .BLKB   81.             ;Input string buffer
SPACE2: .ASCII  /  /<200>
CINUSE: .ASCIZ  /?FILINF-F-Channel in use./
NOFILE: .ASCIZ  /?FILINF-F-Can't find file./
BADDEV: .ASCIZ  /?FILINF-F-Non-directory device./
        .END    START
```

7.21 Setting file creation time

The time that a file is created is stored along with other directory information under TSX-Plus. In order to pack the time into a single word, TSX-Plus represents the file creation time in three second units. For example, if a file was created at 11:13:22, then the special time representation would be 13467 (decimal).

```
11 hr * 60 min/hr * 60 sec/min = 39600
        13 min    * 60 sec/min =   780
                    22 sec     =    22
                                  -----
                                  40402 seconds

40402 sec / 3 sec/unit = 13467 3-sec units
```

A utility program is provided with TSX-Plus to display the creation time and other directory information about a file. See Appendix C for more information on the FILTIM utility.

The creation date and time for a file are automatically stored by TSX-Plus in the directory entry for the file at the time that the file is closed after being created. An EMT is provided for those unusual situations where a different creation time is to be specified for a file after the file is created. The form of this EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
        .BYTE   chan,146
        .WORD   dblk
        .WORD   time
```

where "chan" is the number of an unused channel, "dblk" is the address of a 4-word block containing the RAD50 file specification, and "time" is the time value (in 3-second units since midnight) that is to be set as the creation time for the file.

Errors:

Code	Meaning
0	Channel is currently in use.
1	Unable to locate specified file.
2	Specified device is not file structured.

Example:

```
        .TITLE  SFTIM
        .ENABL  LC

; Demonstrate TSX-Plus EMT to set file creation time

        .MCALL  .PRINT,.CSISPC,.EXIT,.GTLIN
        .GLOBL  ACRTI3          ;Subroutine to convert hh:mm:ss to special
                                ;3-sec internal time format in R0

ERRBYT  = 52                    ;EMT error code location

START:  .PRINT  #GETNAM         ;Prompt for file name
        .CSISPC #OUTSPC,#DEFLT  ;Get file name in RAD50
        .GTLIN  #BUFFER,#GETTIM ;Prompt for and get a time
        MOV     #BUFFER,R0      ;Point to time input buffer
        CALL    ACRTI3          ;Get special time in R0
        BCC     1$              ;Time error?
        .PRINT  #BADTIM         ;Yes, incorrect format
        .EXIT
1$:     MOV     R0,NEWTIM       ;Save special time
        MOV     #SFTIM,R0       ;Point to EMT arg block to
        EMT     375             ;Set creation time in file
        BCC     2$              ;Error?
        MOVB    @#ERRBYT,R0     ;Yes, get error code
        ASL     R0              ;Convert to word offset
        .PRINT  SFTERR(R0)      ;Explain
2$:     .EXIT

        .NLIST  BEX
SFTIM:  .BYTE   0,146           ;EMT arg block to set file creation time
```

```
        .WORD   INSPC           ;Pointer to RAD50 file name
NEWTIM: .WORD   0               ;Will contain new creation time
OUTSPC: .BLKW   15.             ;.CSISPC output files
INSPC:  .BLKW   24.             ;.CSISPC input files (first is the one)
DEFLT:  .WORD   0,0,0,0         ;Default file extensions
SFTERR: .WORD   INUSE           ;SFTIM error message table
        .WORD   NOFILE
        .WORD   BADDEV
BUFFER: .BLKB   81.             ;.GTLIN input buffer - holds time hh:mm:ss
GETNAM: .ASCII  /Set creation time in file: /<200>
GETTIM: .ASCII  /New creation time: /<200>
BADTIM: .ASCIZ  /?SFTIM-F-Invalid time./
INUSE:  .ASCIZ  /?SFTIM-F-Channel in use./
NOFILE: .ASCIZ  /?SFTIM-F-Can't find file./
BADDEV: .ASCIZ  /?SFTIM-F-Non-directory device./
        .END    START
```

7.22 Determining or changing the user name

When using the LOGON system access program, each user is assigned both a user name and a project, programmer number. TSX-Plus provides an EMT which allows an application program to obtain the user name or (with SETNAME privilege) to change it. User names may be up to twelve characters in length. If the LOGON program is not used, the user name will initially be blank, although it may be changed to a non-blank name. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block to determine the user name:

```
.BYTE   0,147
.WORD   buff-addr
```

where "buff-addr" is a pointer to a 12 byte area to contain the user name which is returned.

To change the current user name, R0 should instead point to the following argument block:

```
.BYTE   1,147
.WORD   buff-addr
```

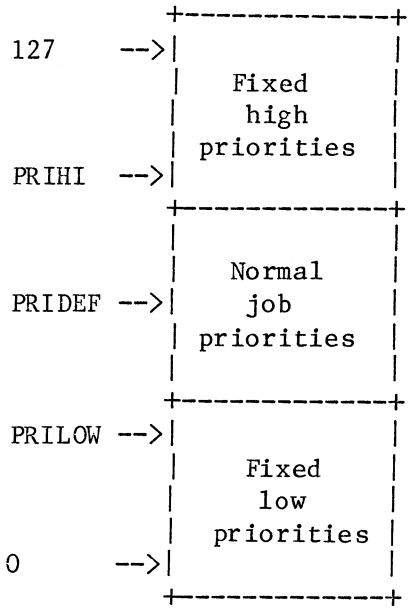
where "buff-addr" is a pointer to a 12 byte area containing the new user name. SETNAME privilege is required to change the user name. If changing the user name is attempted without SETNAME privilege, the name will not be changed and the carry bit will be set on return.

Example:

```
        .TITLE  GSUNAM
        .ENABL  LC

; Demonstrate TSX-Plus EMT to get/set user name

ERRBYT  = 52                    ;EMT error code location

        .MCALL  .PRINT,.EXIT

START:  .PRINT  #NAMEIS         ;Preface user name
        MOV     #GSUNAM,R0      ;Point to EMT arg block to
        EMT     375             ;Get user name
        .PRINT  #NAMBUF         ;And display it

        MOV     #NEWNAM,NAMADD  ;Point to new user name
        INCB    GSUNAM          ;Set low bit to set name
        MOV     #GSUNAM,R0      ;Point to EMT arg block to
        EMT     375             ;Set new user name
        BCC     1$              ;Error?

        .PRINT  #NOPRIV         ;Must have SETNAME privilege
1$:     .EXIT

        .NLIST  BEX
GSUNAM: .BYTE   0,147           ;EMT arg block to get user name
NAMADD: .WORD   NAMBUF          ;Pointer to receive area
NAMBUF: .BLKW   6               ;Six word name area (12 bytes)
        .WORD   0               ;Make it ASCIZ
NEWNAM: .ASCII  /CHAUNCY     /  ;The new name (12 bytes)
NAMEIS: .ASCII  /Your current user name is: /<200>
NOPRIV: .ASCIZ  /SETNAME privilege necessary to set user name./
        .END    START
```

7.23 Setting job priority

Jobs may be assigned priority values in the range 0 to 127 to control their execution scheduling relative to other jobs. The priority values are arranged in three groups: the fixed-low-priority group consists of priority values from 0 up to the value specified by the PRILOW sysgen parameter; the fixed-high-priority group ranges from the value specified for the PRIHI sysgen parameter up to 127; the middle priority group ranges from (PRILOW+1) to (PRIHI-1). The following diagram illustrates the priority groups:



Job scheduling is performed differently for jobs in the fixed-high-priority and fixed-low-priority groups than for jobs with normal interactive priorities. Jobs with priorities in the fixed-low-priority group (0 to PRILOW) and the fixed-high-priority group (PRIHI to 127) execute at fixed priority values. That is, the priority absolutely controls the scheduling of the job for execution relative to other jobs. A job with a fixed priority is allowed to execute as long as it wishes until a higher priority job becomes active.

The fixed-high-priority group is intended for use by real-time programs. The fixed-low-priority group is intended for use by very low priority background tasks. Normal time-sharing jobs should not be assigned priorities in either of the fixed priority groups.

The middle group of priorities from (PRILOW+1) to (PRIHI-1) are intended to be used by normal, interactive, time-sharing jobs. Jobs with these assigned priorities are scheduled in a more sophisticated manner than the fixed-priority jobs. In addition to the assigned priority, external events such as terminal input completion, I/O completion, and timer quantum expiration play a role in determining the effective scheduling priority.

When a job with a normal priority switches to a subprocess, the priority of the disconnected job is reduced by the amount specified by the PRIVIR sysgen parameter. This causes jobs that are not connected to terminals to execute at a lower priority than jobs that are. This priority reduction does not apply to jobs with priorities in the fixed-high-priority group or the fixed-low-priority group. The priority reduction is also constrained so that the priority of jobs in the normal job priority range will never be reduced below the value of (PRILOW+1).

The following EMT can be used to set the job priority from within a program. The job priority can also be set from the keyboard with the SET PRIORITY command. The current job priority, maximum allowed priority, and fixed-high- and fixed-low-priority boundaries may be determined with the .GVAL request. See the TSX-Plus System Manager's Guide for more information on the significance of priority in job scheduling. The form of this EMT is:

```
        EMT     375
```

with R0 pointing to the following EMT argument block:

```
        .BYTE   0,150
        .WORD   value
```

where "value" is the priority value for the job. The valid range of priorities is 0 to 127 (decimal). The maximum job priority may be restricted by the system manager. If a job attempts to set its priority above its maximum allowed priority, its priority will be set to the maximum allowed. This EMT does not return any errors.

Example:

```
        .TITLE  GSPRI
        .ENABL  LC

;  Demonstrate EMT to set job priority

        .MCALL  .GVAL,.GTLIN,.PRINT,.EXIT
        .GLOBL  PRTDEC

CURPRI  = -16.                  ;GVAL offset to get current priority
MAXPRI  = -18.                  ;GVAL offset to get maximum priority

START:  .PRINT  #CURIS          ;"current priority is"
        .GVAL   #AREA,#CURPRI   ;Obtain current job priority in R0
        MOV     R0,R1           ;Save it
        CALL    PRTDEC          ; and display it
        .PRINT  #MAXIS          ;"maximum priority is"
        .GVAL   #AREA,#MAXPRI   ;Obtain maximum allowable job priority
        MOV     R0,R2           ;Save it
        CALL    PRTDEC          ; and display it
        ADD     #10.,R1         ;Try to boost priority by 10
        CMP     R1,R2           ;Unless exceeds maximum
        BLE     1$              ;Use 10 larger if <= maxpri
        MOV     R2,R1           ;Else use maxpri
1$:     MOV     R1,NEWPRI       ;Set new priority in EMT arg block
        MOV     #SETPRI,R0      ;Point to EMT arg block to
        EMT     375             ;Sset new job priority
        .PRINT  #NEWIS          ;"new priority is"
        .GVAL   #AREA,#CURPRI   ;Obtain new priority
```

```
        CALL    PRTDEC          ; and display it
        .EXIT

AREA:   .BLKW   10              ;General EMT arg block
SETPRI: .BYTE   0,150           ;EMT arg block to set job priority
NEWPRI: .WORD   50.             ;New job priority goes here

        .NLIST  BEX
CURIS:  .ASCII  /Current job priority = /<200>
MAXIS:  .ASCII  <15><12>/Maximum job priority = /<200>
NEWIS:  .ASCII  <15><12>/- New - job priority = /<200>

        .END    START
```

7.24 Determining or changing job privileges

A TSX-Plus EMT is available to allow running programs to determine the privileges for the job and to change privileges. This is particularly useful to check user-defined privileges. See the TSX-Plus System Manager's Guide for complete information on job privileges. The form of the EMT argument block is:

```
EMT     375
```

with R0 pointing to an argument block of the following form:

```
.BYTE   1,150
.BYTE   function,privtype
.WORD   buffer
.WORD   0
```

Where "buffer" is the address of a four word buffer which contains the privilege flags to be set or cleared or which will receive the privilege flags. Note, not all of the privilege words may be in current use, but four words should be reserved to allow for future expansion.

"Function" indicates the type of operation being done and must be 0, 1, or 2 according to the following table:

Function	Meaning
0	Read job's privilege flags into "buffer"
1	Clear bits set in "buffer" in job's privilege flag bits
2	Set bits set in "buffer" in job's privilege flag bits

Functions 1 and 2 are bit-clear and bit-set operations so that individual privileges may be selectively changed without affecting other privileges.

"Privtype" indicates which of the three sets of privilege flags are to be accessed, and must be 0, 1, or 2 according to the following table:

Privtype	Privilege table
0	Current privileges
1	Set privileges
2	Authorized privileges

The current privileges for the job are reset to the set privileges when the currently executing program exits. If set privileges are changed, then current privileges are changed as well. If authorized privileges are changed, then set and current privileges are changed as well. SETPRV privilege is required to set any new privileges in the authorized privilege set.

Errors:

Code	Meaning
1	Attempt to enable privileges for which the job is not authorized. Only those privileges for which the job is authorized are set.

Example:

```
        .TITLE  SETPRV
        .ENABL  LC
        .DSABL  GBL

; Demonstrate EMT to determine or set privileges.

        .MCALL  .PRINT,.EXIT,.TTYOUT
        .GLOBL  PRTOCT

SPACE   = 40                    ;ASCII SPACE
ERRBYT  = 52                    ;EMT ERROR BYTE

START:  CALL    SHOPRV          ;DISPLAY PRIVILEGES BEFORE
        .PRINT  #CRLF
        MOVB    #2,RCS          ;WANT TO SET PRIV FLAGS
        MOVB    #1,CSA          ;SELECT "SET" PRIVILEGES
        MOV     #700,PRIVS      ;SET 3 PRIV FLAGS IN PRIV WORD 1
        CLR     PRIVS+2         ;DON'T CHANGE ANY IN PRIV WORD 2
        MOV     #GSPRIV,R0      ;POINT TO EMT ARG BLOCK TO
        EMT     375             ;SET SOME PRIVILEGE FLAGS
        BCC     1$              ;BRANCH ON ERROR
        MOVB    @#ERRBYT,-(SP)  ;ELSE GET ERROR BYTE
        ADD     #'0,(SP)        ;CONVERT TO DIGIT
        .PRINT  #ERR
        .TTYOUT (SP)+
```

```
        .PRINT  #CRLF
1$:     CALL    SHOPRV          ;DISPLAY PRIVILEGES AFTER
        .EXIT

SHOPRV: .PRINT  #AUTPRV         ;"AUTHORIZED"
        MOVB    #2,CSA          ;LOOK AT AUTHORIZED PRIVILEGES
        CALL    DSPPRV          ;READ AND DISPLAY FIRST 2 PRIV WORDS
        .PRINT  #SETPRV         ;"SET"
        MOVB    #1,CSA          ;LOOK AT SET PRIVILEGES
        CALL    DSPPRV
        .PRINT  #CURPRV         ;"CURRENT"
        CLRB    CSA             ;LOOK AT CURRENT PRIVILEGES
        CALL    DSPPRV          ;DISPLAY PRIVILEGE BITS
        RETURN

DSPPRV: CLRB    RCS             ;READ PRIVILEGES
        MOV     #GSPRIV,R0      ;POINT TO EMT ARG BLOCK TO
        EMT     375             ;READ SELECTED PRIVILEGES
        MOV     PRIVS,R0        ;GET PRIV WORD 1
        CALL    PRTOCT          ;DISPLAY ITS BITS
        .TTYOUT #SPACE
        MOV     PRIVS+2,R0      ;GET PRIV WORD 2
        CALL    PRTOCT
        .PRINT  #CRLF
        RETURN

GSPRIV: .BYTE   1,150           ;GET/SET PRIVILEGE EMT
RCS:    .BYTE   0               ;0=READ,1=CLEAR,2=SET
CSA:    .BYTE   0               ;0=CURRENT,1=SET,2=AUTHORIZED
        .WORD   PRIVS           ;PUT PRIV FLAGS HERE
        .WORD   0               ;REQUIRED 0

PRIVS:  .WORD   0,0,0,0         ;PRIVILEGE FLAGS 2 OF 4 USED

        .NLIST  BEX
AUTPRV: .ASCII  /Authorized privileges: /<200>
SETPRV: .ASCII  /Set privileges:        /<200>
CURPRV: .ASCII  /Current privileges:    /<200>
CRLF:   .ASCIZ  //
ERR:    .ASCII  /Set privilege error # /<200>
        .LIST   BEX
        .END    START
```

7.25 Program controlled terminal options

Programs may dynamically change various parameters related to terminal control. The following EMT may be used to set various program controlled terminal options:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   0,152
.WORD   function-code
.WORD   argument-value
```

where "function-code" is a character which specifies which option is to be set or changed, and "argument-value" specifies a value used only by some options. See the section on program controlled terminal options earlier in this manual for more information on the specific options which may be selected and details on their effects.

Example:

See the example program EMTMTH in the chapter on program controlled terminal options.

7.26 Forcing [non]interactive job characteristics

The following EMT can be used to cause a job to be scheduled either as an interactive job or as a non-interactive job. Programs which do a large amount of terminal input, but which are not truly interactive jobs in the usual sense, such as file transfer programs, should use this EMT to avoid excessive interference with normal interactive time-sharing jobs. This feature may also be selected with the R[UN]/NONINTERACTIVE command. See the TSX-Plus System Manager's Guide for more information on job scheduling and the significance of interactive vs. non-interactive jobs.

The form of this EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   0,153
.WORD   mode
.WORD   0
```

If the value of "mode" is 0, then the job will never be scheduled as an interactive job. If "mode" is 1, then the job will be scheduled as other interactive jobs are, dependent on terminal input.

Example:

```
        .TITLE  NONINT
        .ENABL  LC

; Demonstrate EMT to schedule job as interactive or non-interactive

        .MCALL  .TTYIN,.TTYOUT,.PRINT,.EXIT

JSW     = 44                    ;Job Status Word address
TTSPC   = 10000                 ;TT special mode bit (single-char)
CTRLZ   = 32                    ;ASCII CTRL-Z (move on command)

START:  MOV     #SINGLE,R0      ;Point to EMT arg block to
        EMT     375             ;Turn on single character activation
        BIS     #TTSPC,@#JSW    ;Finish turning on single char mode

        MOV     #NONINT,R0      ;Point to EMT arg block to
        EMT     375             ;Schedule this as non-interactive job

        .PRINT  #SLOW           ;"May be slow now if system busy"
1$:     .TTYIN                  ;Get a char
        CMPB    R0,#CTRLZ       ;If CTRL-Z
        BEQ     2$              ;Then move on
        .TTYOUT                 ;Else echo it back (we have to echo
                                ; when in single char mode)
        BR      1$              ;And repeat

2$:     MOV     #1,SELECT       ;Want to be interactive now
        MOV     #NONINT,R0      ;Point to EMT arg block to
        EMT     375             ;Schedule this as an interactive job
        .PRINT  #FAST           ;"See how much faster now"
3$:     .TTYIN                  ;Get a char
        CMPB    R0,#CTRLZ       ;If CTRL-Z
        BEQ     4$              ;Then move on
        .TTYOUT                 ;Else echo it back
        BR      3$              ;And repeat

4$:     .EXIT

SINGLE: .BYTE   0,152           ;EMT arg block to set term option
        .WORD   'S              ;Single char activation
        .WORD   0
NONINT: .BYTE   0,153           ;EMT arg block to sched as [non]interactive
SELECT: .WORD   0               ;Initially make non-interactive
        .WORD   0
        .NLIST  BEX
SLOW:   .ASCII  /Type some characters in now. If the system has several /
        .ASCII  /interactive jobs/<15><12>
        .ASCII  /response will be slow. (Control-Z to get out /
```

```
        .ASCIZ  /of this mode.)/
FAST:   .ASCIZ  <15><12>/Try again. Response should be much better./
        .END    START
```

7.27 Setting terminal baud rates

The transmit/receive speed for time-sharing lines or CL lines may be set either with the keyboard command SET TT SPEED or from within a program. Use of this EMT requires TERMINAL privilege. Line speeds may only be set for terminal interfaces which support programmable baud rates, such as: DLV11-E, DZ(V)11, DH(V)11 type interfaces and the PRO-350 printer, communication and QSL ports. The EMT to set line speeds from within a program is:

```
EMT     375
```

with R0 pointing to an argument block of the form:

```
.BYTE   0,154
.WORD   line-number
.WORD   line-parameters (OPLxSSSS)
```

where "line-number" indicates the TSX-Plus line number for which the speed is to be set. If the line-number is 0, then the speed is set on the line from which the EMT is issued. "Line-parameters" is a combined word which is used to specify the speed, number of data bits, and parity control. Bits 0-3 "SSSS" select the baud rate according to the following table:

Speed	Octal Code	Speed	Octal Code	Speed	Octal Code
75	1	600	6	3600	13
110	2	1200	7	4800	14
134.5	3	1800	10	7200	15
150	4	2000	11	9600	16
300	5	2400	12	19200	17

Split speeds (different transmit and receive baud rates) are not supported. Bit 4 "x" is not used. Bit 5 "L" specifies the character length. If this bit is 0, the character length is 8 bits; if this bit is 1, the character length is 7 bits. Bit 6 "P" specifies if parity control is wanted. If this bit is 0, no parity is selected and bit 7 is ignored; if this bit is 1, parity generation and checking is enabled. Bit 7 "O" selects even or odd parity and is only meaningful if bit 6 is 1. If bit 7 is 0, even parity is selected; if bit 7 is 1, odd parity is selected. Note that if only the speed value is specified, with all other bits zero, 8 bit characters with no parity are selected.

A baud rate of 19200 is not supported by DEC DZ(V)11 controllers. DHV11 interfaces do not support 3600 or 7200 baud. DH11 interfaces do not support 2000, 3600 or 7200 baud. The PRO QSL interface does not support 3600 or 7200 baud.

Errors:

Code	Meaning
1	Job does not have TERMINAL privilege
2	Invalid line number specified

Example:

```
        .TITLE  SETSPD
        .ENABL  LC
;
;  Demonstrate EMT to set a line's transmit/receive baud rate
;
        .MCALL  .PRINT,.EXIT
        .GLOBL  PRTDEC
        .DSABL  GBL

ERRBYT  = 52                    ;EMT error byte address

START:  MOV     #SETSPD,R0      ;Point to EMT arg block to
        EMT     375             ;Set line speed
        BCC     9$              ;Branch if OK
        MOVB    @#ERRBYT,-(SP)  ;Fetch EMT error code
        .PRINT  #ERRIS          ;"EMT error is:"
        MOV     (SP)+,R0        ;Retrieve error code
        CALL    PRTDEC          ;Display it
9$:     .EXIT

SETSPD: .BYTE   0,154           ;EMT arg block to set line speed
        .WORD   6               ;Line number
        .WORD   14.             ;Speed code for 9600 baud

        .NLIST  BEX
ERRIS:  .ASCII  /?SETSPD-F-EMT error code = /<200>
        .EVEN
        .END    START
```

7.28 Assigning a CL unit to a time-sharing line

Time-sharing terminal lines which are not in use may be reassigned as general purpose serial I/O lines by directing the TSX-Plus CL facility to assign a CL unit to the line. This can be done either with a keyboard command (see the SET CL LINE=n command in Chapter 2) or from within a program. A special system service call (EMT) is available to assign a CL line from within a program. Use of this EMT requires TERMINAL privilege. The form of the EMT is:

```
EMT     375
```

with R0 pointing to an argument block of the form:

```
.BYTE   0,155
.WORD   CL-unit
.WORD   line-number
```

where "CL-unit" specifies the CL unit number to be assigned to the line, and "line-number" identifies the TSX-Plus line number to be disabled as a time-sharing line and reassigned as a CL unit. The valid range of CL unit numbers is determined by the number of CL units defined during TSX-Plus system generation. For example, if 3 CL units are defined, then the valid CL units are CL0, CL1 and CL2. If "line-number" is zero, then the CL unit is disassociated from the line and the line is restored to its previous function. The line number may also refer to lines generated as dedicated CL lines. In this case, when a CL unit is disassociated from the line, it is simply returned to a pool of lines available for CL use. It does not become redefined as a time-sharing line.

See the TSX-Plus System Manager's Guide for more information on CL units.

Errors:

Code	Meaning
1	Job issuing request does not have TERMINAL privilege
2	Invalid CL unit number specified
3	Invalid line number specified
4	Specified line number already assigned to a CL unit
5	Specified line number in use for time-sharing
6	Specified CL unit is currently busy

Example:

```
        .TITLE  GETCL
        .ENABL  LC
;
;  Demonstrate EMT to switch time-sharing line to CL line
;  Demonstrate EMT to allocate a device
;  Demonstrate .SPFUN request to CL
;
;  This example attempts to attach a CL unit to
;    a line which is linked to another machine,
;    allocate it for exclusive use,
;    modify the default CL settings,
;    and then start up the RT-11 VTCOM utility.
```

```
;
;  Since it is difficult to make logical assignments from within
;    a program, use a special .EXIT to pass the ASSIGN command to
;    KMON and then run VTCOM.
;
        .MCALL  .PRINT,.EXIT,.LOOKUP,.SPFUN,.PURGE
        .DSABL  GBL
;
ERRBYT  = 52                    ;EMT error byte address
JSW     = 44                    ;Job Status Word address
CHNIF$  = 4000                  ;Chain information bit in JSW
;
START:
;
;  Issue EMT to attach the line
;
        MOV     #ATTCL,R0       ;Point to EMT arg block to
        EMT     375             ;Attach CL unit to T-S line
        BCC     1$              ;Branch if OK, else
;
;  EMT error, explain it before exiting
;
        MOVB    @#ERRBYT,R1     ;Get EMT error code
        ASL     R1              ;Convert error byte to word index
        .PRINT  ATTERR(R1)      ;Print appropriate error message
        BR      10$             ;And force simple exit
;
;  Allocate device so nobody else infringes it
;
1$:     MOV     #ALOCAT,R0      ;Point to EMT arg block to
        EMT     375             ;Allocate CL for exclusive use
        BCC     2$              ;Branch if OK, else
;
;  EMT error, explain it before exiting
;
        MOVB    @#ERRBYT,R1     ;Get EMT error code
        ASL     R1              ;Convert to word index
        .PRINT  ALLERR(R1)      ;Print appropriate error message
        BR      10$             ;And exit
;
;  Issue SET CL command (not the easiest way to do this).
;  If a channel were already open to CL, then this would
;  make more sense. But, as an example, why not?
;
2$:     .LOOKUP #AREA,#0,#CLUNAM        ;Open a channel to CL
        .SPFUN  #AREA,#0,#251,#CLFLAG,#0,#0 ;Turn off flagged options
        .PURGE  #0              ;Done with channel
```

```
;
;  Set up for special exit passing commands to KMON
;
        MOV     #COMAND,R1      ;Point to command line text
        MOV     #510,R2         ;Point to chain info area
        MOV     #COMLEN,(R2)+   ;# of bytes in chain data area
3$:     MOVB    (R1)+,(R2)+     ;Move command lines into chain area
        CMP     R1,#COMEND      ;Reached end yet?
        BLO     3$              ;Repeat if not
        BIS     #CHNIF$,@#JSW   ;Set pass command bit in JSW
                                ;(aborts any pending command file)
        CLR     R0              ;Required for special exit
        MOV     #1000,SP        ;Reset stack pointer
10$:    .EXIT                   ;Done (Note: unit remains allocated
                                ;            after program exit!)
;
;  EMT arg blocks and word buffers
;
AREA:   .BLKW   10              ;General purpose EMT arg block
CLFLAG: .WORD   10              ;NOLFOUT flag for CL .SPFUN
;
ATTCL:  .BYTE   0,155           ;EMT arg block to take over TS line by CL
        .WORD   0               ;Selected CL unit number
        .WORD   6               ;Selected TS line number
;
ALOCAT: .BYTE   0,156           ;EMT arg block to allocate a device
        .WORD   CLUNAM          ;Address of 4-word device specification
CLUNAM: .RAD50  /CL0/           ;Start with first CL unit
        .WORD   0,0,0           ;Dummy file specification
;
;  General messages and byte buffers
;
        .NLIST  BEX
COMAND: .ASCIZ  /ASSIGN CL0 XL/ ;Make logical assignment of XL for VTCOM
        .ASCIZ  /R VTCOM/       ;Run VTCOM (part of RT11 V5.01 kit)
COMEND:
        .LIST   BEX
        .EVEN
COMLEN  = COMEND-COMAND         ;# bytes in commands passed to KMON
        .IF     GT <COMLEN-<1000-512>>
        .ERROR  1       ; Chain data area overflow
        .ENDC
```

```
;
ATTERR: .WORD   0               ;Attach CL EMT error message table
        .WORD   NOPRIV          ; 1
        .WORD   BADCLU          ; 2
        .WORD   BADTSL          ; 3
        .WORD   ALRDCL          ; 4
        .WORD   INUSE           ; 5
        .WORD   CLBUSY          ; 6
        .NLIST  BEX
NOPRIV: .ASCIZ  /Not privileged to use this program./
BADCLU: .ASCIZ  /Attempt to use invalid CL unit./
BADTSL: .ASCIZ  /Attempt to use invalid time-sharing line./
ALRDCL: .ASCIZ  /Time-sharing line already in use as CL unit./
INUSE:  .ASCIZ  /Somebody is already using time-sharing line./
CLBUSY: .ASCIZ  /CL unit already active./
        .LIST   BEX
        .EVEN
;
ALLERR: .WORD   0               ;Allocate EMT error table
        .WORD   ALRDAL          ; 1
        .WORD   BADDEV          ; 2
        .WORD   ALLFUL          ; 3
        .WORD   DEVUSE          ; 4
        .NLIST  BEX
ALRDAL: .ASCIZ  /CL unit already allocated by someone else./
BADDEV: .ASCIZ  /Cannot allocate that device./
ALLFUL: .ASCIZ  /Too many devices already allocated./
DEVUSE: .ASCIZ  /Device in use by someone else./
        .LIST   BEX
        .EVEN
;
        .END    START
```

7.29 Allocating a device for exclusive use

Devices may be allocated for exclusive use by a single user. This prevents mixing input and output on common, but non-spooled, devices like a communications line (XL or CL devices) or a magnetic tape. Access restriction by device allocation remains in effect until deallocated by the job or until the job logs off. See the description of the ALLOCATE command in Chapter 2 for more information on device allocation.

There are three system service calls relating to device allocation: allocate a device; deallocate a device; check to see if a device is allocated by another user. Use of these EMTs requires ALLOCATE privilege. The form of the EMT is the same for all three:

```
EMT     375
```

with R0 pointing to an argument block of the form:

```
.BYTE   n,156
.WORD   device-pointer
```

where "device-pointer" is the address of a four word block in which the first word contains the RAD50 name of the device to be allocated and the next three words contain zeros. The specific function is defined by the first byte of the argument block, as follows:

n	Function
0	Allocate a device
1	Deallocate a device
2	Check to see if a device is allocated by another user

You can only allocate a device if no other user has already allocated the device or has a channel open to it. If the device is allocated to another job or another job has a channel open to the device, then the number of the job which is accessing the device is returned in R0. If a job which has already allocated the device or has a channel open to the device is not associated with the same primary line as the job attempting to allocate the device, then the carry bit will be set on return from the EMT and the number of the job which is accessing the device will be returned in R0. If the device is currently allocated by a job which was started from the same primary line as the job which is now attempting to allocate it, then the carry flag will be clear on return, but the other job number will be returned in R0. If both the job with the current allocation and the job attempting to allocate the device are subprocesses, the first one to allocate the device gets the allocation. If either is the primary line, then the primary line will get the allocation.

Errors:

Code	Meaning
1	Device is already allocated by another job
2	Invalid device specified
3	Device allocation table is full (TSGEN parameter MAXALC)
4	Device is currently in use by another job
5	Job does not have ALLOCATE privilege (sub-function to check device allocation does not require privilege)

Example:

See the example program GETCL in the section on assigning a CL unit to a time-sharing line.

7.30 Job monitoring

A monitoring watch may be established to allow a job to monitor the status of other time-sharing jobs. For example, if a detached job were being used as a common file server for several other jobs, it would be useful to know if a served program with a pending request aborts. The outstanding request could then be purged. The monitoring facility may also be used in lieu of message channels (see Chapter 10) when only a small amount of information needs to be communicated (e.g. one word).

When a job is being monitored, the operating system will report certain job status changes, such as logging on, starting or exiting a program, or logging off. In addition, the monitored job itself may issue status reports to any job which may be monitoring it. After a job has established a monitor watch for a given line, a completion routine is entered in the monitoring job whenever a monitor status report is issued for the monitored line, whether the report was issued by the monitored job itself or by the system because of a status change. Job monitoring may be used effectively in conjunction with inter-job message communications and with detached jobs.

There are three system service calls related to job monitoring. All have the form:

```
EMT     375
```

with R0 pointing to an argument block of the form:

```
.BYTE   n,157
.WORD   job-number
.WORD   completion-routine
```

where "n" designates which job monitoring function is to be performed, "job-number" designates the line number which is to be monitored, and "completion-routine" is the address of a completion routine in the monitoring job which is to be entered whenever a monitor status report is generated for the line being monitored ("job-number"). The job-number may designate any primary time-sharing line, detached job or subprocess job number. It may not refer to a dedicated CL line. Job-numbers (lines) are assigned in the following order: time-sharing lines in the order they were declared during system generation, starting with number 1; detached job lines; subprocess lines. Detached jobs and subprocesses are assigned to line numbers in the order they were activated. Unused detached lines are reserved and are never assigned to subprocesses.

7.30.1 Establishing a monitoring connection:
The form of the argument block to establish a monitoring connection with a line is:

```
.BYTE   0,157
.WORD   job-number
.WORD   completion-routine
```

Errors:

Code	Meaning
1	Invalid job number specified
2	No free job monitoring control blocks (increase TSGEN parameter MAXMON)

The specified completion routine will be entered whenever a monitor status report is issued for the specified job-number. On entry to the completion routine, the low order byte of R0 contains the line number of the job originating the monitor status report. Note that the same completion routine may be specified when monitoring more than one job. The high-order bit (mask 100000) of R0 will be clear (0) if the monitor status was originated by the system and will be set if the monitored job itself issued the status. R1 will contain a 16-bit status value. Status values generated by the system for monitored lines are:

Status Code	Meaning
1	Job has been initialized
2	Job has logged on using the LOGON program
3	Job has started running a program
4	Job has returned control to the keyboard monitor
5	Job has logged off

Status code 1 is generated when a logged off line is started, usually by typing a carriage-return at that terminal. Status code 3 is generated whenever a program is either run or chained to. Status code 4 is generated whenever a program exits or is aborted, but not when it chains to another program.

7.30.2 Cancel a monitoring connection:
The form of the argument block to cancel a monitoring connection with a line is:

```
.BYTE   1,157
.WORD   job-number
```

If "job-number" is zero (0), then all job monitoring connections established by the monitoring job (the job issuing this EMT) are cancelled. All job monitoring requests are also cancelled if the job exits, aborts, chains or issues a .SRESET or .HRESET.

Errors:

Code	Meaning
1	Invalid job number specified

7.30.3 Broadcast status report to monitoring jobs:
The form of the argument block to broadcast a monitor status report is:

```
.BYTE   2,157
.WORD   status-value
```

where "status-value" is a 16-bit value to be broadcast to all jobs which are monitoring the job which broadcasts the status-value (the job issuing this EMT). On entry to the completion routine in the monitoring job(s), the status-value is in R1, the low byte of R0 contains the job-number of the job broadcasting the status-value, and the high-order bit of R0 (mask 100000) is set (1).

Errors:

Code	Meaning
0	No jobs are monitoring this line

Example:

```
        .TITLE  MONCPL
        .ENABL  LC
;
;  Demonstrate job monitoring completion routines.
;  Watch a dial-in line and announce when it is activated.
;
        .MCALL  .PRINT,.EXIT,.SPND,.RSUM
        .DSABL  GBL
        .GLOBL  R50ASC

ERRBYT  = 52                    ;EMT error byte address
MONLIN  = 8.                    ;Line number to be monitored
NFYLIN  = 1.                    ;Line number to be notified

START:  MOV     #MONJOB,R0      ;Point to EMT arg block to
        EMT     375             ;Schedule job monitor compl rtn
        BCC     1$              ;Branch if OK
```

```
;  Job monitoring scheduling error
        MOVB    @#ERRBYT,R1     ;Get EMT error code
        ADD     #'0,R1          ;Convert to ASCII
        MOVB    R1,ERRCOD       ;Stuff into error message
4$:     .PRINT  #CPLERR         ;Report error
        .EXIT                   ;And abort

;
;  Wait for event on monitored line
;
1$:     .SPND                   ;Wait for event
        BR      4$              ;Only get here on error
;
;  Completion routine which is entered when event occurs on monitored line
;
MONCPL: MOV     R0,SENDER       ;Remember whose monitor report
        MOV     #MONJOB,R0      ;Point to EMT arg block to
        EMT     375             ;Reschedule myself
        BCC     1$              ;Branch if OK
        MOVB    @#ERRBYT,R0     ;Get error code
        ADD     #'0,R0          ;Convert to ASCII
        MOVB    R0,ERRCOD       ;Save error code
        .RSUM                   ;Restart mainline and report error
        BR      3$              ;Abort completion routine
1$:     TST     SENDER          ;Was this a system generated message?
        BMI     3$              ;Ignore if not
        CMP     R1,#3           ;Running program?
        BNE     2$              ;Branch if not
        MOV     #GPRGNM,R0      ;Point to EMT arg block to
        EMT     375             ;Get program name
;  Note that a short program may already have returned to KMON by now!
        MOV     #R50BLK,R0      ;Point to program name
        CALL    R50ASC          ;Convert into ASCII in message
2$:     DEC     R1              ;0 index status code
        MUL     #CODLEN,R1      ;Convert status code to message offset
        ADD     #CODBEG,R1      ;Convert to message address
        MOV     R1,MSADR        ;Point to correct status message
        MOV     #NOTIFY,R0      ;Point to EMT arg block to
        EMT     375             ;Send notification to operator
3$:     RETURN
;
;  EMT argument blocks and word buffers
;
MONJOB: .BYTE   0,157           ;EMT arg block to monitor a line
        .WORD   MONLIN          ;Line (job) number to be monitored
        .WORD   MONCPL          ;Address of completion routine
NOTIFY: .BYTE   0,127           ;EMT arg block to send text
        .WORD   NFYLIN          ;Line number to be notified
MSADR:  .WORD   0               ;Address of message to be sent
```

```
GPRGNM: .BYTE   0,144           ;EMT arg block to get program name
        .BYTE   MONLIN,5        ;Line number, sub-function
        .WORD   R50NAM          ;Address to put RAD50 name
R50BLK: .WORD   R50NAM          ;Address of input buffer (RAD50)
        .WORD   PRGNAM          ;Address of output buffer (ASCII)
        .WORD   6               ;Number of chars to convert
R50NAM: .WORD   0,0             ;RAD50 value of program name
SENDER: .WORD   0               ;Copy of sending infor
;
;  Text and byte buffers
;
        .NLIST  BEX
AC      = .
CODBEG: .ASCIZ  <15><12><7>/Job has been initialized       /
CODLEN  = . - AC
        .ASCIZ  <15><12><7>/Job has completed LOGON         /
        .ASCII  <15><12><7>/Job executing program /
PRGNAM: .ASCIZ                                    /PRGNAM   /
        .ASCIZ  <15><12><7>/Job returned to KMON            /
        .ASCIZ  <15><12><7>/Job logged off                  /
CPLERR: .ASCII  /Job monitoring completion routine error /
ERRCOD: .ASCIZ  /0/
        .END    START
```

7.31 Acquiring another job's file context

One job may acquire the file context of another job. This is principally intended for detached jobs (such as RTSORT) which operate as file servers, so that they may access files for the job they are servicing even if those files are on logical subset disks or are access restricted.

The following EMT may be used to acquire another job's file context:

```
EMT     375
```

with R0 pointing to an argument block of the following form:

```
.BYTE   0,160
.WORD   job-number
.WORD   0
```

where "job-number" is the number of the job whose file context is to be acquired.

The job which issues this EMT must have GETCXT privilege except in the case where "job-number" specifies the parent of the job issuing the EMT.

On successful return from the EMT, the following actions have been taken:

1. All channels for the issuing job which are opened to files on logical disks are purged.

2. All devices mounted by the issuing job are dismounted.

3. The following items are copied from the target job, replacing the previous information for the issuing job:

    a) ASSIGN commands
    b) ACCESS command restrictions
    c) Logical disk information
    d) Mounted device information

See Chapter 4 for more information on detached jobs. See the TSX-Plus System Manager's Guide for more information on GETCXT privilege.

Errors:

Code	Meaning
0	Issuing job is not privileged to use this EMT
1	Target job number is invalid or is not logged on

Example:

```
        .TITLE  GETCXT
        .ENABL  LC
;
;  Demonstrate EMT to get context of another job.
;
        .MCALL  .GTLIN,.EXIT,.PRINT,.ENTER,.CSTAT,.PURGE,.TTYOUT
        .DSABL  GBL
        .GLOBL  ACRDEC,PRTR50
;
ERRBYT  = 52                    ;EMT error byte address
BS      = 10                    ;ASCII backspace BS
;
START:  .GTLIN  #BUFFER,#PRMPT1 ;Prompt for line # to check
        MOV     #BUFFER,R1      ;Get pointer to line # string
        CALL    ACRDEC          ;Convert to number
        MOV     R0,JOBNUM       ;Put line number in EMT arg block
        MOV     #GETCXT,R0      ;Point to EMT arg block to
        EMT     375             ;Get context of another job
        BCC     1$              ;Branch if no error
        TSTB    @#ERRBYT        ;Privilege or no job?
        BGT     2$              ;Branch if requested line not logged on
        .PRINT  #NOPRIV         ;No privilege for this EMT
        BR      9$              ;Quit
```

```
2$:     .PRINT  #NOTON          ;That job not logged on
        BR      9$              ;Quit
;
1$:     MOV     #^RSY,DEVNAM    ;Locate SY first
        CALL    SHODEV          ;Determine and display its device
        MOV     #^RDK,DEVNAM    ;Same for DK
        CALL    SHODEV
9$:     .EXIT
;
AREA:   .BLKW   10              ;General purpose EMT arg block
GETCXT: .BYTE   0,160           ;EMT arg block to get job context
JOBNUM: .WORD   0               ;Line number of job in question
        .WORD   0               ;Required
STATUS: .WORD   0,0,0,0,0,0     ;.CSTAT channel status result
DEVNAM: .RAD50  /DK TEMP  FIL/  ;Name of temporary file
;
        .NLIST  BEX
BUFFER: .BLKB   81.
PRMPT1: .ASCII  /Get context of line number - /<200>
NOPRIV: .ASCIZ  /Sorry, you are not privileged to run this program./
NOTON:  .ASCIZ  /Sorry, that job is not currently logged on./
ARROW:  .ASCII  / --/<76><40><200>
COLRTN: .ASCIZ  /:/
CRLF:   .ASCIZ  //
        .LIST   BEX
        .EVEN
;
; Let system translate device assignments by opening
; a temporary file and use the .CSTAT EMT.
;
SHODEV: .ENTER  #AREA,#0,#DEVNAM,#1 ;Try to open temporary file
        BCS     9$              ;Give up on error
        .CSTAT  #AREA,#0,#STATUS ;Try to get channel info on file
        BCS     9$              ;Give up on error
        MOV     DEVNAM,R0       ;Recover logical device name
        CALL    PRTR50          ;Display it
        .PRINT  #ARROW          ;" --> "
        MOV     STATUS+12,R0    ;Recover physical device name
        CALL    PRTR50          ;Display it
        .TTYOUT #BS             ;Back up over empty unit number
        MOV     STATUS+10,R0    ;Recover physical unit number
        ADD     #'0,R0          ;Convert to ASCII
        .TTYOUT                 ;Display it
        .PRINT  #COLRTN         ;Format
9$:     .PURGE  #0              ;Throw away temp file
        RETURN
;
        .END    START
```

7.32 Manipulating process windows

The TSX-Plus process windowing facility allows the system to remember the contents and status of the terminal screen display and to redisplay windows as you switch between processes or on demand by programs.

The process windowing facility also provides a "print window" function which allows you to print the contents of a window on a printer by typing a control character or by use of an EMT. Windows are only allowed on VT200, VT100, and VT52 series terminals. The contents and status of each window is stored in a named global region and you must have SYSGBL privilege in order to use process windows. See Chapter 1 for more information on the use of windows and Chapter 2 for window related commands (SET WINDOW, SET PRINTWINDOW).

Each job may have up to 26 windows active at one time. A window is identified by an ID number in the range 1 to 26. Two jobs may have windows with the same ID number without conflict.

When windowing is turned on, the system monitors all characters sent to the terminal and maintains an updated screen image in memory. Terminal attributes such as line width, reverse/normal video, application keypad mode, etc. are saved along with line attributes (double wide, double high), and character attributes. The attributes retained for each character consist of blinking, bold, underlined, reverse video, and character set information (ascii, U.K. national, DEC supplemental, or graphics -- line drawing).

The most common use of windows is to completely refresh the display when switching among subprocesses to avoid the confusion of mixed displays. In addition, a keyboard command can be used to send a copy of the current window to a printer.

For some special program applications, it may be useful to utilize multiple windows from the same job. System service calls (EMTs) are provided to create, select the current, delete, and print process windows.

7.32.1 Creating a window.

The system service call (EMT) used to create a window has the form:

```
EMT 375
```

with R0 pointing to an argument block of the following form:

```
.BYTE   0,161
.BYTE   window-id,perm-flag
.BYTE   window-width,max-scroll
.WORD   0
.WORD   0
```

"Window-id" is a window identification number in the range 1 to 26 which identifies the particular job window. The global memory regions created for windows have names of the form "WINjji" where "jj" is the job number and "i" is a letter which corresponds to the window ID (A=1,...,Z=26). Different jobs may have windows with the same ID without conflict.

"Perm-flag" should be either 0 or 1. If it is 0 (zero), the window is temporary and will be automatically deleted when the program exits to the keyboard monitor (other than doing a chain). If perm-flag is 1, the window is permanent and is only deleted when explicitly requested (by the delete-window EMT, or by SET WINDOW OFF) or when the job logs off.

"Window-width" is the width of the window in columns and should not exceed 132. (VT52 may use only 80.)

"Max-scroll" is the maximum number of lines which are allowed to scroll off the window during a time when the window is disconnected from the terminal because a different subprocess has been selected. A value of 0 (zero) may be specified to disable any scrolling. If a value of 255 is specified, an unlimited amount of scrolling is allowed.

Errors:

Code	Meaning
0	Window management not included in system generation or invalid EMT argument block.
1	Maximum allowed number of windows are already in use. Increase value of MAXWIN sysgen parameter.
2	Unable to create global memory region for window. Job may not have SYSGBL privilege or you may need to increase the value of the NGR sysgen parameter, or there may be insufficient memory space available.

Creating a window allocates a window control block and a global memory region for the window. The window contents are set to all blank.

Example:

```
        .TITLE  WINDOW
;
;  Demonstrate use of multiple process windows.
;
        .DSABL  GBL
        .ENABL  LC
        .MCALL  .PRINT,.EXIT,.TWAIT
;
ERRBYT  = 52                    ;EMT error code address
;
```

```
;  Create and initialize contents of 10 windows
;
START:  MOV     #10.,R1         ;Init window number
1$:     MOVB    R1,WINID1       ;Point to next window
        MOV     #MAKWIN,R0      ;Point to EMT arg block to
        EMT     375             ;Create a window
        BCS     MAKERR          ;Branch on error
        MOVB    R1,WINID2       ;Point to next window
        MOV     #SELWIN,R0      ;Point to EMT arg block to
        EMT     375             ;Select a window
        BCS     SELERR          ;Branch on error
        MOV     R1,R2           ;Copy window number
        DEC     R2              ;0 index
        ASL     R2              ;Convert to word index
        .PRINT  WINTXT(R2)      ;Write something to each screen
        SOB     R1,1$           ;Repeat through ten windows
;
; Cyle through the windows for pseudo-animation.
;
        MOV     #5,R2           ;Loop 5 times with all windows
2$:     MOV     #10.,R1         ;Init window number
22$:    MOVB    R1,WINID2       ;Point to next window
        MOV     #SELWIN,R0      ;Point to EMT arg block to
        EMT     375             ;Select next window
        BCS     SELERR          ;Branch on error
        .TWAIT  #AREA,#TIME     ;Delay a little bit
        SUB     NWINS,R1        ;Step to next window
        BGT     22$             ;And repeat
        CMP     NWINS,#2        ;Already doing half?
        BEQ     2$              ;Branch if so
        SOB     R2,2$           ;Repeat all windows 5 times
;
;  Now delete half the windows
;
        MOV     #2,NWINS        ;Only do half of them
        MOV     #9.,R1          ;Delete odd numbered windows
3$:     MOVB    R1,WINID3       ;Point to next window
        MOV     #DELWIN,R0      ;Point to EMT arg block to
        EMT     375             ;Delete a window
        BCS     DELERR          ;Branch on error
        SUB     NWINS,R1        ;Point to next window
        BGT     3$              ;Repeat through 5 windows
        BR      2$              ;Repeat rest forever
;
MAKERR: MOV     #METXT,R0       ;Point to error message
        BR      DSPERR          ;Go display error
SELERR: MOV     #SETXT,R0       ;Point to error message
        BR      DSPERR          ;Go display error
DELERR: MOV     #DETXT,R0       ;Point to error message
DSPERR: MOVB    @#ERRBYT,R1     ;Get error code
```

```
        ADD     #'0,R1          ;Convert to digit
        MOVB    R1,EC1          ;Store in all
        MOVB    R1,EC2          ; output
        MOVB    R1,EC3          ;  strings
        .PRINT                  ;Display error message
        .EXIT

MAKWIN: .BYTE   0,161           ;EMT arg block to make window
WINID1: .BYTE   0               ;Window id number
        .BYTE   0               ;Temporary window
        .BYTE   80.             ;Narrow window
        .BYTE   0               ;No scrolling restrictions
        .WORD   0
        .WORD   0

SELWIN: .BYTE   1,161           ;EMT arg block to select window
WINID2: .BYTE   0,0             ;Window id number,0
        .WORD   0

DELWIN: .BYTE   2,161           ;EMT arg block to delete window
WINID3: .BYTE   0,0             ;Window id number,0

TIME:   .WORD   0,18.           ;Time delay in ticks (arbitrary)
NWINS:  .WORD   1               ;Window id increment
AREA:   .BLKW   10              ;General EMT arg block

WINTXT: .WORD   L1L,L2L,L3L,L4L,L5L,L5R,L4R,L3R,L2R,L1R
        .NLIST  BEX
L1L:    .ASCII  <12>                            /      */<200>
L2L:    .ASCII  <12><12>                        /   */<200>
L3L:    .ASCII  <12><12><12><12>                / */<200>
L4L:    .ASCII  <12><12><12><12><12><12>        /   */<200>
L5L:    .ASCII  <12><12><12><12><12><12><12>/       */<200>
L5R:    .ASCII  <12><12><12><12><12><12><12>/         */<200>
L4R:    .ASCII  <12><12><12><12><12><12>        /           */<200>
L3R:    .ASCII  <12><12><12><12>                /             */<200>
L2R:    .ASCII  <12><12>                        /           */<200>
L1R:    .ASCII  <12>                            /         */<200>
METXT:  .ASCII  /Window creation error #/
EC1:    .ASCIZ  /0/
SETXT:  .ASCII  /Window selection error #/
EC2:    .ASCIZ  /0/
DETXT:  .ASCII  /Window deletion error #/
EC3:    .ASCIZ  /0/
        .LIST   BEX
        .END    START
```

7.32.2 Selecting a current window.

When this EMT is executed, the terminal screen is cleared and the selected window is drawn on the screen.

The EMT argument block used to select the current window has the form:

```
.BYTE   1,161
.BYTE   window-id,0
.WORD   0
```

"Window-id" is the window identification number as specified when the window was created. A window-id value of 0 (zero) has a special meaning: it causes windowing to be disabled for the job but the contents of all existing windows are retained and may be reselected later.

Errors:

Code	Meaning
0	Window management not included in system generation or invalid EMT argument block.
3	Unable to locate window with specified window-id.

7.32.3 Deleting windows.

The EMT argument block used to delete a window has the following form:

```
.BYTE   2,161
.BYTE   window-id,0
```

"Window-id" is the identification number of the window to be deleted. There are two special window-id values which may be used with this EMT: a value of 0 (zero) causes all temporary windows for the job to be deleted; a value of 255 (decimal) causes all windows for the job, both temporary and permanent, to be deleted.

The global memory region used by a window is freed when the window is deleted.

Errors:

Code	Meaning
0	Window management not included in system generation or invalid EMT argument block.
3	Unable to locate window with specified window-id.

7.32.4 Suspending window processing

Window processing may be suspended to allow characters to be sent to the terminal which are not processed by the window manager. If the job does not have a currently active window, the suspend and resume functions have no effect. The EMT 375 argument block to suspend window processing is:

```
.BYTE   3,161
```

7.32.5 Resuming window processing

Window processing which has been suspended may be resumed by EMT 375 with the following argument block:

```
.BYTE   4,161
```

7.32.6 Printing a window

The contents of a window may be printed by issuing EMT 375 with the following argument block:

```
.BYTE   5,161
.BYTE   window-id,0
```

"Window-id" is the id number used when the window was created. The WINPRT program must be executing in order for the window to be printed.

Errors:

Code	Meaning
0	Window management not included in system generation
3	Unable to locate window with specified window-id
4	WINPRT program not running

8. TSX-Plus JOB ENVIRONMENT

8.1 Virtual and physical memory

The memory space that is accessible by a job is known as the virtual address space for the job. Because of the architectural design of the PDP-11 computer which uses 16 bits to represent a virtual memory address, the maximum amount of virtual address space that can be accessed at one time by a job is limited to 65,536 (64 Kb) bytes. Thus, the virtual addresses for a job range from 000000 to 177777 (octal).

The actual amount of virtual address space available to a job may be as large as 64 Kb but it may be restricted to less than this amount. The following factors control the size of the virtual address space available to a job:

1. The maximum amount of memory allowed for each job as determined by the HIMEM system generation parameter.

2. The amount of memory specified with the MEMORY keyboard command (initialized by the DFLMEM system generation parameter).

3. The memory limit reserved in the disk file image by the SETSIZ program (see Appendix A).

4. The amount of memory acquired by use of the TSX-Plus EMT that expands or contracts the job space.

The physical address space for a PDP-11 computer is not limited to 64 Kb. The maximum physical address space depends on the model of PDP-11 and the amount of memory installed on the computer. LSI-11/23 and 11/34 computers can access up to 256 Kb of physical memory. The 11/23-Plus, 11/73, 11/24 and 11/44 computers can access up to 4 Mb of memory.

The process by which an address in the job's virtual address space is transformed into an address in the physical address space is known as mapping. The mapping of the virtual address space for a job into the physical memory space assigned to the job is performed by the memory management hardware facility of the PDP-11 computer. This facility divides the virtual address space into eight sections, called pages, each of which can address up to 8 Kb of memory. The mapping of a page of virtual address space to a page of physical address space is accomplished by setting up information in a page address register (PAR). There is one page address register for each of the eight virtual address pages. These registers are not directly accessible by a user job but are loaded by the TSX-Plus system when it starts a program, changes the size of a program, or switches execution between different jobs. The relationship between the eight pages of memory and the corresponding sections of virtual address is shown in the following table:

Page	Virtual address range
0	000000 - 017777
1	020000 - 037777
2	040000 - 057777
3	060000 - 077777
4	100000 - 117777
5	120000 - 137777
6	140000 - 157777
7	160000 - 177777

Because of the design of the memory management system in the PDP-11, it is not possible to divide the virtual address space more finely than eight pages of 8 Kb each. However, it is possible to map each page of virtual address space into any section of physical memory. (This facility allows TSX-Plus to keep multiple user jobs in physical memory and to switch rapidly among them by reloading the page address registers.)

8.2 User virtual address mapping

The virtual address space accessed by a job can be divided into five categories:

1. Normal program space which is used by instructions and data for programs.

2. Simulated RMON. This is the virtual address region from 160000 to 177777 that is mapped to a simulated RMON (RT-11 resident monitor).

3. Extended memory regions. Programs can create regions in physical memory and then cause one or more pages of virtual address space to be mapped to the regions.

4. Shared run-time systems. Several TSX-Plus jobs can cause a portion of their virtual address space to be mapped to the same area of physical memory. This allows several users to execute the same program or share common data without having to allocate a separate area of physical memory for each user.

5. System I/O page. TSX-Plus real-time programs may map the system I/O page into their virtual address space.

These categories of virtual address space are discussed in the sections below.

8.3 Normal programs and virtual programs

Programs run under TSX-Plus may be divided into two categories: normal programs and virtual programs. The only difference between the two types of programs is the manner in which TSX-Plus handles page 7 (addresses 160000 to 177777) of the virtual address space. In the case of normal programs, page 7 is mapped to a simulated RMON. RMON is the name of the resident RT-11 monitor. When running under RT-11 this is the actual system control program. When running under TSX-Plus, the simulated RMON does not contain any of the instructions that are part of RT-11 but contains only a table that provides information about the system and the job. This information includes such items as the system version number, and information about the hardware configuration. The cells in this table are known as RMON fixed offsets. Their position within the table and their contents are documented in the RT-11 Software Support Manual, although not all cells are relevant to or maintained by TSX-Plus.

The address of the base of the simulated RMON table is stored in location 54 of the job's virtual address space. Modern RT-11 and TSX-Plus programs should not directly access the RMON table but rather should use the .GVAL EMT to obtain values from the table. However, since some older programs and some RT-11 utility programs directly access the RMON tables, it is mapped through page 7 for normal programs. As a result, normal programs are restricted to using pages 0 to 6 (56 Kb) for their own instructions and data.

Virtual programs are programs that do not require direct access to the simulated RMON table. These programs may still access the RMON values with the .GVAL and .PVAL EMTs. Since direct access to the simulated RMON is not needed, page 7 is available for the program to use for its own instructions and data, thus providing a total of 64 Kb of virtual address space. A program may indicate that it is a virtual program by any of the following techniques:

1. Set bit 10 (VIRT$ -- mask 2000) in the Job Status Word (location 44) of the SAV file. See Appendix A for information about how this bit can be set by use of the SETSIZ program.

2. Use the /V LINK switch (/XM switch for the LINK keyboard command) which stores the RAD50 value for "VIR" in location 0 of the SAV file.

3. Use the TSX-Plus SETSIZ program (see Appendix A) and indicate that more than 56 Kb of memory is to be used for the program.

8.4 Extended memory (PLAS) regions

Programs running under TSX-Plus have available the Programmed Logical Address Space (PLAS) facility that is compatible with the RT-11XM monitor. This facility allows a program to allocate regions of physical memory and then create virtual windows that can be used to access the regions. There are 7 system service calls (EMTs) provided for PLAS support:

.CRRG -- Create a region
.ELRG -- Eliminate a region
.CRAW -- Create a virtual address window
.ELAW -- Eliminate a virtual address window
.MAP -- Map a virtual window to a region
.UNMAP -- Unmap a virtual window
.GMCX -- Get information about the status of a window

A region is an area of physical memory set aside for use by a job in addition to its normal job space. The .CRRG EMT is used by a program to request that a region be created. The size of a region is not restricted to 64 Kb and may be as large as the physical memory installed on the system (less the space used by the TSX-Plus system, device handlers, tables, and the remainder of the program). Up to eight unnamed regions may be created by each job.

PLAS memory regions can be grouped into two main categories: named regions and unnamed regions. Unnamed PLAS regions can only be accessed by the job that created them and only remain in existence as long at the job that created them is running. They are always deleted when the job exits or chains. Named PLAS regions may be shared between multiple jobs. Use of named PLAS regions requires SYSGBL privilege. Unlike unnamed PLAS regions, named regions are not necessarily deallocated when the program which created the region terminates execution. Named regions may be used to communicate between programs, to hold common code executed by multiple users (e.g., shared run-times), and to pass information from one program to another program - possibly run at a later time.

In addition to supporting named global PLAS regions in a fashion compatible with RT-11, TSX-Plus also provides an additional facility known as local named regions. Local named regions are regions which can only be accessed by the job that created them. Their names are private to the creating job and more than one job may create (different) local regions with the same name. Local named regions are deallocated when the creating job specifies that they are to be eliminated or when the creating job logs off.

Local named regions are allocated memory space associated with the creating job and are swapped in and out of memory with the job (like unnamed regions). Global named regions are allocated memory space at the top of the area of memory used for jobs. They are never swapped out of memory and are only deallocated when a job eliminates the region. Thus global named regions may continue to occupy memory after the job that created the region logs off. Caution should be exercised when creating global regions since it is possible to lock jobs out of memory by creating large global regions.

Local named regions are distinguished from global named regions at creation time by setting bit 0 (mask 000001) in the status word (the third word - R.GSTS) of the region definition block used with the .CRRG EMT.

Summary of Characteristics for Extended Memory (PLAS) Region Types			
Region type	Maximum lifetime of region	Accessible by other jobs?	Swapped out of memory with job?
Unnamed	Until program exits	No	Yes
Named local	Until job logs off	No	Yes
Named global	Indefinite	Selectable	No

A SHOW REGIONS keyboard command may be used to display information about local and global named regions accessible by the job.

The REMOVE keyboard command may be used to eliminate a local or global named region. The form of this command is:

REMOVE region

In order to access a region, a program must use the .CRAW and .MAP EMTs to create a virtual window and map the virtual window to a selected portion of the region. A virtual window is a section of virtual address space mapped to a region rather than to the normal job physical address space. Up to eight virtual address windows can be created by each job. The same virtual window (i.e., the same range of virtual addresses) may be mapped to different regions or different sections of the same region at different times by use of the .MAP EMT. This allows a program to selectively access different sections of code or data in extended memory regions during the course of its execution.

When an unnamed or named local PLAS memory region is created by use of the .CRRG EMT, space is allocated in physical memory and in a TSX-Plus region swap file. Whenever a job is swapped out of memory, its extended memory regions are swapped to the region swap file. Space in the region swap file is allocated and deallocated dynamically as regions are created and eliminated. In order to create a region, space must be available in physical memory and in the region swap file.

The PLAS facility is most often used implicitly through the virtual overlay and virtual array features. Using the PLAS facilities, it is possible for a single job to use all of the physical memory space available on a system (exclusive of the space used by the TSX-Plus system, handlers, tables, etc.). Proper use of the PLAS facilities such as with reasonable size virtual overlays or arrays can lead to substantial performance improvements for programs. Excessive use of memory space with the PLAS facility can lead to excessive job swapping and degraded system performance.

8.5 Shared run-time systems

A shared run-time system is a program or data area in physical memory that can be accessed by multiple TSX-Plus jobs. Shared run-time systems are somewhat similar to extended memory regions in that they are both allocated in extended memory areas and must be accessed by mapping a portion of the job's virtual address space to the physical memory area. The difference is that extended memory regions are private to the job that creates them and may not be accessed by any other job. Shared run-time systems can be simultaneously accessed (hence "shared") by any number of TSX-Plus jobs. Another difference between regions and shared run-time systems is that regions can be created dynamically and can be swapped out of memory; shared run-time systems are specified when the system is generated and reside in memory as long as the system is running. See Chapter 12 for more information on shared run-time systems.

8.6 Access to system I/O page

The system I/O page is an 8 Kb section of addresses which is not connected with ordinary memory but rather is used to control peripheral devices and hardware operation. Access to the I/O page is risky in that a program can interfere with peripheral devices and cause system crashes. For this reason, programs do not ordinarily have access to the I/O page. However, a program that is running with MEMMAP privilege may issue a system service call to cause page 7 (160000-177777) of the job's virtual address space to be mapped to the system I/O page. See Chapter 11 for more information on real-time programs.

8.7 VM pseudo-device handler

While the VM handler is not actually mapped into a job's memory space, its use can dramatically increase job performance. The VM handler enables the use of a portion of physical memory as a pseudo-disk device. This permits very rapid access to programs and data which are placed on the VM unit. For programs such as compilers which heavily utilize overlay segments, a considerable speed-up can be achieved by loading them onto the VM device. A similar improvement for overlaid programs can be obtained with the general data cache facility. However, when the data cache is full the least recently used blocks are lost. The presence of particular programs and their overlay segments in memory can be guaranteed by copying them to the VM pseudo-device. Another example of the usefulness of the VM device is with compilers which heavily use temporary work files. Depending on the number of write operations, which are not helped by general data caching, significant improvements in speed can be obtained by directing the work files to the VM pseudo-device.

In order to use the VM device, it must be included in the device definitions during TSX-Plus system generation. An upper limit must also be placed on the amount of memory available to TSX-Plus. The physical memory above that available to TSX-Plus can then be used as a memory based pseudo-disk. If for some reason, it is desirable to use less than all of the memory above the top of TSX-Plus, the SET VM BASE command can be used to restrict the memory available to VM. Each time TSX-Plus is restarted, VM must be initialized just

as you would for a new physical disk or a fresh logical subset disk. For example:

```
INITIALIZE VM:
```

Only one unit (VM0:) is available. However, logical subset disks may be created within the VM pseudo-device to partition it if necessary. On initialization, the VM handler automatically determines the amount of memory available to it.

See the TSX-Plus System Manager's Guide for more information on the use of data caching (general and shared files) and the VM pseudo-disk.

9. SHARED FILE RECORD LOCKING

TSX-Plus allows several programs to have the same file open simultaneously. In order to control access to such files, TSX-Plus provides system calls to "lock" shared files and records within shared files. Through the record locking facility a program may gain exclusive access to one or more blocks in a file by locking those blocks. Other users attempting to lock the same blocks will be denied access until the first user releases the locked blocks. The TSX-Plus shared file facility also provides data caching on blocks being read from shared files.

Note that shared file access protection is only meaningful for cooperating jobs requesting shared access. This scheme does not prevent other jobs from opening or writing to files if those jobs do not adhere to the file sharing protocol.

The usual protocol for updating a shared file being accessed by several users is as follows.

1) Open file.
2) Tell TSX-Plus that file is "shared".
3) Lock all blocks in file which contain desired record.
4) Read locked blocks into memory.
5) Make update to record.
6) Write updated blocks to file.
7) Unlock blocks.
8) Repeat steps 3-7 as needed.
9) Close file.

Use of shared files and record locking requires RLOCK privilege.

DIBOL record locking procedures

Subroutines to control record locking from within DIBOL programs are provided with TSX-Plus. These are discussed in Appendix B.

Record locking from other languages

Record locking may be interfaced to other languages with appropriate subroutine calls. Record locking under COBOL-Plus is built into the run-time library provided with COBOL-Plus. The remainder of this chapter describes the techniques used to control shared file access and record locking.

9.1 Opening a shared file

Before a file can be used with shared access it must be opened by using a standard .LOOKUP EMT. After the file has been successfully opened, the following EMT may be used to declare the file to be opened for shared access. The form of this EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   chan,125
.WORD   access-code
```

where "chan" is the number of the I/O channel open to the desired file and "access-code" is a value indicating the type of access protection desired for the file. The following access codes are recognized:

Code	Protection	Access
0	Exclusive	Input
1	Exclusive	Update
2	Protected	Input
3	Protected	Update
4	Shared	Input
5	Shared	Update

The access-code specifies two things: The type of access that you intend to make to the file (input only or update) and the type of access that you are willing to grant to other users of the file. There are three protection classes: Exclusive, Protected and Shared. Exclusive access means that you demand exclusive access to the file and will allow no other users to access the file in any fashion (input or update). Protected access means that you will allow other users to open the file for input but wish to prohibit any other users from opening the file for update. Shared access means that you are willing to allow other users to open the file for both input and update access.

When this EMT is executed, TSX-Plus checks your specified protection mode and access type with that previously declared for the file by other users. If an access conflict arises because of your specified access characteristics an error code of 4 is returned for the EMT. If no access conflict is detected, your specified access code is saved with the file and will be used to check for conflicts with future shared access requests issued by other users.

Normally all files that are declared to TSX-Plus using this EMT are enabled for use of the data caching facility (see description below). However, in some cases it may be desirable to suppress data caching for certain files. For example, sequential access files usually benefit little from data caching and enabling data caching for these files causes the data cache buffers to be used non-productively when they could be providing a better service for other types of files. To disable data caching for a file set bit 8 (octal 400) in the access-code word. When shared access is declared with bit 8 set, new data is not brought into the data cache when the file is read. However, if the data being read is already stored in the cache because of a read by another user, it is used. When data being written to a file is currently stored in the cache, the data in the cache is updated even if the file is declared to be non-cached.

It is possible to have several channels simultaneously open to different shared files. The exact number of channels that can be open to shared files and the total number of shared files that may be opened are specified when the TSX-Plus system is generated.

Once all access to a shared file is completed, the I/O channel should be closed using the standard .CLOSE or .PURGE EMT's. See the next section for information about saving the status of a channel that has been opened to a shared file.

The error codes that can be returned by this EMT are listed below:

Errors:

Code	Meaning
0	Job does not have RLOCK privilege or system does not include shared-file support
1	Channel has not been opened to a file.
2	Too many channels opened to shared files.
3	Too many shared files open.
4	File protection-access conflict

Example:

```
        .TITLE  SHARED
        .ENABL  LC

; This program cooperates with the example program (SHARE2) in the
; following section to demonstrate shared file access protection.

        .MCALL  .PRINT,.GTLIN,.TWAIT,.EXIT,.READW
        .MCALL  .LOOKUP,.CLOSE,.SAVESTATUS,.REOPEN,.PURGE

ERRBYT = 52                     ;EMT error byte
EXUP = 1.                       ;Shared file access code: Exclusive, Update
PRIN = 2.                       ;Shared file access code: Protected, Input
BUFSIZ = 256.                   ;Number of words in a disk block

START:  .LOOKUP #AREA,#0,#SHR1  ;Open SHR1.DAT
        BCC     1$              ;Branch if OK
        .PRINT  #LKPERR         ;Lookup error message
        .EXIT
1$:     MOV     #EXUP,<SHRFIL+2> ;Set Exclusive, Update access
        MOV     #SHRFIL,R0      ;Point to EMT arg block to
        EMT     375             ;Declare SHR1.DAT as a shared file
                                ;with Exclusive and Update access
        BCC     2$              ;Branch if sharing OK
        JMP     EMTERR          ;Explain the error and quit
2$:     .READW  #AREA,#0,#BUFFER,#BUFSIZ,#0 ;Read block 0 of SHR1.DAT
        BCC     3$              ;Branch if read OK
```

```
        .PRINT  #RDWERR          ;Say there was a read error
        .EXIT
3$:     .PRINT  #BUFFER          ;Print out the file (must have 0 or 200 byte)
        .SAVESTATUS #AREA,#0,#BLOK1 ;Save channel 0 status for reuse
        BCC     4$               ;Branch if savestatus OK
        .PRINT  #SVSERR          ;Savestatus error message
        .EXIT
4$:     MOV     #SAVSHR,R0       ;Point to EMT arg block to
        EMT     375              ;Save shared file status
        .PURGE  #0               ;Purge the channel for reuse
        .LOOKUP #AREA,#0,#SHR2   ;Open SHR2.DAT
        BCC     5$               ;Branch if OK
        .PRINT  #LKPER2          ;Say bad lookup on SHR2
        .EXIT
5$:     MOV     #PRIN,<SHRFIL+2> ;Set Shared, Input access
        MOV     #SHRFIL,R0       ;Point to EMT arg block to
        EMT     375              ;Declare SHR2.DAT as a shared file
        BCC     6$               ;Branch on no error
        JMP     EMTER2           ;Say error on SHR2 sharing
6$:     .READW  #AREA,#0,#BUFFER,#BUFSIZ,#0 ;Read block 0 of SHR2.DAT
        BCC     7$               ;Branch if read OK
        .PRINT  #RDWER2          ;Say read error on SHR2
        .EXIT
7$:     .PRINT  #BUFFER          ;Print out the contents (1 line, null filled)
        .PRINT  #PROMPT          ;Say it's time to try companion program
        .TWAIT  #AREA,#TIME      ;Wait 30 seconds to run other program
        .PURGE  #0               ;Now, release SHR2
        .GTLIN  #BUFFER,#PRMPT2 ;Wait for return from subprocess
;This job will be suspended for output while gone to subprocess
        .REOPEN #AREA,#0,#BLOK1 ;And get SHR1 back
        .READW  #AREA,#0,#BUFFER,#BUFSIZ,#1 ;Read in second block of SHR1
        .PRINT  #BUFFER          ;And print it to prove status was saved
        .CLOSE  #0               ;Release SHR1
        .EXIT
EMTER2: MOV     #SHR2NM,FILNUM   ;Point to alternate file error
EMTERR: MOVB    @#ERRBYT,R0      ;Get the error type
        DEC     R0               ;Zero offset
        ASL     R0               ;Convert to word offset
        .PRINT  SHRERR(R0)       ;Print the appropriate error message
        .PRINT  FILNUM           ;And the file name
        .EXIT

AREA:   .BLKW   10               ;EMT arg block area
BLOK1:  .BLKW   5                ;Savestatus area for SHR1.DAT
FILNUM: .WORD   SHR1NM           ;File name for error message
TIME:   .WORD   0,30.*60.        ;30.sec * 60.tics/sec
SHRERR: .WORD   NOTOPN           ;Pointer to EMT error messages
        .WORD   XSSCHN
        .WORD   XSSFIL
        .WORD   AXSCON
```

```
        .NLIST  BEX
SHR1:   .RAD50  /DK SHR1  DAT/  ;File descriptor for SHR1.DAT
SHR2:   .RAD50  /DK SHR2  DAT/  ;File descriptor for SHR2.DAT
SHRFIL: .BYTE   0,125           ;EMT arg block to declare shared file
        .WORD   1               ;Exclusive Update access (GETS CHANGED)
SAVSHR: .BYTE   0,122           ;EMT arg block to save shared file status
NOTOPN: .ASCII  /Attempt to share unopened channel/<7><200>
XSSCHN: .ASCII  /Too many channels opened to shared files/<7><200>
XSSFIL: .ASCII  /Too many shared files open/<7><200>
AXSCON: .ASCII  /Attempt to protect already protected shared file/<7><200>
SHR1NM: .ASCIZ  /: SHR1.DAT/
SHR2NM: .ASCIZ  /: SHR2.DAT/
LKPERR: .ASCIZ  /Lookup error for SHR1.DAT/<7>
LKPER2: .ASCIZ  /Lookup error for SHR2.DAT/<7>
SVSERR: .ASCIZ  /Error occurred attempting to save SHR1.DAT file status/<7>
RDWERR: .ASCIZ  /Error occurred while reading SHR1.DAT/<7>
RDWER2: .ASCIZ  /Error occurred while reading SHR2.DAT/<7>
PROMPT: .ASCII  /Go to a subprocess and RUN SHARE2 which attempts /<15><12>
        .ASCII  /to share the same files (SHR1.DAT, SHR2.DAT)./<15><12>
        .ASCIZ  /Waiting 30 seconds . . . . ./<7>
PRMPT2: .ASCII  /When you have returned, hit RETURN to continue/<200>
BUFFER: .BLKW   BUFSIZ

        .END    START
```

See also the example program SHARE2 in the section on saving the status of a shared file channel.

9.2 Saving the status of a shared file channel

A standard .SAVESTATUS EMT may be used to save the status of a shared file channel. If this is done, all blocks that are being held locked in the file remain locked until the channel is reopened and the blocks are unlocked (see below).

When using a single channel number to access several shared files it is convenient to initially do a .LOOKUP on each file, then declare the file to be shared (EMT above), and then do a .SAVESTATUS. The channel being used to access the set of files can then be switched from one file to another by doing a .PURGE followed by a .REOPEN. However, before doing the .PURGE, TSX-Plus must be told that you wish to save the shared-file status of the file, otherwise all locked blocks will be unlocked and the file will be removed from the shared-file list. The form of the EMT used to perform this function is:

```
        EMT     375
```

with R0 pointing to the following argument block:

```
        .BYTE   chan,122
```

where "chan" is the I/O channel number. The effect of this EMT is to suspend the connection between the shared file information table and the I/O channel. Any blocks that are currently locked in the file remain locked until the channel is reopened to the file (by using a standard .REOPEN EMT). After saving a shared file status, the channel may be freed by using a .PURGE EMT.

Example:

```
        .TITLE  SHARE2
        .ENABL  LC

; This program cooperates with the example program (SHARED) in the
; previous section to demonstrate saving of shared file status with
; the .SAVESTATUS EMT.

        .MCALL  .LOOKUP,.PRINT,.EXIT,.READW
        .MCALL  .CLOSE,.TWAIT

ERRBYT = 52                     ;EMT error byte
BUFSIZ = 256.                   ;Size of disk file block

START:  .LOOKUP #AREA,#0,#SHR1  ;Try to open a file which is access locked
        BCC     1$              ;Branch if OK
        .PRINT  #LKPERR         ;Say couldn't get the file
        BR      3$              ;Go on to try second file

1$:     MOV     #SHRFIL,R0      ;Point to EMT arg block to
        EMT     375             ;Declare file for shared access
        BCC     2$              ;If got the file, branch to read it
        CALL    EXPLER          ;Else explain why
        .PRINT  #INSHR1         ;Say we can't share SHR1
        .CLOSE  #0              ;Release channel 0
        BR      3$              ;Go on to next file

2$:     .READW  #AREA,#0,#BUFFER,#BUFSIZ,#0 ;Try to read block 0 of SHR1
        .PRINT  #BUFFER         ;Display it for kicks
        .CLOSE  #0              ;Done with SHR1 for the moment

3$:     .LOOKUP #AREA,#0,#SHR2  ;Try to open SHR2
        BCC     4$              ;Branch if OK
        .PRINT  #LKPER2         ;Say we couldn't even open it
        BR      6$              ;Go on to try SHR1 again

4$:     MOV     #SHRFIL,R0      ;Point to EMT arg block to
```

```
        EMT     375             ;Declare file for shared access
                                ;Access Input, Update to show lockout
                                ; though we don't write in this example
        BCC     5$              ;Branch if we can share it
        CALL    EXPLER          ;Explain why not
        .PRINT  #AGAIN          ;Say we will try again later
        .TWAIT  #AREA,#TIME     ;Wait 5 seconds and
        BR      4$              ;Try again

5$:     .READW  #AREA,#0,#BUFFER,#BUFSIZ,#0 ;Read block 0 of SHR2
        .PRINT  #BUFFER         ;Prove that we got it
        .CLOSE  #0              ;Done with SHR2

6$:     .LOOKUP #AREA,#0,#SHR1  ;Try SHR1 again
        BCC     7$              ;Branch if it worked
        .PRINT  #LKPERR         ;Say we couldn't do it
        .EXIT

7$:     MOV     #SHRFIL,R0      ;Point to EMT arg block to
        EMT     375             ;Declare shared file
        BCC     10$             ;Branch if OK
        CALL    EXPLER          ;And explain the error
        .PRINT  #STLLOK         ;Say it was still locked
        BR      11$             ;And quit

10$:    .READW  #AREA,#0,#BUFFER,#BUFSIZ,#1 ;Read in block 1
        .PRINT  #BUFFER         ;And display it
11$:    .CLOSE  #0              ;Done with SHR1

        .EXIT

EXPLER: MOVB    @#ERRBYT,R0     ;Find out why can't share it
        DEC     R0              ;Convert to zero index
        ASL     R0              ;Make into word offset
        .PRINT  SHRERR(R0)      ;Say why we couldn't get it
        RETURN

        .NLIST  BEX
AREA:   .BLKW   10              ;EMT arg block
SHRFIL: .BYTE   0,125           ;EMT arg block to declare file shared
        .WORD   5               ;Access Shared, Update
SHRERR: .WORD   NOTOPN          ;Shared file error message pointers
        .WORD   XSSFCH
        .WORD   XSSFOP
        .WORD   AXSCON
TIME:   .WORD   0,5.*60.        ;5.sec * 60.tics/sec
SHR1:   .RAD50  /DK SHR1  DAT/  ;Input file #1 name
SHR2:   .RAD50  /DK SHR2  DAT/  ;Input file #2 name
NOTOPN: .ASCIZ  /Cannot share unopened file/
XSSFCH: .ASCIZ  /Too many channels opened to shared files/
```

```
XSSFOP: .ASCIZ  /Too many shared files open/
AXSCON: .ASCIZ  /Shared file protected by another job/
INSHR1: .ASCIZ  /On first try at SHR1.DAT/
LKPERR: .ASCIZ  /Unable to lookup SHR1.DAT/
LKPER2: .ASCIZ  /Unable to lookup SHR2.DAT/
AGAIN:  .ASCIZ  /Can't access SHR2.DAT, will try again in 5 seconds/
STLLOK: .ASCIZ  /On second try at SHR1.DAT/
        .EVEN
BUFFER: .BLKW   BUFSIZ          ;Input read buffer

        .END    START
```

See also the example program SHARED in the section on opening a shared file.

9.3 Waiting for a locked block

The following EMT can be used to lock a specific block in a file. If the requested block is locked by another job, the requesting job will be suspended until the desired block becomes available. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following area:

```
.BYTE   chan,102
.WORD   block
```

where "chan" is the number of an I/O channel that has previously been declared to be open to a shared file and "block" is the number of the block in the file to be locked. Other blocks in the file which were previously locked remain locked. The maximum number of blocks which may be simultaneously held locked is specified when TSX-Plus is generated. A block number of -1 (octal 177777) can be used to request that all blocks in the file be locked. If several users request the same block, access will be granted sequentially in the order that the requests are received.

Errors:

Code	Meaning
0	Job does not have RLOCK privilege or system does not include shared-file support
1	Channel is not open to a shared file
2	Request to lock too many blocks in file

Example:

```
        .TITLE  LOCKW
        .ENABL  LC

; This program cooperates with the example program (LOCK) in the next
; section to demonstrate shared file record locking.

        .MCALL  .PRINT,.EXIT,.TWAIT,.LOOKUP,.READW,.CLOSE

ERRBYT = 52                         ;EMT error code byte
BUFSIZ = 256.                       ;Words per disk block

START:  .LOOKUP #AREA,#0,#SHR1      ;Open SHR1.DAT
        BCC     1$                  ;Branch if OK
        .PRINT  #LKPERR             ;Say bad lookup
        .EXIT

1$:     MOV     #SHRFIL,R0          ;Point to EMT arg block to
        EMT     375                 ;Declare shared file
        BCC     3$                  ;Branch if OK
        MOVB    @#ERRBYT,R0         ;Get the error code
        DEC     R0                  ;Make zero index
        ASL     R0                  ;Convert to word offset
        .PRINT  SHRERR(R0)          ;Print the error message
2$:     .CLOSE  #0                  ;Give back the channel
        .EXIT

3$:     MOV     #LOCKW,R0           ;Point to EMT arg block to
        EMT     375                 ;Lock block 0 of SHR1.DAT
        ;(Job is suspended until block available to be locked)
        BCC     5$                  ;Branch when block is ready
        CMPB    @#ERRBYT,#1         ;Which error?
        BHI     4$                  ;Too many blocks locked?
        .PRINT  #SFCNOP             ;Wasn't open to shared file!
        BR      2$                  ;Give up
4$:     .PRINT  #XSLKBL             ;Too many locked blocks in file
                        ;(Defined by MXLBLK parameter in TSGEN)
        BR      2$                  ;Give up

5$:     .PRINT  #PROMPT             ;Switch lines to attempt access
        .TWAIT  #AREA,#SEC20        ;Wait 20 seconds before unlocking
        MOV     #UNLOCK,R0          ;Point to EMT arg block to
        EMT     375                 ;Unlock a single block
        BCC     6$                  ;Branch if OK
        .PRINT  #SFCNOP             ;Wasn't shared file!
        BR      2$                  ;Give up

6$:     .TWAIT  #AREA,#SEC10        ;Wait 10 seconds for companion
        MOV     #CKWSHR,R0          ;Point to EMT arg block to
```

```
        EMT     375             ;Check for writes to shared file
        BCC     8$              ;If none, wrap up
        .PRINT  #CHANGD         ;Say we have new data
        .READW  #AREA,#0,#BUFFER,#BUFSIZ,#0 ;Get block 0
        .PRINT  #BUFFER         ;Show current contents block 0
        .READW  #AREA,#0,#BUFFER,#BUFSIZ,#1 ;Get block 1
        .PRINT  #BUFFER         ;Show contents block 1
        BR      DONE

8$:     .PRINT  #NOCHNG         ;Say nothing has changed

DONE:   .CLOSE  #0              ;Free up channel
        .EXIT

        .NLIST  BEX
AREA:   .BLKW   10              ;EMT arg block area
SHRFIL: .BYTE   0,125           ;EMT arg block to declare shared file
        .WORD   4               ;Access Shared, Input
LOCKW:  .BYTE   0,102           ;EMT arg block to lock shared file block
        .WORD   0               ;Block number to be locked
UNLOCK: .BYTE   0,113           ;EMT arg block to unlock shared file block
        .WORD   0               ;Block number to be unlocked
CKWSHR: .BYTE   0,121           ;EMT arg block to check writes to shared file
SHRERR: .WORD   NOTOPN          ;Shared file error message table
        .WORD   XSSFCH
        .WORD   XSSFOP
        .WORD   AXSCON
SHR1:   .RAD50  /DK SHR1  DAT/  ;File name to be shared
SEC20:  .WORD   0,20.*60.       ;20.sec * 60.tics/sec
SEC10:  .WORD   0,10.*60.       ;10.sec * 60.tics/sec
NOTOPN: .ASCIZ  /Channel not opened to shared file/<7>
XSSFCH: .ASCIZ  /Too many channels opened to shared files/<7>
XSSFOP: .ASCIZ  /Too many shared files open/<7>
AXSCON: .ASCIZ  /File protection access conflict/<7>
LKPERR: .ASCIZ  /Unable to open SHR1.DAT/
SFCNOP: .ASCIZ  /Can't lock or unlock block not open to shared file/
XSLKBL: .ASCIZ  /Can't lock so many blocks in one file/
CHANGD: .ASCIZ  /Data has been written to file.  Contents follow:/
NOCHNG: .ASCIZ  /Data in file is unchanged/
PROMPT: .ASCII  /Block 0 in SHR1.DAT will remain locked for 20 sec/<15><12>
        .ASCIZ  /Go to another line and RUN TLOCK to test it/<7>
        .EVEN
BUFFER: .BLKW   BUFSIZ

        .END    START
```

9.4 Trying to lock a block

This EMT is similar in operation to the previous EMT: it too is used to request that file blocks be locked. The difference is that if the requested block is already locked by another user the previous EMT suspends the requesting program whereas this EMT does not suspend the program but rather returns an error code. As above, a request to lock block #-1 is treated as a request to lock the entire file. If the block is available it is locked for the requesting user and no error is reported. The form of this EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   chan,103
.WORD   block
```

where "chan" is the number of the I/O channel associated with the file and "block" is the number of the block which is to be locked.

Errors:

Code	Meaning
0	Job does not have RLOCK privilege or system does not include shared-file support
1	Channel is not open to a shared file.
2	Request to lock too many blocks in file.
3	Requested block is locked by another user.

Example:

```
        .TITLE  LOCK
        .ENABL  LC

; This program cooperates with the example program (LOCKW) in the
; previous section to demonstrate shared file record locking.

        .MCALL  .PRINT,.EXIT,.WRITW,.TWAIT,.LOOKUP,.CLOSE

ERRBYT = 52                     ;Error byte address

START:  .LOOKUP #AREA,#0,#SHR1  ;Try to open SHR1.DAT
        BCC     1$              ;Branch if OK
        .PRINT  #LKPERR         ;Say we couldn't open
        .EXIT

1$:     MOV     #SHRFIL,R0      ;Point to EMT arg block to
        EMT     375             ;Declare shared file
        BCC     3$              ;Branch if OK
        MOVB    @#ERRBYT,R0     ;Get error type
```

```
        DEC     R0              ;Convert to zero index
        ASL     R0              ;Make into word offset
        .PRINT  SHRERR(R0)      ;Display the error type
2$:     .CLOSE  #0              ;Release the channel
        .EXIT                   ;And give up

3$:     MOV     #LOCK,R0        ;Point to EMT arg block to
        EMT     375             ;Try to unlock block 0
        BCC     6$              ;Branch if OK
        CMPB    @#ERRBYT,#2     ;Which error was it
        BLO     4$              ;Wasn't open to share file?
        BEQ     5$              ;Request to open too many blocks in file?
        .PRINT  #WAITNG         ;Block locked by another user
        .TWAIT  #AREA,#TIME     ;Wait 3 seconds
        BR      3$              ;And try again
4$:     .PRINT  #NOPNSF         ;Not open to shared file
        BR      2$              ;Give up
5$:     .PRINT  #XSLKBL         ;Too many blocks locked in file
        BR      2$              ;Give up

6$:     .WRITW  #AREA,#0,#BUFFER,#BUFSIZ,#0 ;Rewrite block 0
        MOV     #UNLALL,R0      ;Point to EMT arg block to
        EMT     375             ;Release all blocks locked by this program
        .PRINT  #GOBACK         ;Message: done, go back to original line
        BR      2$              ;Done

        .NLIST  BEX
AREA:   .BLKW   10              ;EMT arg block
SHR1:   .RAD50  /DK SHR1  DAT/  ;Name of shared file
SHRFIL: .BYTE   0,125           ;EMT arg block to share file on chan 0
        .WORD   3               ;Access Protected, Update
LOCK:   .BYTE   0,103           ;EMT arg block to lock block on chan 0
        .WORD   0               ;number of block to be locked
UNLALL: .BYTE   0,101           ;EMT arg block to unlock all blocks on chan 0
                                ;(Only applies to blocks locked by this job)
TIME:   .WORD   0,3.*60.        ;3.sec * 60.tics/sec
SHRERR: .WORD   SFCNOP          ;File sharing EMT error table
        .WORD   XSSFCN
        .WORD   XSSFOP
        .WORD   AXSCON
SFCNOP: .ASCIZ  /Channel not open to file/<7>
XSSFCN: .ASCIZ  /Too many channels open to shared files/<7>
XSSFOP: .ASCIZ  /Too many shared files open/<7>
AXSCON: .ASCIZ  /Shared file access conflict/<7>
LKPERR: .ASCIZ  /Couldn't open SHR1.DAT/<7>
WAITNG: .ASCII  /Requested block not available for locking/<15><12>
        .ASCIZ  /Will try again in 3 seconds/
GOBACK: .ASCIZ  /Done, log off and go back to original line/
NOPNSF: .ASCIZ  /Channel not open to shared file/<7>
XSLKBL: .ASCIZ  /Attempt to lock too many blocks in file/<7>
```

```
        .EVEN
BUFFER: .ASCII  /(SHR1)This line was written by the program LOCK./
        .ASCIZ  /                                       /<15><12>
BUFSIZ = <.-BUFFER+1>/2         ;Number of words to write
        .BYTE   0,0             ;Safety bumper

        .END    START
```

9.5 Unlocking a specific block

The following EMT is used to unlock a specific block in a file. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   chan,113
.WORD   block-number
```

where "chan" is the number of the I/O channel opened to the shared file and "block-number" is the number of the block to be unlocked.

Errors:

Code	Meaning
0	Job does not have RLOCK privilege or system does not include shared-file support
1	Specified channel not opened to a shared file

Example:

See the example program LOCKW in the section on waiting for a locked block.

9.6 Unlocking all locked blocks in a file

The following EMT is used to unlock all blocks held locked in a file. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   chan,101
```

where "chan" is the I/O channel number open to the shared file. When this EMT is executed all blocks previously locked by the user on the shared file are unlocked. Blocks locked by the user on other files are not released nor are blocks of the same file that are locked by other users.

Errors:

Code	Meaning
0	Job does not have RLOCK privilege or system does not include shared-file support
1	Channel is not open to a shared file.

Example:

See the example program LOCK in the section on trying to lock a block.

9.7 Checking for writes to a shared file

The following EMT can be used to determine if any other user has written to a shared file. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   chan,121
```

where "chan" is the I/O channel number opened to the shared file. If no other user has written to the file since the file was opened by the user issuing this EMT or since that last time this EMT was issued for the file, the carry-flag is clear on return from the EMT.

Errors:

Code	Meaning
0	Job does not have RLOCK privilege or system does not include shared-file support or channel not opened to shared file
2	Some other job has written to file since last check

This EMT is useful when data from a shared file is being held in a program buffer. If no other user has written to the file, then the data is still valid. However, if the data in the file has been re-written then it must be re-read. The usual sequence of operations in this situation is to first lock the block whose data is in the program's buffer, then do the EMT to see if the file has been written to. If the file has not been modified the data in memory is valid and can be used, otherwise the block must be re-read from the file.

Example:

See the example program LOCKW in the section on waiting for a locked block.

9.8 Data caching

Data caching is a technique provided by TSX-Plus to speed access to files. When TSX-Plus is generated a certain number of 512-byte buffer areas may be set aside for data caching. These buffer areas are part of the resident system data area and are not associated with any particular job. There are two kinds of data caching: generalized data caching; and shared-file data caching. Both kinds may used automatically with minimal intervention on the part of the programmer or operator. Generalized data caching applies to all files on MOUNTed devices, while shared-file data caching applies only to files which have been declared as shared files. Generally, only one of these types is selected during generation of a TSX-Plus system. The following discussion applies to shared-file data caching. See the TSX-Plus System Manager's Guide for more information on data caching.

Each time a request is issued to read a shared file, a check is made to see if the blocks being read are currently stored in the data cache. If so, the data is moved from the cache buffer to the program buffer and no disk I/O operations are performed. When data in the cache buffers is accessed, a use count is incremented. Periodically, the use counts for all buffers is divided by two. If the data blocks being read are not currently in the cache, the data is read from the disk into the program buffer and then it is moved into the cache buffers with the lowest use count.

When a write operation is done to a file that is being cached, a check is made to see if the data being written is currently stored in the cache. If so, the cache buffers are updated. In any case the data is written to the disk. In other words, this is a "write-through" cache; the disk file is always updated and caching does not improve the performance of "writes".

All data files that are declared to TSX-Plus for shared access (using EMT 375 with function code 125) are eligible for data block caching regardless of their access protection type. Data caching on a shared file may be disabled by setting bit 8 (octal 400) in the access-code word of the EMT argument block when the file is declared for shared access. Data caching is particularly effective for COBOL-Plus ISAM files.

10. MESSAGE COMMUNICATIONS FACILITIES

TSX-Plus provides an optional facility that allows running programs to send messages to each other. This message communication facility allows programs to send messages through named channels, check to see if messages are pending, and suspend execution until a message is received. TSX-Plus provides EMTs for each of these operations which are described below. Use of named message channels requires MESSAGE privilege.

10.1 Message channels

Messages are transferred to and from programs by using TSX-Plus "Message Channels". A message channel accepts a message from a sending program, stores the message in a queue associated with the channel and delivers the message to a receiving program when requested. Message channels are totally separate from I/O channels.

Each message channel is identified to the sending and receiving programs by a one to six character name. The total number of message channels is defined when TSX-Plus is generated. The names associated with the channels are defined dynamically by the running programs. A message channel is said to be "active" if any messages are being held in the queue associated with the channel or if any program is waiting for a message from the channel. When message channels become inactive they are released and may be reused.

Once a message is queued on a channel, that message will remain in the queue until some program receives it or the TSX-Plus system is halted. A program may exit after queuing a message without affecting the queued message. This allows one program to leave a message for another program that will run later.

10.2 Sending a message

The following EMT is used to queue a message on a named channel. If other messages are already pending on the channel, the new message is added to the end of the list of waiting messages. The sending program continues execution after the EMT and does not wait for the message to be accepted by a receiving program. During processing of the EMT the message is copied to an internal buffer, and the sending program is free to destroy its message on return from the EMT. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   0,104
.WORD   chnadr
.WORD   msgadr
.WORD   msgsiz
```

where "chnadr" is the address of a six byte field containing the name of the message channel (ASCII with trailing blanks if the name is less than six characters), "msgadr" is the address of the beginning of the message text, and "msgsiz" is the message length in bytes.

Errors:

Code	Meaning
0	Job does not have MESSAGE privilege or system does not include message channel support.
1	All message channels are busy.
2	Maximum allowed number of messages already in message queues.
4	The transmitted message is too long. The message is truncated to maximum allowed length.
5	Maximum number of message requests pending.

The system manager may alter parameters during TSX-Plus generation to alleviate these error conditions.

Example:

```
        .TITLE SNDMSG
        .ENABL  LC

; Demonstrates use of the TSX-Plus EMT to queue a message to the interprocess
; message communication facility.

        .MCALL  .EXIT,.PRINT,.GTLIN

ERRBYT = 52                     ;EMT error byte

START:  .GTLIN  #MSGBUF,#MSGPRT ;Get the message to be queued
        MOV     #MSGBUF,R1      ;Point to beginning of buffer
1$:     TSTB    (R1)+           ;Find end of message
        BNE     1$              ;
        SUB     #<MSGBUF+1>,R1  ;Determine message length
                                ;accounting for post-increment
        MOV     R1,MSGLEN       ;Set message length in EMT arg block
        .GTLIN  #CNLBUF,#CNLPRT ;Get the six character channel name
        MOV     #MSGBLK,R0      ;Point to EMT arg block to
        EMT     375             ;Send message on named channel
        BCC     9$              ;Branch if no error
        MOVB    @#ERRBYT,R0     ;Which error?
        ASL     R0              ;Convert to word index
        .PRINT  ERRTBL(R0)      ;Display the appropriate message
        .EXIT

9$:     CLRB    CNLBUF+6        ;Make channel name ASCIZ
        .PRINT  #DONEOK         ;Inform user message queued
        .PRINT  #CNLBUF         ;on channel CNLBUF
        .EXIT

        .NLIST  BEX
MSGBLK: .BYTE   0,104           ;EMT block: send message on named channel
```

```
        .WORD   CNLBUF          ;Address of channel name
        .WORD   MSGBUF          ;Address of message
MSGLEN: .WORD   0               ;Char length of message
ERRTBL: .WORD   NOPRIV          ;Table of send error messages
        .WORD   BSYERR
        .WORD   FULERR
        .WORD   OHOH            ;Error code 3 not used
        .WORD   TRNERR
NOPRIV: .ASCIZ  /?SNDMSG-F-No privilege or no message support./
BSYERR: .ASCIZ  /?SNDMSG-F-All message channels are busy./
FULERR: .ASCIZ  /?SNDMSG-F-Maximum number of messages have been queued./
OHOH:   .ASCIZ  /?SNDMSG-F-This is a non-existent error./
TRNERR: .ASCIZ  /?SNDMSG-W-Message was too long, truncated./
MSGPRT: .ASCIZ  /Message to be queued: /
CNLPRT: .ASCII  <15><12>/Channel Name (six characters max): /<200>
DONEOK: .ASCII  /Message queued on channel /<200>
        .EVEN
CNLBUF: .BLKB   80.             ;First 6 chars to contain file name
MSGBUF: .BLKB   80.             ;Message buffer.

        .END    START
```

10.3 Checking for pending messages

The following EMT is used to receive a message from a named channel if a message is pending on the channel. If no message is pending, an error code (3) is returned, and the program is allowed to continue execution. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   0,105
.WORD   chnadr
.WORD   msgadr
.WORD   msgsiz
```

where "chnadr" points to a field with a six character channel name, "msgadr" points to the buffer in which the message is to be placed, and "msgsiz" is the size of the message buffer (bytes).

If a message is received, its length (bytes) is placed in R0 on return from the EMT. If the message is longer than the message buffer (msgsiz), only the first part of the message will be received.

Errors:

Code	Meaning
0	Job does not have MESSAGE privilege or system does not include message channel support.
1	All message channels are busy.
3	No message was queued on the named channel.
4	Message was longer than the receiving buffer.
5	Maximum number of message requests pending.

Example:

```
        .TITLE GETMSG

; Demonstrates use of the TSX-Plus EMT to check for pending messages in the
; interprocess message communication facility.

        .MCALL  .EXIT,.PRINT,.GTLIN

ERRBYT = 52                             ;EMT error byte

START:  .GTLIN  #CNLBUF,#CNLPRT         ;Get the channel name
        MOV     #MSGBLK,R0              ;Put EMT argument block address in R0
        EMT     375                     ;EMT to check channel for message
        BCC     5$                      ;Error?
        TSTB    @#ERRBYT                ;No privilege?
        BNE     1$                      ;Branch if different error
        .PRINT  #NOPRIV
        BR      9$
1$:     CMPB    @#ERRBYT,#4             ;Only two errors possible
        BEQ     2$                      ;Overflow message buffer?
        .PRINT  #NOMERR                 ;No message
        BR      9$
2$:     .PRINT  #TRNERR                 ;Print truncation warning
5$:     .PRINT  #PNDMSG                 ;Print message preamble
        .PRINT  #MSGBUF                 ;Print actual message
9$:     .EXIT

MSGBLK: .BYTE   0,105                   ;GETMSG EMT block
        .WORD   CNLBUF                  ;Channel name buffer address
        .WORD   MSGBUF                  ;Buffer address to receive message
        .WORD   81.                     ;Buffer length
        .NLIST  BEX
CNLBUF: .BLKB   80.                     ;First 6 chars are channel name
MSGBUF: .BLKB   80.                     ;Message buffer
        .WORD   0                       ;Insure ASCIZ
        .NLIST  BEX
CNLPRT: .ASCII  /Channel Name (6 chars): /<200>
NOMERR: .ASCIZ  /?GETMSG-F-No messages pending in named channel./
```

```
TRNERR: .ASCIZ  /?GETMSG-W-Message truncated/<7>
PNDMSG: .ASCIZ  /Message pending in named queue is:/
NOPRIV: .ASCIZ  /?GETMSG-F-No privilege or no message support./
        .LIST   BEX
        .END    START
```

10.4 Waiting for a message

The following EMT is used to suspend execution of a program until a message becomes available on a named channel. The form of the EMT is:

```
        EMT     375
```

with R0 pointing to the following argument area:

```
        .BYTE   0,106
        .WORD   chnadr
        .WORD   msgadr
        .WORD   msgsiz
```

where "chnadr" points to a six byte field containing the channel name, "msgadr" points to the buffer where the message is to be placed, and "msgsiz" is the size of the message buffer (bytes).

The length of the received message (bytes) is placed in R0 on return from the EMT.

Errors:

Code	Meaning
0	Job does not have MESSAGE privilege or system does not include message channel support.
1	All message channels are busy.
4	Message was longer than the receiving buffer.
5	Maximum number of message requests pending.

Example:

```
        .TITLE  WATMSG
        .ENABL  LC

; Demonstrate TSX-Plus EMT to wait for a queued message from the
; interprocess message communication facility.

        .MCALL  .EXIT,.PRINT,.GTLIN

ERRBYT  = 52                            ;EMT error byte

START:  .GTLIN  #CNLBUF,#CNLPRT         ;Get the channel name
```

```
        .PRINT  #WAITNG                 ;Explain waiting
        MOV     #MSGBLK,R0              ;Put EMT argument block address in R0
        EMT     375                     ;EMT to check channel for message
        BCC     5$                      ;Check for error
        TSTB    @#ERRBYT                ;No privilege?
        BNE     1$                      ;Branch if different error
        .PRINT  #NOPRIV
        BR      9$
1$:     CMPB    @#ERRBYT,#1             ;Error?
        BHI     2$                      ;Message truncated
        .PRINT  #NOMERR                 ;All channels busy
        BR      9$
2$:     .PRINT  #TRNERR                 ;Print truncation warning
5$:     .PRINT  #RCVMSG                 ;Print message preamble
        .PRINT  #MSGBUF                 ;Print actual message
9$:     .EXIT

MSGBLK: .BYTE   0,106                   ;WATMSG EMT block
        .WORD   CNLBUF                  ;Channel name buffer address
        .WORD   MSGBUF                  ;Buffer address to receive message
        .WORD   81.                     ;Buffer length
CNLBUF: .BLKB   80.                     ;Channel name first 6 chars
MSGBUF: .BLKB   80.                     ;Message buffer
        .WORD   0                       ;Insure ASCIZ
        .NLIST  BEX
CNLPRT: .ASCII  /Channel Name (6 chars): /<200>
WAITNG: .ASCII  /Waiting for a message . . ./<15><12>
        .ASCIZ  /Go to another line and send me something./
NOMERR: .ASCIZ  /?WATMSG-F-All message channels are busy./
TRNERR: .ASCIZ  /?WATMSG-W-Message truncated./<7>
RCVMSG: .ASCIZ  /Message received in named queue is:/
NOPRIV: .ASCIZ  /?WATMSG-F-No privilege or no message support./
        .LIST   BEX
        .END    START
```

10.5 Scheduling a message completion routine

The following EMT is used to schedule a completion routine to be entered when a message is received on a named channel. The form of the EMT is:

```
EMT     375
```

with R0 pointing to an argument block of the form:

```
.BYTE   1,106
.WORD   chnadr
.WORD   msgadr
.WORD   msgsiz
.WORD   cplrtn
```

where "chnadr" points to a six byte field containing the message channel name, "msgadr" is the address of the buffer where the message is to be placed, "msgsiz" is the size of the message buffer (bytes), and "cplrtn" is the address of the completion routine to be entered when a message is received.

On entry to the completion routine, R0 contains the number of bytes in the message that was received and R1 contains the number of the job that sent the message. Another message completion routine may be scheduled from within the completion routine if desired.

The .SPND and .RSUM system service calls may be used with this facility if the program reaches a point where it must suspend its execution until a message arrives.

Errors:

Code	Meaning
0	Job does not have MESSAGE privilege or system does not include message channel support.
1	All message channels are busy
4	Message was longer than the receiving buffer.
5	Maximum number of message requests pending.

Example:

```
        .TITLE  MSGCPL
        .ENABL  LC
;
;  Demonstrate message completion routine
;  Do processing while waiting for a message,
;   then display the message and repeat.
;
        .MCALL  .PRINT,.EXIT,.TTYOUT
        .GLOBL  PRTDEC
        .DSABL  GBL
;
ERRBYT  = 52                    ;EMT error byte address
SPACE   = 40                    ;ASCII space char
BELL    = 7                     ;ASCII bell char
REPTS   = 50                    ;Outer idle loop repeat counter
WIDTH   = 32.                   ;Screen formatting width
;
;  Schedule message completion routine
;
START:  MOV     #MSGCPL,R0      ;Point to EMT arg block to
        EMT     375             ;Schedule completion routine
        BCC     2$              ;Branch if OK
        MOVB    @#ERRBYT,R1     ;Get error code
1$:     ASL     R1              ;Convert to word index
```

```
        .PRINT  SCHERR(R1)      ;Print appropriate error message
        .EXIT                   ;Quit
;
;  Idle processing loop while waiting for completion routine
;
2$:     MOV     #REPTS,R2       ;Outer idle loop counter
3$:     MOV     #-1,R3          ;Inner idle loop counter
        TST     MESSAG          ;Any message pending?
        BEQ     5$              ;Do other processing if not
        BMI     4$              ;Msg compl rtn error?
        CALL    DSPMSG          ;No error, display message
        BR      2$              ;Continue waiting for next
4$:     MOV     MESSAG,R1       ;Recover error code
        BR      1$              ;Go print error and die
5$:     SOB     R3,5$           ;Inner idle loop
        SOB     R2,3$           ;Outer idle loop
        .TTYOUT #BELL           ;Indicate activity
        BR      2$              ;And repeat forever
;
;  Display the received message
;
DSPMSG: MOV     R3,-(SP)
        .PRINT  #CRLF           ;Format display
        MOV     MSGLEN,R2       ;Get length count
        MOV     R2,R0           ;Again for display
        CALL    PRTDEC          ;Show message size
        .PRINT  #MSGFRM         ;"byte message rec'd from job #"
        MOV     JOBNUM,R0       ;Get sending job number
        CALL    PRTDEC          ;Display job number
        MOV     #MSGADR,R1      ;Get pointer to message
        ADD     R1,R2           ;Save pointer to message end
1$:     MOV     #WIDTH,R4       ;Display-width counter
        .PRINT  #LEFT           ;Format display
2$:     MOVB    (R1)+,R0        ;Get next character
        CMPB    R0,#SPACE       ;Printable?
        BGE     3$              ;Branch if so
        .TTYOUT #'^             ;Mark control character
        DEC     R4              ;Sub 1 from width
        MOVB    -1(R1),R0       ;Recover character
        ADD     #'@,R0          ;Convert to uppercase char
3$:     .TTYOUT                 ;Display char
        CMP     R1,R2           ;End of display?
        BHIS    4$              ;Branch if so
        SOB     R4,2$           ;Continue unless need to wrap
        .PRINT  #RIGHT          ;Format display
        BR      1$              ;Next line
4$:     .PRINT  #RIGHT          ;Format display
        CLR     MESSAG          ;Say we are done with this one
        MOV     (SP)+,R3
        RETURN
```

```
;
;  Completion routine to be entered when message received
;
CPLRTN: TST     MESSAG          ;Done with last message?
        BNE     1$              ;Branch (and lose this one) if not
        MOV     R0,MSGLEN       ;Save message length
        MOV     R1,JOBNUM       ;Save sending job number
        MOV     #1,MESSAG       ;Flag message received
1$:     MOV     #MSGCPL,R0      ;Point to EMT arg block to
        EMT     375             ;Reschedule myself
        BCC     2$              ;Branch if OK
        MOVB    @#ERRBYT,MESSAG ;Else save error code
        BIS     #100000,MESSAG  ;And flag it as error
2$:     RETURN
;
;  EMT arg blocks and word buffers
;
MSGCPL: .BYTE   1,106           ;EMT arg block - msg compl rtn
        .WORD   CHANAM          ;Pointer to channel name
        .WORD   MSGADR          ;Address of message buffer
        .WORD   MSGEND-MSGADR   ;Size of message buffer
        .WORD   CPLRTN          ;Address of completion routine
JOBNUM: .WORD   0               ;Cell for # of message sender
MSGLEN: .WORD   0               ;Cell for received message length
MESSAG: .WORD   0               ;Cell for msg rcvd signal
SCHERR: .WORD   NOPRIV          ;Msg compl rtn sched error table
        .WORD   NOFREE          ; 1 No free message channels
        .WORD   UNUSED          ; 2 Max messages already queued
        .WORD   UNUSED          ; 3 No message queued on channel
        .WORD   TOOLNG          ; 4 Message overflowed buffer
        .WORD   NOMRB           ; 5 Max messages requests pending
;
;  Messages and byte buffers
;
        .NLIST  BEX
CHANAM: .ASCII  /CHANEL/        ;Name of watched message channel
NOPRIV: .ASCIZ  /No privilege or no message support./
NOFREE: .ASCIZ  /All message channels are busy./
UNUSED: .ASCIZ  /MSGCPL should never generate this error./
TOOLNG: .ASCIZ  /Message was longer than message buffer./
NOMRB:  .ASCIZ  /Maximum number of message requests pending./
MSGFRM: .ASCII  / byte message received from job number /<200>
CRLF:   .BYTE   15,12,200
LEFT:   .ASCII  <15><12>/--/<76><200>
RIGHT:  .ASCII  <74>/--/<200>
MSCADR: .BLKB   200.            ;Message buffer
MSGEND:
        .LIST   BEX
        .EVEN
        .END    START
```

11. REAL-TIME PROGRAM SUPPORT

TSX-Plus provides a real-time program support facility that allows multiple real-time programs to run concurrently with normal time-sharing operations. The basic functions provided by this facility are summarized below.

1. The ability to map the I/O page into the user's virtual memory region so that device status and control registers may be directly accessed by the program.

2. The ability to connect device interrupt vectors to program interrupt service routines running at fork level or to program completion routines running at user-selectable priority levels with full job context.

3. The ability for a program to lock itself in memory so that rapid interrupt response can be assured.

4. The ability for a program to suspend its execution until an interrupt occurs.

5. The ability to set execution priorities for tasks.

6. The ability to convert a virtual address within the job's region to a physical address for DMA I/O control.

7. The ability to map a virtual address region to a physical address region.

8. The ability for a program to declare a list of addresses of device control registers to be reset when the program exits or aborts (.DEVICE EMT).

Most of the features associated with the real-time facility are a basic part of TSX-Plus, but the ability to attach interrupt service routines or interrupt completion routines to interrupt vectors is optional during system generation.

Special privilege is required to perform some of the requests described in this chapter. For example: REALTIME privilege is required to use the .DEVICE request or to get exclusive system control; MEMMAP privilege is required to map to the I/O page or other specific locations in physical memory; PSWAPM privilege is required to lock a program in memory. The real-time facilities are available to both normal jobs controlled by time-sharing lines and to detached jobs. Note that detached jobs that are specified during system generation for automatic startup run with all privileges, unless specifically changed; detached jobs started by time-sharing users have the same privilege as the job starting them.

11.1 Accessing the I/O page

A basic facility required by most real-time programs is the ability to access the PDP-11 I/O page (160000-177777) which contains the device control and status registers. Under TSX-Plus, addresses in this range are normally mapped to a simulated RMON or may be used as normal program space. This is done since many old programs require direct access to certain system values at fixed offsets into RMON, although recent programs should access these values with the .GVAL and .PVAL EMTs. TSX-Plus provides several EMTs to deal with mapping of the I/O page and accessing locations within it. These are discussed below. See Chapter 8 for a discussion of various mapping techniques which may be used under TSX-Plus. The /IOPAGE switch to the R[UN] command may also be used to map a program's PAR 7 to the I/O page.

A TSX-Plus real-time program can access the I/O page in one of two ways: It can cause the program's virtual address region in the range 160000 to 177777 to be mapped directly to the I/O page so that it can directly access device registers; or it can leave the virtual address range mapped to the simulated RMON and use a set of EMTs to peek, poke, bit-set and bit-clear registers in the I/O page. It is much more efficient to directly access the device control registers by mapping the I/O page into the program's virtual address region than to use EMTs to perform each access. However, this technique will not work if the program must also directly access offsets inside RMON. The correct way for a program to access RMON offsets is to use the .GVAL EMT which will work even if the I/O page is mapped into the program region.

11.1.1 EMT to map the I/O page into the program space.

The following EMT can be used to cause the program's virtual address region in the range 160000 to 177777 to be mapped to the I/O page. Use of this EMT requires MEMMAP privilege. The /IOPAGE switch to the R[UN] command may also be used to map a program's PAR 7 to the I/O page. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   5,140
```

The I/O page mapping set up by this EMT remains in effect until the program exits, chains, or the EMT described in the next section is used to remap to RMON. Note that completion routines and interrupt service routines run with the same memory mapping as the mainline code of the job.

The .GVAL EMT with offset value -8. may be used to determine if PAR 7 is currently mapped to the I/O page or to the simulated RMON. See the description in Chapter 7 of the special use of .GVAL for further information.

Example:

```
        .TITLE  MAPIOP
        .ENABL  LC

;Demonstrate TSX-Plus EMTs to map to the I/O page and back to RMON

RMONST = 54                     ;SYSCOM location holding base of RMON
CONFIG = 300                    ;Fixed offset into RMON of CONFIG word
RCSR   = 176540                 ;Serial line RCSR address
RBUF   = RCSR+2                 ;Line input buffer address
CTRLC  = 3                      ;Control-C

        .MCALL  .PRINT,.EXIT,.TTYOUT,.GVAL
        .GLOBL  PRTOCT

START:  CALL    SHOMAP          ;Display current PAR 7 mapping
        CALL    SHODAT          ;Demonstrate "RMON" mapping

        .PRINT  #IOPMSG         ;Say we are switching to I/O page mapping
        MOV     #MAPIOP,R0      ;Point to EMT arg block to
        EMT     375             ;Map to I/O page
        BCC     1$              ;Branch if OK to map
        .PRINT  #NOPRIV         ;You aren't allowed to do that
        .EXIT
1$:     CALL    SHOMAP          ;Display current PAR 7 mapping
        .PRINT  #TYPE           ;Prompt for input from I/O page
        MOV     @#RCSR,CSRSAV   ;Save a copy of current CSR
        CLR     @#RCSR          ;Disable interrupts on serial line
2$:     TSTB    @#RCSR          ;Is anything available from the line
        BPL     2$              ;No, keep checking
        MOVB    @#RBUF,R0       ;Get the new character
        CMPB    R0,#CTRLC       ;Should we quit?
        BEQ     3$              ;Quit on ^C
        .TTYOUT                 ;Display the character
        BR      2$              ;And repeat

3$:     MOV     CSRSAV,@#RCSR   ;Restore original CSR
        .PRINT  #GOBACK         ;Say we are returning to original mapping
        MOV     #MAPMON,R0      ;Point to EMT arg block to
        EMT     375             ;Map back to simulated RMON
        CALL    SHOMAP          ;Display current PAR 7 mapping
        CALL    SHODAT          ;And prove we are back
        .EXIT

SHOMAP: .PRINT  #MAPMSG         ;Current mapping preface
        .GVAL   #AREA,#-8.      ;What is our current PAR 7 mapping?
        ASL     R0              ;Convert to word offset
        .PRINT  CURMAP(R0)      ;Show which one it is
        RETURN
```

```
SHODAT: .PRINT  #CNFGIS          ;Preface config value
        MOV     @#RMONST,R0      ;Pick up pointer to RMON base
        MOV     CONFIG(R0),R0    ;Get the current CONFIG value
        CALL    PRTOCT           ;Display it
        RETURN

MAPIOP: .BYTE   5,140            ;EMT arg block to map to I/O page
MAPMON: .BYTE   6,140            ;EMT arg block to map to "RMON"
AREA:   .WORD   10               ;EMT arg block
CSRSAV: .WORD   0                ;Save CSR for restoration on exit
CURMAP: .WORD   TORMON           ;Current mapping message table
        .WORD   TOIOPG
        .NLIST  BEX
TORMON: .ASCIZ  /simulated RMON./
TOIOPG: .ASCIZ  "I/O page."
MAPMSG: .ASCII  /PAR 7 is currently mapped to /<200>
CNFGIS: .ASCII  /Current value of CONFIG word in simulated RMON is /<200>
TYPE:   .ASCIZ  /Characters entered on serial line will be displayed here:/
IOPMSG: .ASCIZ  <12>"Now switching PAR 7 mapping to the I/O page."
GOBACK: .ASCIZ  <15><12>/Returning PAR 7 mapping to simulated RMON./
NOPRIV: .ASCII  /Real-time support not specified during TSGEN or /
        .ASCIZ  /user not privileged./
        .END    START
```

11.1.2 EMT to remap the program region to the simulated RMON.

The following EMT can be used to cause the virtual address mapping region of the job in the range 160000 to 177777 to be returned to normal mapping if it had previously been mapped to the I/O page. Use of this EMT requires MEMMAP privilege. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   6,140
```

Example:

See the example program MAPIOP in the section on mapping the I/O page into the program space.

11.1.3 EMT to peek at the I/O page.

The following EMT can be used to access a word in the I/O page without requiring the job's virtual address region to be mapped to the I/O page. (Note that the .PEEK and .POKE EMTs can also be used to access parts of the I/O page. See Chapter 14 for more information on the effects of the .PEEK and .POKE EMTs with TSX-Plus.) Use of this EMT requires MEMMAP privilege. The form of this EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   1,140
.WORD   address
```

where "address" is the address of the word in the I/O page to be accessed. The contents of the specified word in the I/O page are returned in R0. Note that with this and other EMTs that access the I/O page, if an invalid address is specified, an error will result with the message:

```
?MON-F-Kernel mode trap within TSX-Plus
```

Example:

```
        .TITLE  PEEKIO
        .ENABL  LC

;Demonstrate TSX-Plus EMTs to peek and poke into the I/O page

CTRLC   = 3                     ;Control-C
RMONST  = 54                    ;Pointer in SYSCOM area to start of "RMON"
CONFIG  = 300                   ;Fixed offset into "RMON" of config word
RCSR    = 176540                ;Serial line RCSR address
RBUF    = RCSR+2                ;Line input buffer address

        .MCALL  .PRINT,.EXIT,.TTYOUT,.GVAL
        .GLOBL  PRTOCT

START:  CALL    SHOMAP          ;Display current PAR 7 mapping
        CALL    SHOCON          ;Demonstrate "RMON" mapping

        MOV     #PEEKIO,R0      ;Point to EMT arg block to
        EMT     375             ;Peek into the I/O page
        BCC     1$              ;Branch if OK
        .PRINT  #NOPRIV         ;You aren't allowed to do that
        .EXIT
1$:     MOV     R0,CSRSAV       ;Save a copy of current CSR

        CLR     POKVAL          ;Want to disable interrupts
```

```
        MOV     #POKEIO,R0      ;Point to EMT arg block to
        EMT     375             ;Poke a value into the I/O page
                                ;Shouldn't be error if peek worked
        .PRINT  #TYPE           ;Prompt for input from I/O page
2$:     MOV     #PEEKIO,R0      ;Point to EMT arg block to
        EMT     375             ;Check the RCSR
        TSTB    R0              ;Is anything available from the line
        BPL     2$              ;No, keep checking

        ADD     #2,PEKADD       ;Point to the receiver buffer
        MOV     #PEEKIO,R0      ;Point to EMT arg block to
        EMT     375             ;Get the input character
        CMPB    R0,#CTRLC       ;Should we quit?
        BEQ     3$              ;Quit on ^C
        .TTYOUT                 ;Display the character
        SUB     #2,PEKADD       ;Point back to the RCSR
        BR      2$              ;And repeat

3$:     MOV     CSRSAV,POKVAL   ;Want to restore the original CSR status
        MOV     #POKEIO,R0      ;Point to EMT arg block to
        EMT     375             ;Restore the CSR

        .EXIT

SHOMAP: .PRINT  #MAPMSG         ;Current mapping preface
        .GVAL   #AREA,#-8.      ;What is our current PAR 7 mapping?
        ASL     R0              ;Convert to word offset
        .PRINT  CURMAP(R0)      ;Show which one it is
        RETURN

SHOCON: .PRINT  #CNFGIS         ;Preface config value
        MOV     @#RMONST,R0     ;Pick up pointer to RMON base
        MOV     CONFIG(R0),R0   ;Get the current CONFIG value
        CALL    PRTOCT          ;Display it
        RETURN

PEEKIO: .BYTE   1,140           ;EMT arg block to peek into the I/O page
PEKADD: .WORD   RCSR            ;Address to be read
POKEIO: .BYTE   2,140           ;EMT arg block to poke into the I/O page
POKADD: .WORD   RCSR            ;Address to be modified
POKVAL: .WORD   0               ;Word to be moved to POKADD
AREA:   .WORD   10              ;EMT arg block
CSRSAV: .WORD   0               ;Save CSR for restoration on exit
CURMAP: .WORD   TORMON          ;Current mapping message table
        .WORD   TOIOPG
        .NLIST  BEX
TORMON: .ASCIZ  /simulated RMON./
TOIOPG: .ASCIZ  "I/O page."
MAPMSG: .ASCII  /PAR 7 is currently mapped to /<200>
CNFGIS: .ASCII  /Current value of CONFIG word in simulated RMON is /<200>
```

```
TYPE:   .ASCIZ  /Characters entered on serial line will be displayed here:/
NOPRIV: .ASCII  /Real-time support not specified during TSGEN or /
        .ASCIZ  /user not privileged./
        .END    START
```

11.1.4 EMT to poke into the I/O page.

The following EMT can be used to store a value into a cell in the I/O page without requiring the job's virtual address region to be mapped to the I/O page. Use of this EMT requires MEMMAP privilege. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   2,140
.WORD   address
.WORD   value
```

where "address" is the address of the cell in the I/O page and "value" is the value to be stored.

Example:

See the example program PEEKIO in the section on peeking into the I/O page.

11.1.5 EMT to bit-set a value into the I/O page.

The following EMT can be used to perform a bit-set (BIS) operation into a cell in the I/O page without requiring the job's virtual address region to be mapped to the I/O page. Use of this EMT requires MEMMAP privilege. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   3,140
.WORD   address
.WORD   value
```

where "address" is the address of the cell in the I/O page and "value" is the value that will be bit-set into the cell.

Example:

```
        .TITLE  BISIO
        .ENABL  LC

;Demonstrate TSX-Plus EMTs to bit-set and bit-clear into the I/O page

CTRLC  = 3                      ;Control-C
RMONST = 54                     ;Pointer in SYSCOM area to start of "RMON"
INTNBL = 100                    ;RCSR interrupt enable bit
CONFIG = 300                    ;Fixed offset into "RMON" of config word
RCSR   = 176540                 ;Serial line RCSR address
RBUF   = RCSR+2                 ;Line input buffer address

        .MCALL  .PRINT,.EXIT,.TTYOUT,.GVAL

START:  CALL    SHOMAP          ;Display current PAR 7 mapping
        CALL    SHOCON          ;Demonstrate "RMON" mapping

                                ;Want to clear input interrupts
        MOV     #BICIO,R0       ;Point to EMT arg block to
        EMT     375             ;Clear a bit in the I/O page
        BCC     1$              ;Branch if OK
        .PRINT  #NOPRIV         ;You aren't allowed to do that
        .EXIT
1$:                             ;OK, interrupts should be disabled
        .PRINT  #TYPE           ;Prompt for input from I/O page
2$:     MOV     #PEEKIO,R0      ;Point to EMT arg block to
        EMT     375             ;Check the RCSR
        TSTB    R0              ;Is anything available from the line
        BPL     2$              ;No, keep checking

        ADD     #2,PEKADD       ;Point to the receiver buffer
        MOV     #PEEKIO,R0      ;Point to EMT arg block to
        EMT     375             ;Get the input character
                                ;Value from peek is returned in R0
        CMPB    R0,#CTRLC       ;Should we quit?
        BEQ     3$              ;Quit on ^C
        .TTYOUT                 ;Display the character
        SUB     #2,PEKADD       ;Point back to the RCSR
        BR      2$              ;And repeat

3$:                             ;Want to set input interrupts
        MOV     #BISIO,R0       ;Point to EMT arg block to
        EMT     375             ;Set a bit in the I/O page

        .EXIT

SHOMAP: .PRINT  #MAPMSG         ;Current mapping preface
        .GVAL   #AREA,#-8.      ;What is our current PAR 7 mapping?
```

```
        ASL     R0              ;Convert to word offset
        .PRINT  CURMAP(R0)      ;Show which one it is
        RETURN

SHOCON: .PRINT  #CNFGIS         ;Preface config value
        MOV     @#RMONST,R0     ;Pick up pointer to RMON base
        MOV     CONFIG(R0),R0   ;Get the current CONFIG value
        CALL    PRTOCT          ;Display it
        RETURN

PRTOCT: MOV     R1,-(SP)        ;Save r1-r3 on the stack
        MOV     R2,-(SP)        ;R0 contains word of interest
        MOV     R3,-(SP)
        MOV     #EOW,R2         ;Point to end of 6 char output buffer
        MOV     #6,R3           ;Set up counter for 6 chars
1$:     MOV     R0,R1           ;Set up mask for low 3 bits (1s digit)
        BIC     #177770,R1      ;Get low 3 bits
        ADD     #'0,R1          ;Convert to ascii
        MOVB    R1,-(R2)        ;Fill octal digits in from end
        CLC
        ROR     R0
        ASH     #-2,R0          ;Shift out bits just converted
        SOB     R3,1$           ;Repeat for 6 chars
        .PRINT  #CHARS          ;Display result at console
        MOV     (SP)+,R3        ;Restore registers r1-r3
        MOV     (SP)+,R2
        MOV     (SP)+,R1
        RETURN

PEEKIO: .BYTE   1,140           ;EMT arg block to peek into the I/O page
PEKADD: .WORD   RCSR            ;Address to be read
BICIO:  .BYTE   4,140           ;EMT arg block to clear a bit in the I/O page
        .WORD   RCSR            ;Input status register
        .WORD   INTNBL          ;Interrupt enable mask
BISIO:  .BYTE   3,140           ;EMT arg block to set a bit in the I/O page
        .WORD   RCSR            ;Input status register
        .WORD   INTNBL          ;Interrupt enable mask
AREA:   .BLKW   10              ;EMT arg block
CSRSAV: .WORD   0               ;Save CSR for restoration on exit
CHARS:  .BLKB   6               ;6 char output buffer
EOW:    .WORD   0               ;Terminator for .PRINT
CURMAP: .WORD   TORMON          ;Current mapping message table
        .WORD   TOIOPG
        .NLIST  BEX
TORMON: .ASCIZ  /simulated RMON./
TOIOPG: .ASCIZ  "I/O page."
MAPMSG: .ASCII  /PAR 7 is currently mapped to /<200>
CNFGIS: .ASCII  /Current value of CONFIG word in simulated RMON is /<200>
TYPE:   .ASCIZ  /Characters entered on serial line will be displayed here:/
NOPRIV: .ASCII  /Real-time support not specified during TSGEN or /
```

```
        .ASCIZ  /user not privileged./
        .END    START
```

11.1.6 EMT to do a bit-clear into the I/O page.

The following EMT can be used to perform a bit-clear (BIC) operation into a cell in the I/O page without requiring the job's virtual address region to be mapped to the I/O page. Use of this EMT requires MEMMAP privilege. The form of the EMT is:

```
        EMT     375
```

with R0 pointing to the following argument area:

```
        .BYTE   4,140
        .WORD   address
        .WORD   value
```

where "address" is the address of the cell in the I/O page and "value" is the value to be bit-cleared into the specified cell.

Example:

See the example program BISIO in the section on doing a bit-set into the I/O page.

11.2 Mapping to a physical memory region

In certain circumstances, it is desirable to map a portion of virtual memory to a specific area in physical memory which is not in the I/O page. Possible examples would be ROM memory or an array processor. This mapping is done by altering one or more of the Page Address Registers (PARs) for the job. Each PAR maps 8192 bytes of memory from the virtual job space into physical memory. There are 8 PAR's (8*8192=64Kb). The region of memory mapped through each PAR is shown by the table below:

PAR	Virtual Region
0	000000 - 017777
1	020000 - 037777
2	040000 - 057777
3	060000 - 077777
4	100000 - 117777
5	120000 - 137777
6	140000 - 157777
7	160000 - 177777

Use of this EMT requires MEMMAP privilege.
The form of this EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   17,140
.WORD   par-number
.WORD   phys-address
.WORD   size
.WORD   access
```

"par-number" is the number of the Page Address Register (PAR) that corresponds to the beginning of the program virtual address region that is to be mapped.

"phys-address" is the physical address to which the virtual address is to be mapped. The physical address is specified as an address divided by 64 (decimal). That is, the physical address represents the 64-byte block number of the start of the physical region. Note that the physical address of any 64-byte block within a 22-bit physical address space can be represented in 16 bits.

"size" is the number of 64-byte blocks of memory to be mapped through the virtual region. Each PAR can map up to 128 64-byte blocks of memory. If more than 128 blocks are mapped, successively higher PARs are set up to map the remainder of the region.

"access" indicates if the mapped region is to be allowed read-only access or both read and write access: 0 = read-only; 1 = read/write.

This EMT may be used to map any of the PARs to any physical address regions desired (even to map PAR 7 to the I/O page). The use of this EMT does not affect mapping set up previously for other PARs. If the "size" parameter is 0 (zero), all PAR mapping is reset and the normal virtual address mapping for the job is restored.

Note that this EMT is not equivalent to the extended memory EMTs used with PLAS (Program's Logical Address Space) requests and virtual overlays and virtual arrays. See Chapter 8 for a discussion of job environment and the appropriate RT-11 manuals for a more complete discussion of PLAS features.

Example:

```
        .TITLE  MAPPHY
        .ENABL  LC

; Demonstrate TSX-Plus EMT to map to any physical address

CTRLC  = 3                      ;Control-C
INTNBL = 100                    ;Interrupt enable bit
RCSR   = 176540                 ;Serial line RCSR address
RBUF   = RCSR+2                 ;Line input buffer address

        .MCALL  .PRINT,.EXIT,.TTYOUT,.GVAL

START:  .PRINT  #MAPMSG         ;Say we are switching to physical mapping
        MOV     #MAPPHY,R0      ;Point to EMT arg block to
        EMT     375             ;Map to physical memory
        BCC     1$              ;Branch if OK to map
        .PRINT  #NOPRIV         ;You aren't allowed to do that
        .EXIT
1$:     .PRINT  #TYPE           ;Prompt for input from I/O page
        BIC     #INTNBL,@#RCSR  ;Disable interrupts on serial line
2$:     TSTB    @#RCSR          ;Is anything available from the line
        BPL     2$              ;No, keep checking
        MOVB    @#RBUF,R0       ;Get the new character
        CMPB    R0,#CTRLC       ;Should we quit?
        BEQ     3$              ;Quit on ^C
        .TTYOUT                 ;Display the character
        BR      2$              ;And repeat

3$:     CLR     SIZE            ;If .size is 0, original mapping is restored
        MOV     #MAPPHY,R0      ;Point to EMT arg block to
        EMT     375             ;Revoke mapping to physical address

        .EXIT

MAPPHY: .BYTE   17,140          ;EMT arg block to map to physical memory
        .WORD   7               ;remap PAR 7
        .WORD   177600          ;17760000/64. address to map into PAR 7
SIZE:   .WORD   200             ;size of region to be mapped - full 8kb
        .WORD   1               ;access 0=read-only, 1=read/write
        .NLIST  BEX
MAPMSG: .ASCIZ  /PAR 7 mapping is now directed to top of physical memory./
TYPE:   .ASCIZ  /Characters entered on serial line will be displayed here:/
NOPRIV: .ASCIZ  /You are not privileged to run this program./
        .END    START
```

11.3 Requesting exclusive system control

The following EMT allows real-time jobs to gain exclusive access to the system while they perform time-critical tasks. Use of this EMT requires REALTIME privilege. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   14,140
```

The effect of this EMT is to cause the TSX-Plus job scheduler to ignore all other jobs, even higher priority jobs - including fixed-high-priority jobs, until the real-time job relinquishes exclusive access control. Note that this is different (and more powerful) than giving the real-time job a higher execution priority because all other jobs are completely prevented from executing even if the real-time job goes into a wait state causing the CPU to become idle.

The form of the EMT used to relinquish exclusive system access is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   15,140
```

The following restrictions apply to a job that has issued an exclusive access EMT:

1. The job is automatically locked in memory during the time it has exclusive access to the system. If you wish to use the TSX-Plus EMT that locks a job in the lowest portion of memory, that EMT must be executed before calling this EMT to gain exclusive access to the system.

2. The size of the job may not be changed while it has exclusive access to the system.

Exclusive access is automatically relinquished if the job exits or traps but is retained if the job chains to another job.

Example:

```
        .TITLE  STEALS
        .ENABL  LC

; Demonstrate TSX-Plus EMT to obtain exclusive system control

LEADIN  =       35              ;TSX-Plus program controlled terminal
                                ;option lead-in character.
JSW     =       44              ;Job status word address
TTSPC   =       10000           ;TT special mode bit in JSW
NOWAIT  =       100             ;TT nowait bit in JSW


        .MCALL  .PRINT,.TTYOUT,.TTYIN,.EXIT

START:  MOV     #TTSPC!NOWAIT,@#JSW     ;Set TT special mode and nowait
                                        ;bits in the JSW
        .TTYOUT #LEADIN         ;And make TSX-Plus understand both
        .TTYOUT #'S
        .TTYOUT #LEADIN
        .TTYOUT #'U

        .PRINT  #MSG            ;Prompt for input
        MOV     #STEALS,R0      ;Point to EMT arg block to
        EMT     375             ;Steal exclusive system control
; . . .                         ;Time critical processing goes here
        .TTYIN                  ;Simulated here with terminal input
        MOV     #LETGO,R0       ;Point to EMT arg block to
        EMT     375             ;Relinquish exclusive system control
        .EXIT

        .NLIST  BEX
STEALS: .BYTE   14,140          ;EMT arg block for exclusive system control
LETGO:  .BYTE   15,140          ;EMT arg block to relinquish exclusive control
MSG:    .ASCII  /Other users are locked out until you press a key:/<200>

        .END    START
```

11.4 Locking a job in memory

In time-critical real-time applications where a program must respond to an interrupt with minimum delay, it may be necessary for the job to lock itself in memory to avoid program swapping. Use of the EMTs to lock a program in memory or to lock into low memory (below 256 Kb) or to unlock a program from memory (reenable swapping) requires PSWAPM privilege. This facility should be used with caution since if a number of large programs are locked in memory there may not be enough space left to run other programs.

TSX-Plus provides two program locking facilities. The first moves the program to the low end of memory before locking it; this is done to avoid fragmenting available free memory. This type of lock should be done if the program is going to remain locked in memory for a long period of time. However, this form of locking is relatively slow since it may involve program swapping. The second locking facility simply locks the program into the memory space it is occupying when the EMT is executed without doing any repositioning. This EMT has the advantage that it is extremely fast but free memory space may be non-contiguous.

The form of the EMT used to lock a program in low memory (re-positioning if necessary) is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   7,140
```

The form of the EMT used to lock a job in memory without repositioning it is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   13,140
```

Error:

Code	Meaning
0	Job does not have PSWAPM privilege

Example:

See the example program ATTVEC in the section on connecting a real-time interrupt to a completion routine.

11.5 Unlocking a job from memory

When a job locks itself in memory, it remains locked until the job exits or the following EMT is executed. The form of the EMT used to unlock a job from memory is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   10,140
```

Example:

See the example program ATTVEC in the section on connecting a real-time interrupt to a completion routine.

11.6 Suspending/Resuming program execution

The RT-11 standard .SPND and .RSUM EMTs are used by TSX-Plus real-time jobs to suspend and resume their execution. Frequently, a real-time job will begin its execution by connecting interrupts to completion routines and doing other initialization and then will suspend its execution while waiting for a device interrupt to occur.

The .SPND EMT causes the main-line code in the job to be suspended. Completion routines are not affected and execute when interrupts occur. If a completion routine executes a .RSUM EMT, the main-line code will continue execution at the point following the .SPND when the completion routine exits. Refer to the RT-11 Programmer's Reference Manual for further information about the use of .SPND and .RSUM.

Example:

See the example program ATTVEC in the section on connecting a real-time interrupt to a completion routine.

11.7 Converting a virtual address to a physical address

When controlling devices that do direct memory access (DMA), it is necessary to be able to obtain the physical memory address (22-bit) that corresponds to a virtual address in the job. Note that a job should lock itself in memory before performing this EMT. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
        .BYTE   0,140
        .WORD   virtual-address
        .WORD   result-buffer
```

where "virtual-address" is the virtual address that is to be converted to a physical address and "result-buffer" is the address of a two word area that is to receive the physical address. The low-order 16 bits of the physical address are stored in the first word of the result buffer and the high-order 6 bits of the physical address are stored in bit positions 4-9 of the second word of the result buffer.

Example:

```
        .TITLE  PHYADD
        .ENABL  LC

; Demonstrate TSX-Plus EMT to convert a virtual to a physical address

        .MCALL  .PRINT,.EXIT

START:  MOV     #LOKJOB,R0      ;Point to EMT arg block to
        EMT     375             ;Lock job in memory
        BCC     1$              ;Continue if OK
        .PRINT  #NOPRIV         ;Explain the problem
        BR      2$              ;and quit
1$:     .PRINT  #STRADD         ;Say where this program was loaded
        MOV     #START,R0       ;Get the virtual address
        CALL    PRTADD          ;and display it to the terminal
2$:     .EXIT

PRTADD: MOV     R0,VIRADD       ;Put the virtual address into the arg block
        MOV     #PHYADD,R0      ;Point to EMT arg block to
        EMT     375             ;Convert virtual to physical address
        MOV     BUFFER,R1       ;Retrieve the low address
        MOV     <BUFFER+2>,R2   ;And the high address
        BIC     #^C1760,R2      ;Use only bits 4-9
        MOV     #4,R3           ;Throw away bits 0-3
1$:     ASR     R2
        SOB     R3,1$
        MOV     #CHREND,R4      ;Point to end of character output buffer
        MOV     #8.,R3          ;Need to convert 8 digits
2$:     MOV     R1,R0           ;Get a copy of low bits into R0
        BIC     #^C7,R0         ;Mask out all but low digit
        ADD     #'0,R0          ;Convert to ASCII
        MOVB    R0,-(R4)        ;Put low digit in output buffer
        MOV     #3,R5           ;Shift over 3 bits to next digit
3$:     ASR     R2              ;Low bit of high address
        ROR     R1              ;into high bit of low address
```

```
        SOB     R5,3$
        SOB     R3,2$           ;Do all 8 digits
        .PRINT  R4              ;Print out the result
        RETURN

LOKJOB: .BYTE   13,140          ;EMT arg block to lock job in memory
PHYADD: .BYTE   0,140           ;EMT arg block to determine physical address
VIRADD: .WORD   0               ;Virtual address to be located
        .WORD   BUFFER          ;Location of 2 word result buffer
BUFFER: .WORD   0,0             ;Will hold low and high physical address
        .BLKB   10.             ;Buffer to hold ASCII value of address
CHREND: .WORD   0               ;End of ASCII buffer
        .NLIST  BEX
NOPRIV: .ASCIZ  /User not privileged./
STRADD: .ASCII  /This program is loaded at START = /<200>
        .END    START
```

11.8 Specifying a program-abort device reset list

The standard RT-11 .DEVICE EMT is used by TSX-Plus real-time jobs to specify a list of device control registers to be loaded with specified values when the job terminates. This feature is useful in allowing real-time devices to be turned-off if the real-time control program aborts. The TSX-Plus .DEVICE EMT has the same form and options as the standard RT-11 .DEVICE EMT. Use of this EMT requires REALTIME privilege. See the RT-11 Programmer's Reference Manual for further information.

The connection between interrupt vectors and interrupt service routines or interrupt completion routines is automatically dropped when a job terminates. The interrupt vector is then connected to the system unexpected interrupt routine. If an address specified in a .DEVICE list corresponds to an interrupt vector connected to the job during job cleanup, then the vector is not connected to the unexpected interrupt routine.

11.9 Setting processor priority level

The following EMT allows a program to set the processor priority level. Use of this EMT requires REALTIME privilege. This EMT can be useful in a situation where it is necessary for a real-time job to block interrupts for a short period of time while it is performing some critical operation. On return from this EMT, the job is executing in user mode with the specified processor priority level. The form of the EMT is:

```
        EMT     375
```

with R0 pointing to the following EMT argument block:

```
        .BYTE   16,140
```

```
.WORD   prio-level
```

where "prio-level" should be 7 to cause interrupts to be disabled or 0 to reenable interrupts. Interrupts should not be disabled for a long period of time or clock interrupts and terminal I/O interrupts will be lost.

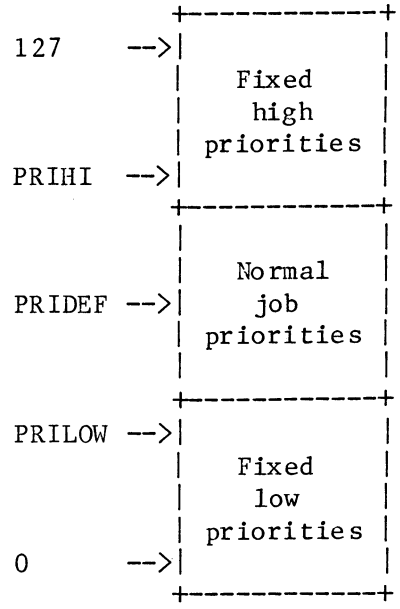
Note that it is not possible to raise the processor priority level by storing directly into the processor status word from a real-time program because the PDP-11 hardware disallows modification of the PSW by a user mode program even if the program has access to the I/O page.

Example:

See the example program ATTVEC in the section on connecting a real-time interrupt to a completion routine.

11.10 Setting Job Execution Priority

Jobs may be assigned priority values in the range 0 to 127 to control their execution scheduling relative to other jobs. The priority values are arranged in three groups: the fixed-low-priority group consists of priority values from 0 up to the value specified by the PRILOW sysgen parameter; the fixed-high-priority group ranges from the value specified for the PRIHI sysgen parameter up to 127; the middle priority group ranges from (PRILOW+1) to (PRIHI-1). The current values for PRIHI and PRILOW may be determined with the SHOW PRIORITY command, or from within a program with a .GVAL request. The following diagram illustrates the priority groups:



Job scheduling is performed differently for jobs in the fixed-high-priority and fixed-low-priority groups than for jobs with normal interactive priorities. Jobs with priorities in the fixed-low-priority group (0 to PRILOW) and the fixed-high-priority group (PRIHI to 127) execute at fixed priority values. That is, the priority absolutely controls the scheduling of the job for execution relative to other jobs. A job with a fixed priority is allowed to execute as long as it wishes until a higher priority job becomes active.

The fixed-high-priority group is intended for use by real-time programs. The fixed-low-priority group is intended for use by very low priority background tasks. Normal time-sharing jobs should not be assigned priorities in either of the fixed priority groups.

The middle group of priorities from (PRILOW+1) to (PRIHI-1) are intended to be used by normal, interactive, time-sharing jobs. Jobs with these assigned priorities are scheduled in a more sophisticated manner than the fixed-priority jobs. In addition to the assigned priority, external events such as terminal input completion, I/O completion, and timer quantum expiration play a role in determining the effective scheduling priority.

When a job with a normal priority switches to a subprocess, the priority of the disconnected job is reduced by the amount specified by the PRIVIR sysgen parameter. This causes jobs that are not connected to terminals to execute at a lower priority than jobs that are. This priority reduction does not apply to jobs with priorities in the fixed-high-priority group or the fixed-low-priority group. The priority reduction is also constrained so that the priority of jobs in the normal job priority range will never be reduced below the value of (PRILOW+1).

The following EMT can be used to set the job priority from within a program. The maximum priority which may be used by a job is set by the system manager. The job priority can also be set from the keyboard with the SET PRIORITY command. The current job priority, maximum allowed priority, and fixed-high- and fixed-low-priority boundaries may be determined with the .GVAL request. See the TSX-Plus System Manager's Guide for more information on the significance of priority in job scheduling. The form of this EMT is:

```
EMT     375
```

with R0 pointing to the following EMT argument block:

```
.BYTE   0,150
.WORD   value
```

where "value" is the priority value for the job. The valid range of priorities is 0 to 127 (decimal). The maximum job priority may be restricted through the logon mechanism. If a job attempts to set its priority above its maximum allowed priority, its priority will be set to the maximum allowed. This EMT does not return any errors.

Example:

See Chapter 7 for an example of the use of this EMT.

11.11 Connecting interrupts to real-time jobs

One of the most important uses for real-time jobs is to service interrupts for non-standard devices. TSX-Plus provides three mechanisms for connecting user-written real-time programs to interrupts: device handlers, interrupt service routines, and interrupt completion routines. Interrupt service routines and interrupt completion routines permit jobs to process interrupts without the necessity of writing a special device handler. However, there are restrictions on the use of these two methods which must be considered when deciding the appropriate method for handling special device interrupts.

REALTIME privilege is required to connect either interrupt service routines or interrupt completion routines to an interrupt vector or to release an interrupt connection.

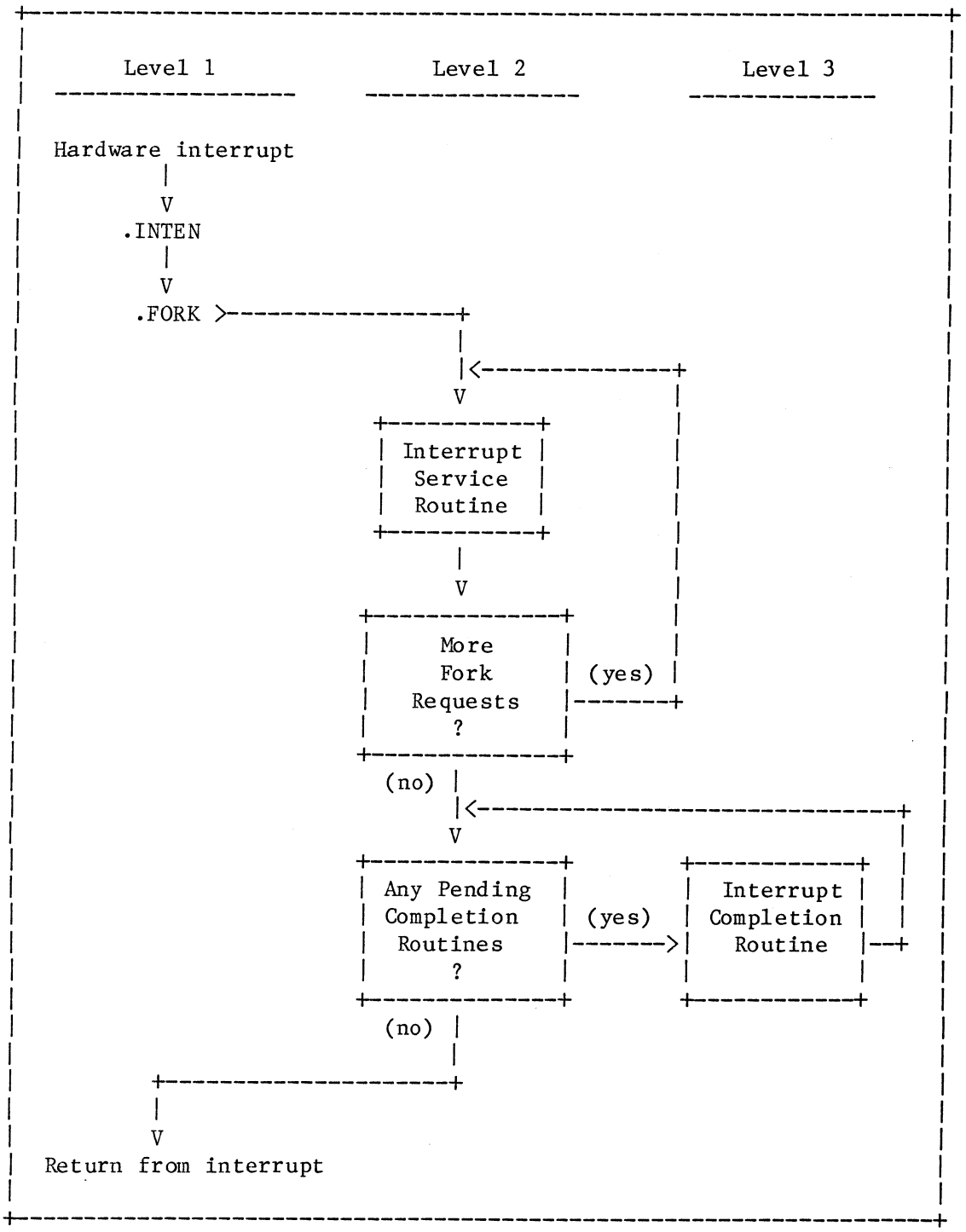
The fastest method of handling interrupts is to write a device handler (driver). Device handlers execute in kernel mode and provide the fastest possible response to interrupts. A device handler is the best choice when interrupts occur at a rate which significantly loads the system. Device handlers written for use with TSX-Plus should conform to the rules for writing device handlers for RT-11XM.

The second method for processing real-time interrupts is to connect the interrupt to a real-time interrupt service routine. The interrupt service routine is written as a subroutine in a real-time job; it is not necessary to write a separate device handler. Interrupt service routines are connected with minimal system overhead and can service interrupts quite rapidly (approximately 2000 per second on an 11/44). Interrupt service routines are called in user mode but can only execute a limited set of system service calls (EMT's). Interrupt service routines can trigger the execution of interrupt completion routines to perform additional processing.

The third method for processing real-time interrupts is to connect the interrupt to an interrupt completion routine. Real-time interrupt completion routines have access to the full job context and can use most system service calls (EMT's), but have more overhead and should not be used for interrupts that occur more frequently than 200 times per second.

The following diagram illustrates the different levels of interrupt processing.

Interrupt Processing



This diagram shows that there are three "levels" of interrupt processing. Level 1 is entered when a hardware interrupt occurs. In this level the processor (hardware) priority is set to 7 which causes other interrupt requests to be temporarily blocked. After some brief interrupt entry processing, the system performs a .FORK operation which queues a request for processing at fork level and then drops the processor priority to 0. At this time another hardware interrupt can occur, in which case the cycle will be repeated and another request for fork level processing will be placed on the queue. Note that if .FORK requests are issued at a sustained high rate, such that numerous prior requests cannot be serviced, a system error may eventually occur.

Level 2 processing is also known as "fork level" processing. This level of interrupt processing services requests that were placed on a queue by the .FORK operation. Hardware interrupts are enabled during this processing and if any other interrupts occur their .FORK requests are placed at the end of the queue. Interrupt service requests are processed serially in the order that the interrupts occurred. Only two system service calls may be used from service routines running at fork level: a request to queue a user completion routine for subsequent processing; and the .RSUM EMT. Fork level processing also has associated priority levels. Real-time processing has the highest priority. For more information on prioritized .FORK requests, see the TSX-Plus System Manager's Guide.

Level 3 processing occurs in "job state". That is, the TSX-Plus job execution scheduler selects the highest priority job or completion routine and passes execution to it. Completion routines run with full job context and may issue system service calls (except USR calls) as needed. Completion routines are serialized for each job. That is, all other completion routines (including higher priority interrupt completion routines) which are scheduled for the same job are queued for execution and will not be entered until the current completion routine exits. During level 3 processing, interrupts are enabled and job execution may be interrupted to process fork level interrupt service routines or by higher priority completion routines for other jobs.

11.11.1 Interrupt service routines.

Interrupt service routines execute in user mode but require a minimal amount of system overhead. When an interrupt is received through a vector which has been connected to an interrupt service routine, TSX-Plus executes a .INTEN and a .FORK, sets up memory management for the appropriate job, saves the status of the floating point unit (FPU) if it is in use, and passes control to the interrupt service routine. Using this approach, interrupts may be serviced at about 2000 per second on a PDP-11/44. Lower rates should be expected on slower processors.

Several restrictions apply to this method of interrupt processing:

a) The job must be locked in memory before connecting to the interrupt vector and must remain locked in memory as long as the interrupt connection is in effect.

b) The processing done by the interrupt service routine should be brief since other interrupts that do .FORKs will be queued until the interrupt service routine exits.

c) Only two system service calls (EMTs) are valid within a interrupt service routine:

   1) A .RSUM EMT may be issued to cause the job's main-line code to continue processing if it has done a .SPND.

   2) The TSX-Plus EMT which schedules execution of a completion routine.

Access to the I/O page is possible if the main-line code sets up such mapping prior to the interrupt. Registers are undefined on entry to an interrupt service routine, and do not have to be preserved by the interrupt service routine.

An interrupt service routine must exit with a RETURN instruction (RTS PC), not an RTI. Since interrupt service routines execute at fork level, job scheduling is not relevant for them. All fork level processing, whether queued for system processing or for an interrupt service routine, is executed in the order in which the interrupts were received and execute before any completion routines, fixed-priority jobs or normal interactive time-sharing jobs.

Use of this EMT requires REALTIME privilege. The form of the request to connect an interrupt service routine to a vector is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   20,140
.WORD   vector-address
.WORD   service-routine
.WORD   0
```

where "vector-address" is the address of the interrupt vector to which the service routine is to be connected, and "service-routine" is the address of the entry point of the interrupt service routine.

The total number of vectors that can be connected either to interrupt service routines or interrupt completion routines is determined by the RTVECT parameter during TSX-Plus system generation.

Error:

Code	Meaning
0	Real time not included or job not privileged
1	Maximum number of vectors already in use
2	Some other job is already connected to that vector
3	Job is not locked in memory

The association between an interrupt service routine and an interrupt vector may be released by the same EMT as used to disconnect an interrupt completion routine. See the section on releasing an interrupt connection later in this chapter.

Example:

```
        .TITLE  INTSVC
        .ENABL  LC

;  Demonstrate EMT to implement an interrupt service routine
;  Simple file capture program. Steal a time-sharing line
;  and put everything that comes in on it into a file.

        .MCALL  .TTYIN,.TTYOUT,.EXIT,.PEEK,.POKE,.GVAL,.SCCA
        .MCALL  .ENTER,.LOOKUP,.CSISPC,.WRITE,.PURGE,.CLOSE,.DEVICE

VECTOR  = 330                   ;Serial line vector
RCSR    = 176530                ;Serial line RCSR address
RBUF    = RCSR+2                ;Serial input buffer address
BUFSIZ  = 256.                  ;Size of buffer in words
INTNBL  = 100                   ;Interrupt enable bit in RCSR
CTRLC   = 3                     ;ASCII control-C
CTRLD   = 4                     ;ASCII control-D

START:  .GVAL   #AREA,#-6.      ;See if job has SYSPRV
        TST     R0              ;1 if priv, 0 if not
        BEQ     QUIT            ;Immediate exit if not priv
        MOV     #LOKJOB,R0      ;Point to EMT arg block to
        EMT     375             ;Lock job in memory
        MOV     #MAPIO,R0       ;Point to EMT arg block to
        EMT     375             ;Map PAR7 into the I/O page

GETFIL: MOV     SP,SPSAVE       ;Save SP prior to CSI call
1$:     .CSISPC #OUTSPC,#DEFEXT,#0  ;Get file specification
        BCS     1$              ;Repeat until valid command line
        MOV     SPSAVE,SP       ;Restore SP, no valid switches
        .ENTER  #AREA,#0,#INSPC,#-1 ;Open largest possible output file
```

```
        BCS     1$              ;On error, ask for new file
        MOV     #BUFF1,BUFPTR   ;Initialize buffer pointer
        CLR     BLOCK           ;Initialize output file block count

; Set up to accept terminal commands
;   ctrl-c, ctrl-c to abort; ctrl-d to end transmission
        .SCCA   #AREA,#TTSTAT   ;Disable control-c abort
        MOV     #ACTCTD,R0      ;Point to EMT arg block to
        EMT     375             ;Activate input on ^D

; Since we are going to borrow a current time-sharing line, we need
; to save its vector pointers for later restoration
        MOV     @#RCSR,CSRSAV   ;Save old status bits, esp. int. enable
        .DEVICE #AREA,#DEVLST   ;Force restoration of RCSR on exit
        BIC     #INTNBL,@#RCSR  ;Disable interrupts until ready
        .PEEK   #AREA,#VECTOR   ;Get normal vector pointer
        MOV     R0,VECSAV       ;And save it for later restoration
        .PEEK   #AREA,#VECTOR+2 ;Get normal priority
        MOV     R0,VECSV2       ;And save it for later restoration

; Now attach interrupt service routine to input vector
        MOV     #INTSVC,R0      ;Point to EMT arg block to
        EMT     375             ;Schedule interrupt service routine
GO:     BIS     #INTNBL,@#RCSR  ;Enable interrupts and wait for input
        .TTYIN  INBUF           ;Wait for terminal command during transfer

; Resume here when transfer is complete, or want to abort
WHOA:   BIC     #INTNBL,@#RCSR  ;Disable interrupts (data lost if mistake)
        CMPB    INBUF,#CTRLC    ;Was it a control-c?
        BNE     5$              ;Branch if not
        .PURGE  #0              ;If CTRL-C, throw away input
        TST     TTSTAT          ;Did we get double control-c's?
        BEQ     GETFIL          ;If not, get another file name
        BR      QUIT            ;If double control-c, then abort
5$:     CMPB    INBUF,#CTRLD    ;Is the transmission done?
        BNE     GO              ;Branch if not
        CALL    FINISH          ;Write out remainder of current buffer
        .CLOSE  #0              ;If done, close out file

; Done or abort, restore time-sharing line conditions
QUIT:   MOV     #RELVEC,R0      ;Point to EMT arg block to
        EMT     375             ;Release interrupt connection
        .POKE   #AREA,#VECTOR+2,VECSV2 ;Restore old priority
        .POKE   #AREA,#VECTOR,VECSAV   ;And old vector pointer
        .EXIT                   ;And done!

; Interrupt service routine, executes at .FORK level

ISR:    MOVB    @#RBUF,@BUFPTR  ;Put char in buffer
        INC     BUFPTR          ;And point to next location
```

```
        CMP     BUFPTR,#BUFF2   ;Which buffer in use?
        BHI     1$              ;Branch if already in second
        BLO     9$              ;Return if first not full
        MOV     #BUFF1,WRTPTR   ;Exact end of buffer 1, point to it
        BR      2$              ;Schedule write
1$:     CMP     BUFPTR,#BUFEND  ;Second buffer full yet?
        BLO     9$              ;Not yet, return
        MOV     #BUFF1,BUFPTR   ;Second buffer full, reset pointer
        MOV     #BUFF2,WRTPTR   ;Point to second buffer for write

2$:     MOV     #SCHWRT,R0      ;Point to EMT arg block to
        EMT     375             ;Schedule completion routine
                                ;to write buffer to file

9$:     TST     TTSTAT          ;Does mainline want to quit? (^C^C)
        BEQ     10$             ;Branch if not
        BIC     #INTNBL,@#RCSR  ;If so, disable interrupts
10$:    RETURN                  ;Wait for another char
                                ;Note RTS PC, not RTI !

; Completion routine to save buffer to file

CMPRTN: .WRITE  #AREA,#0,R1,#256.,BLOCK ;Write buffer to file
        BCC     1$              ;Br if no error
        MOVB    CTRLC,INBUF     ;On error, set abort flags
        MOV     #-1,TTSTAT
        JMP     WHOA            ;Skip .TTYIN, and abort
1$:     INC     BLOCK           ;Point to next output block
        RETURN

; Routine to complete write of last block

FINISH: MOV     BUFPTR,R0       ;Get current buffer pointer
        MOV     #BUFF2,R1       ;Point to end of first buffer
        CMP     R0,R1           ;See which buffer in use
        BLO     1$              ;Skip if in first
        ADD     #2*BUFSIZ,R1    ;If in second, point to end
1$:     CLRB    (R0)+           ;Zero out buffer
        CMP     R0,R1           ;All the way to the end
        BLO     1$
        SUB     #2*BUFSIZ,R1    ;Now point back to buffer beginning
        CALL    CMPRTN          ;Call write routine (NOT AS COMPLETION)
        RETURN

; EMT arg block areas

AREA:   .BLKW   10              ;General EMT arg block

LOKJOB: .BYTE   13,140          ;EMT arg block to lock job in mem
```

```
MAPIO:  .BYTE   5,140           ;EMT arg block to map I/O page to PAR 7

ACTCTD: .BYTE   0,152           ;EMT arg block to
        .WORD   ^D              ;Set activation character
        .WORD   CTRLD           ;Control-D

INTSVC: .BYTE   20,140          ;EMT arg block to set up interrupt svc routine
        .WORD   VECTOR          ;Vector to attach
        .WORD   ISR             ;Address of Interrupt Service Routine
        .WORD   0               ;Required

SCHWRT: .BYTE   21,140          ;EMT arg block to sched compl routine
        .WORD   CMPRTN          ;Write buffer contents to file
        .WORD   7               ;Real-time priority (adds to PRIHI)
WRTPTR: .WORD   0               ;Passed in R1 to compl routine (buffer addr)
        .WORD   0               ;Required

RELVEC: .BYTE   12,140          ;EMT arg block to release interrupt connection
        .WORD   VECTOR          ;Vector to be released

; General storage

OUTSPC: .BLKW   15.             ;CSI output file specs
INSPC:  .BLKW   24.             ;CSI input file specs
DEFEXT: .WORD   0,0,0,0         ;No default file specs
SPSAVE: .WORD   0               ;Save stack pointer during CSI call
BLOCK:  .WORD   0               ;Output file block counter
TTSTAT: .WORD   0               ;SCCA terminal status word
VECSAV: .WORD   0               ;Save original vector contents
VECSV2: .WORD   0               ; and priority
DEVLST: .WORD   RCSR            ;.DEVICE restoration list
CSRSAV: .WORD   0               ;To hold original value of RCSR
        .WORD   0               ;End of list
BUFPTR: .WORD   0               ;Current input char pointer
INBUF:  .BYTE   0,0,0,0         ;Terminal command buffer
BUFF1:  .BLKW   BUFSIZ          ;1 block input buffer
BUFF2:  .BLKW   BUFSIZ          ;Second buffer
BUFEND:
        .END    START
```

11.11.2 Interrupt completion routines.

The TSX-Plus real-time support facility allows a program to connect a real-time interrupt to a completion routine. If this is done, TSX-Plus schedules the completion routine to be executed each time the specified interrupt occurs.

Interrupt completion routines have much greater flexibility than interrupt service routines, but require more overhead and are only capable of servicing interrupts at a lower rate. Interrupt completion routines run with full job context. This allows them to use all system service calls (except to the USR). Registers will be preserved between calls to the completion routine.

Real-time completion routines can service interrupts at rates up to about 200 interrupts per second. Devices which interrupt at a faster rate should be connected through an interrupt service routine or through a special device handler.

The total number of interrupt vectors that can be connected either to interrupt completion routines or interrupt service routines is determined by the RTVECT parameter during TSX-Plus system generation. It is possible for several interrupts to be connected to the same completion routine in a job but it is illegal for more than one job to try to connect to the same interrupt. When an interrupt completion routine is entered, R0 contains the address of the interrupt vector that caused the completion routine to be executed.

Real-time completion routines, whether directly connected to an interrupt or scheduled with the EMT for that purpose, have an associated job priority. These are software priorities, not hardware priorities; all completion routines are synchronized with the job and execute at hardware priority level 0. Completion routine priorities 1 and larger are classified as "real-time" priorities and are added to the system parameter PRIHI to yield the job execution priority, unless the resultant priority would exceed 127 in which case the priority will be 127. These completion routines will then be scheduled for execution whenever there are no executable jobs with a higher priority.

A real-time completion routine for one job will be suspended if an interrupt occurs which causes a higher priority completion routine to be queued for another job. However, a real-time completion routine for one job will never be interrupted by a completion routine for that same job regardless of the subsequent completion routine's priority. If additional requests are made to trigger the same or different completion routines while a completion routine is executing, the requests are queued for the job and are serviced in order based on their priority and the order in which they were queued.

A real-time completion routine is allowed to run continuously until one of the following events occurs: 1) the completion routine finishes execution and returns; 2) a higher priority completion routine from another job interrupts its execution -- it is re-entered when the higher priority routine exits; or 3) the completion routine enters a system wait state such as waiting for an I/O operation to complete or waiting for a timed interval. If a real-time completion routine enters a wait state, it returns to the same real-time priority when the wait condition completes.

Real-time completion routines with a priority of 0 are treated slightly differently than those with priorities greater than zero. The action taken depends on the priority of the main-line job when the completion routine is scheduled. If the base priority is equal to or greater than PRIHI, then the completion routine is treated just as those with real-time priorities greater than zero. That is, the completion routine is assigned a priority of PRIHI (PRIHI + the real-time priority of 0). On the other hand, if the base job priority is less than PRIHI, then the job is scheduled as a very high priority

normal (non-interactive) job. The effect of this is that completion routines with a real-time priority of 0 and a base job priority less than PRIHI will interrupt normal time-sharing jobs, but are time-sliced in the normal fashion and lose their high priority if they execute longer than the system parameter QUAN1A.

Jobs that have real-time, interrupt completion routines need not necessarily be locked in memory. If an interrupt occurs while the job is swapped out of memory, it is scheduled for execution like any other job and swapped in before the completion routine is executed. Note, however, that this condition is not optimal for timely servicing of interrupts.

When a real-time interrupt occurs, a request is placed in a queue to execute the appropriate completion routine. If the interrupt occurs again before the completion routine is entered, another request is placed in the queue so the completion routine will be invoked twice. A TSX-Plus fatal system error occurs if an interrupt occurs and there are no free completion routine request queue entries.

When a real-time completion routine completes its execution, it must exit by use of a RETURN instruction (RTS PC), not an RTI.

Use of this EMT requires REALTIME privilege. The form of the EMT used to connect an interrupt to a real-time completion routine is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   11,140
.WORD   interrupt-vector
.WORD   completion-routine
.WORD   priority
```

where "interrupt-vector" is the address of the interrupt vector, "completion-routine" is the address of the completion routine, and "priority" is the execution priority for the completion routine.

Error:

Code	Meaning
0	Real-time support not included or job not privileged
1	Maximum number of vectors already in use
2	Some other job is already connected to that vector
3	Job is not locked in memory

Example:

```
        .TITLE  ATTVEC
        .ENABL  LC

; Demonstrate TSX-Plus EMTs to attach a completion routine to an interrupt

CTRLC  = 3                      ;Control-C
ERRBYT = 52
RCSR   = 176540                 ;Serial line RCSR address
RBUF   = RCSR+2                 ;Line input buffer address

        .MCALL  .PRINT,.EXIT,.TTYOUT,.SPND,.RSUM

START:  MOV     #MAPIOP,R0      ;Point to EMT arg block to
        EMT     375             ;Map to I/O page
        BCC     1$              ;Branch if OK to map
        .PRINT  #NOPRIV         ;You aren't allowed to do that
        .EXIT

;+
;If this job were to be resident for a long time, it would be better
;to lock into low memory to avoid memory fragmentation by job swapping.
;However, since this job may have to be swapped now to get into low
;memory, locking into low memory takes longer to execute.
;
;1$:    MOV     #LOKLOW,R0      ;Point to EMT arg block to lock into low mem.
;-
1$:     MOV     #LOKJOB,R0      ;Point to EMT arg block to
        EMT     375             ;Lock the job in memory

        MOV     #ATTVEC,R0      ;Point to EMT arg block to
        EMT     375             ;Attach to an interrupt vector
        BCC     2$              ;Continue if OK
        .PRINT  #BADATT         ;Notify can't attach to interrupt
        MOVB    @#ERRBYT,R0     ;Find out which error
        ASL     R0              ;Convert to word offset
        .PRINT  ATTERR(R0)      ;And explain reason for error
        BR      3$              ;Go on to unlock and exit

2$:     .PRINT  #TYPE           ;Prompt for input from interrupting device
        .SPND                   ;Now wait for an interrupt
;. . .
                                ;Resume here on exit from completion code
        MOV     #RELVEC,R0      ;Point to EMT arg block to
        EMT     375             ;Release an interrupt vector
;+
; NOTE: Any interrupts through this vector after it has been released
;       will cause a TSX-Plus fatal system error - Unexpected Interrupt.
;-
```

```
3$:     MOV     #UNLOKJ,R0      ;Point to EMT arg block to
        EMT     375             ;Unlock this job from memory
        .EXIT

;+
; The following code will be executed as a completion routine
; when the device attached to the vector interrupts.
;-
                                ;Enter here when new character is available
CMPRTN: MOVB    @#RBUF,R0       ;Get the new character
        CMPB    R0,#CTRLC       ;Should we quit?
        BEQ     1$              ;Quit on ^C
        .TTYOUT                 ;Display the character
        MOV     #SETPRI,R0      ;Point to EMT arg block to
        EMT     375             ;Set processor priority (block interrupts)
;. . .                          ;Time critical processing goes here
        CLR     PRILEV          ;Set priority back down
        MOV     #SETPRI,R0      ;Point to EMT arg block to
        EMT     375             ;Set processor priority (reenable interrupts)
        BR      2$
1$:     .RSUM                   ;Return to main-line code
2$:     RETURN                  ;Wait for next interrupt (NOTE: Not RTI)


MAPIOP: .BYTE   5,140           ;EMT arg block to map to I/O page
LOKLOW: .BYTE   7,140           ;EMT arg block to lock job into low mem.
LOKJOB: .BYTE   13,140          ;EMT arg block to lock job in place
UNLOKJ: .BYTE   10,140          ;EMT arg block to unlock job from memory
ATTVEC: .BYTE   11,140          ;EMT arg block to attach to interrupt
        .WORD   340             ;Interrupt vector
        .WORD   CMPRTN          ;Address of completion routine
        .WORD   7               ;Real-time priority (NOT processor priority!)
RELVEC: .BYTE   12,140          ;EMT arg block to release interrupt vector
        .WORD   340             ;Interrupt vector
SETPRI: .BYTE   16,140          ;EMT arg block to set processor priority
PRILEV: .WORD   7               ;Desired priority level (modifiable)
ATTERR: .WORD   NOPRIV          ;Attach to interrupt error table
        .WORD   MAXINT
        .WORD   INUSE
        .NLIST  BEX
TYPE:   .ASCIZ  /Characters entered on serial line will be displayed here:/
BADATT: .ASCIZ  /?ATTVEC-F-Cannot attach to interrupt./<7>
NOPRIV: .ASCII  /Real-time support not specified during TSGEN or /
        .ASCIZ  /user not privileged./
MAXINT: .ASCIZ  /Maximum number of interrupts already in use./
INUSE:  .ASCIZ  /Another job already connected to interrupt./
        .END    START
```

11.12 Releasing an interrupt connection

A connection between an interrupt vector and an interrupt service routine or an interrupt completion routine remains in effect until the job exits or the following EMT is executed to release the connection. Use of this EMT requires REALTIME privilege.

Warning: An interrupt through a vector which has been released with this EMT or which was connected to a job that has terminated will cause a fatal system error: UEI-Interrupt occurred at unexpected location. This can be circumvented by including the vector in a .DEVICE list.

The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   12,140
.WORD   interrupt-vector
```

where "interrupt-vector" is the address of the interrupt vector whose connection is to be released.

Example:

See the example program ATTVEC in the section on connecting a real-time interrupt to a completion routine.

11.13 Scheduling a completion routine

Real-time programs may schedule a completion routine for execution with a special EMT provided for that purpose. This is particularly valuable from within interrupt service routines which do not have access to system service calls other than this EMT and the .RSUM request. The primary intent of this request is to provide a mechanism for access to system service calls from interrupt service routines. The form of this EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   21,140
.WORD   completion-routine
.WORD   priority
.WORD   R1-value
.WORD   0
```

where "completion-routine" is the address of the entry point of the completion routine that is being started, "priority" is the real-time priority level for the completion routine being started, and "R1-value" is a value to be placed in R1 on entry to the completion routine.

Completion routines scheduled in this manner follow the same rules as for interrupt completion routines described above, except that they are scheduled as a result of the EMT call rather than in response to an interrupt.

Example:

See the example program INTSVC in the section on connecting interrupts to real-time jobs/ interrupt service routines.

11.14 Adapting real-time programs to TSX-Plus

The following points should be kept in mind when converting an RT-11 real-time program for use under TSX-Plus.

1. The I/O page (160000-177777) is not directly accessible to the program unless the program executes the TSX-Plus real-time EMT that maps the job's virtual region to the I/O page or is started with the /IOPAGE switch to the R[UN] command.

2. If the program's virtual region 160000 to 177777 is mapped to the I/O page, the program must use .GVAL to access offsets in the simulated RMON.

3. Since FORTRAN uses PAR 7 to map to virtual arrays, if both direct I/O page access and FORTRAN virtual arrays are required in the same program, then some PAR other than 7 must be used to map to the I/O page.

4. Real-time interrupts are connected to interrupt service routines and interrupt completion routines by use of the TSX-Plus real-time EMT for that purpose. The program should not try to connect interrupts by storing into the interrupt vector cells.

5. The .PROTECT EMT is a no-op under TSX-Plus and always returns with the carry-flag cleared.

6. Interrupt service routines and completion routines connected to real-time interrupts should exit by use of a RTS PC instruction rather than RTI.

7. Programs that require very rapid response to interrupts should use the interrupt service routine method and must lock themselves in memory.

8. Real-time interrupts must not occur unless an interrupt service routine or completion routine is connected to the interrupt. If a real-time interrupt occurs with no associated interrupt service or completion routine, a fatal TSX-Plus system error (UEI) occurs and the "argument value" displays the address of the vector of the interrupt.

9. A higher priority real-time completion routine for one job will interrupt a lower priority completion routine being executed by another job but will not interrupt a lower priority completion routine being executed by the same job.

10. A real-time completion routine running at priority 1 or above is not time-sliced and will lock out all lower priority jobs until it completes its processing or enters a wait state.

12. SHARED RUN-TIME SYSTEM SUPPORT

TSX-Plus provides a facility that allows one or more shared run-time systems or data areas to be mapped into the address space of multiple TSX-Plus time-sharing jobs. There are two primary uses of this facility:

1. Memory space can be saved by having multiple jobs that use the same run-time system access a common copy rather than having to allocate space within each job for a copy.

2. Programs can communicate with each other through the use of a common shared memory region to which all of the communicating jobs have direct access.

To use this facility, information about all of the shared run-time systems must be declared when the TSX-Plus system is generated. During system initialization the shared run-time system files are opened and read into memory. These shared run-time systems remain in memory as long as the system is running and are never swapped out of memory even if there are no jobs actively using them.

The EMTs described below can be used to associate one or more shared run-time systems with a job. When such an association is made, a portion of the job's virtual memory space is mapped to allow access to part or all of one or more run-time systems.

12.1 Associating a run-time system with a job

The following EMT is used to associate a shared run-time system with a job. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   0,143
.WORD   name-pointer
```

where "name-pointer" is the address of a two word cell containing the six character name of the shared run-time system in RAD50 form. This name corresponds to the file name which was specified for the run-time system when TSX-Plus was generated. If the name pointer value is zero, the effect of the EMT is to disassociate all shared run-time systems from the job and to re-establish normal memory mapping for the job.

If the run-time system whose name is specified with this EMT is not recognized, the carry flag is set on return with an error code of 1.

The effect of this EMT is to associate a particular shared run-time system with the job. However, this EMT does not affect the memory mapping for the job or make the run-time system visible to the job; that is done by the EMT described below. If some other run-time system has been previously mapped into the job's region, that mapping is unaffected by this EMT. Thus it is possible to have multiple run-time systems mapped into the job's region by associating and

mapping them one at a time into different regions of the job's virtual memory space.

Example:

```
        .TITLE  USERTS
        .ENABL  LC
; Demonstration of TSX-Plus EMT to map to a shared run-time region
        .MCALL  .PRINT,.EXIT
PAR1    = 20000                 ;Base address of PAR 1 window
START:  MOV     #USERTS,R0      ;Point to EMT arg block to
        EMT     375             ;Associate a shared run-time region
        BCC     1$              ;Error?
        .PRINT  #NOSHRT         ;Can't find named shared run-time
        .EXIT
1$:     MOV     #MAPRTS,R0      ;Point to EMT arg block to
        EMT     375             ;Map to shared run-time system
2$:     CALL    @#<PAR1+200>    ;JSR to entry point in shared region
                                ;which prints some data from there.
        CLR     <USERTS+2>      ;Undeclare any shared run-times
        MOV     #USERTS,R0      ;Point to EMT arg block to
        EMT     375             ;Dissociate all shared regions
;. . .                          ;Go on with other processing
        .EXIT
USERTS: .BYTE   0,143           ;EMT arg block to associate
        .WORD   SHRNAM          ;Pointer to file name
SHRNAM: .RAD50  /RTCOM /        ;Shared region file name
MAPRTS: .BYTE   1,143           ;EMT arg block to map shared region
        .WORD   1               ;Map PAR 1
        .WORD   0               ;Offset into region
        .WORD   1000/64.        ;Size of region (64. byte blocks)
        .NLIST  BEX
NOSHRT: .ASCIZ  /Can't find the shared run-time system./<7>
        .END    START
```

The example program RTCOM declared in the above program was defined during TSX-Plus system generation with the RTDEF macro as follows:

```
RTDEF <SY RTCOM SAV>,RW,1
```

and the shared program itself was:

```
        .TITLE  RTCOM
        .ENABL  LC
; Demonstration shared run-time file
; (Position Independent Code.)
        .MCALL  .PRINT
        .NLIST  BEX
        .PSECT  RTCOM,I         ;RTDEF in TSGEN specifies
        ;skip 1 block so default start address of 1000 is OK
```

```
START:  .ASCII  /This data was produced by the /
        .ASCIZ  /RTCOM shared run-time region./
        . = START + 200          ;Entry point for shared code
ENTRY:: MOV     PC,R0            ;Find out where we are
        SUB     #<.-START>,R0    ;Point back to data area
        .PRINT  R0               ;Display what is there
        RETURN                   ;And go back to MAIN
        .END    ENTRY
```

12.2 Mapping a run-time system into a job's region

Once a shared run-time system has been associated with a job by use of the previous EMT, the run-time system (or a portion thereof) can be made visible to the job by mapping it into the job's virtual address region. The form of the EMT to do this is:

```
EMT     375
```

with R0 pointing to the following argument area:

```
.BYTE   1,143
.WORD   par-region
.WORD   run-time-offset
.WORD   mapped-size
```

The "par-region" parameter is a number in the range 0 to 7 that indicates the Page Address Register (PAR) that is to be used to access the run-time system. The PAR number selects the region of virtual memory in the job that will be mapped to the run-time system. The following correspondence exists between PAR numbers and virtual address regions within the job:

PAR	Address Range
0	000000 - 017777
1	020000 - 037777
2	040000 - 057777
3	060000 - 077777
4	100000 - 117777
5	120000 - 137777
6	140000 - 157777
7	160000 - 177777

The "run-time-offset" parameter specifies which portion of the run-time system is to be mapped into the PAR region. The "run-time-offset" specifies the number of the 64-byte block within the run-time system where the mapping is to begin. This makes it possible to access different sections of a run-time system at different times or through different regions.

The "mapped-size" parameter specifies the number of 64-byte blocks to be mapped. If this value is larger than can be contained within a single PAR

region, multiple PAR regions are automatically mapped as necessary to contain the entire specified section of the run-time.

If an error is detected during execution of the EMT, the carry-flag is set on return with an error code of 1 to indicate that there is no run-time system associated with the job.

This EMT only affects the mapping of the PAR region specified in the argument block (and following PAR's if the size so requires). It does not affect the mapping of any other PAR regions that may previously have been mapped to a run-time system. Thus a job may have different PAR regions mapped to different sections of the same run-time system or to different run-times. Real-time programs may map PAR 7 to the I/O page and also map other PAR regions to shared run-time systems.

The memory size of a job is not affected by the use of the shared run-time control EMTs. That is, mapping a portion of a job's virtual address space to a shared run-time system neither increases nor decreases the size of memory occupied by the job. If a job's size is such that a portion of its normal memory is under a PAR region that is mapped to a run-time system, that section of its normal memory becomes inaccessible to the job as long as the run-time system mapping is in effect, but the memory contents are not lost and may be re-accessed by disassociating all run-time systems from the job.

Note that any of the PAR regions may be mapped to a run-time system including PAR 7 (160000-177777).

Example:

See the example program USERTS in the section on associating a run-time system with a job.

13. TSX-Plus PERFORMANCE MONITOR FEATURE

TSX-Plus includes a performance analysis facility that can be used to monitor the execution of a program and determine what percentage of the run time is spent at various locations within the program. During performance analysis, TSX-Plus examines the program being monitored when each clock tick occurs (50 or 60 times per second) and notes at what location in the program execution is taking place. Once the analysis is completed the TSX-Plus performance reporting program (TSXPM) can be used to produce a histogram showing the percentage of time spent at various locations during the monitored run.

There are three steps involved in performing a performance analysis on a program:

1. Use the MONITOR command to begin the analysis.
2. Run the program to be monitored.
3. Run the TSXPM program to print a histogram of the result.

13.1 Starting a performance analysis

The first step in doing a performance analysis is to use the MONITOR keyboard command to tell TSX-Plus that a performance analysis is to be done on the program that will be run next. The form of the MONITOR command is:

MONITOR base-address,top-address[,cell-size]/switches

where "base-address" is the lowest address in the region to be monitored, "top-address" is the highest address in the region to be monitored, and "cell-size" is an optional parameter that specifies the number of bytes of address in the region being monitored to be grouped together into each histogram cell. If the "cell-size" parameter is not specified, TSX-Plus calculates the cell size by dividing the number of bytes in the region being monitored (base-address to top-address) by the total number of histogram cells available (specified when TSX-Plus is generated). This gives the finest resolution possible. The only available switch is "/I" which causes I/O wait time to be included in the analysis. If this switch is not specified, only CPU execution time is included in the analysis. A link map of the program should be available to determine the addresses in the program that are appropriate to monitor.

Examples:

```
MONITOR 1000,13000/I

MONITOR 20000,40000,10

MONITOR 2000,6000
```

The effect of the MONITOR command is to set up parameters within TSX-Plus which will be used to monitor the next program run. It does not actually begin the analysis, so there is no rush in running the program to be monitored. Once the MONITOR command has been issued, the program to be monitored is run by using

the standard "RUN" or "R" commands. If a program being monitored does a .CHAIN to another program, the analysis continues and the times reported will be the composite of the programs run.

Only one user may be doing a performance analysis at a time. This is because the performance analysis histogram buffer is a common memory area that may not be in use by more than one user at a time. An analysis is in effect for a user between the time the MONITOR command is issued and the TSXPM program is run to display the results of the analysis. Running the TSXPM program terminates the performance analysis and allows other users to perform analyses. Note that space for the performance analysis data buffer must be reserved when TSX-Plus is generated.

If the program to be monitored is overlayed and the region to be monitored is in the overlay area, the analysis technique is more complex. In this situation, the EMTs described below must be used to control the performance analysis as overlay segments are run in the segment being monitored.

13.2 Displaying the results of the analysis

After the program being monitored has exited and returned control to the keyboard monitor, the TSXPM performance reporting program is used to generate a histogram of the time spent in the region being monitored. The TSXPM program is started by typing "R TSXPM"; it responds by printing an asterisk ("*"). In response to the asterisk, enter the file specification for the device/file where the histogram is to be written. An optional switch of the form "/M:nnn" may be specified following the file specification. This switch is used to specify the minimum percentage of the total run-time that a histogram cell must contain in order to be included in the display. If this switch is not specified, the default cut-off percentage is 1%.

After receiving the file specification, TSXPM prompts for a title line. Enter a line of text which will be printed as a page title in the histogram file. Press RETURN if you wish no title.

The next item of information requested by TSXPM is a set of base offset values. The base offset values are optional. Base offsets are useful in the situation where you have several modules making up a program being monitored and you want the addresses displayed on the performance analysis histogram to be relative to the base of each module. You may specify up to 10 offset values. Each offset value is specified as an offset module number (in the range 0 to 9) followed by a comma and the base address of the module (see example below). If offset values are specified, TSXPM determines in which module each cell of the histogram falls and displays the address as a module number and offset within the module. After you enter all desired module offsets, enter RETURN without a value.

After the base offset values are entered, the histogram will be produced and written to the specified device and file. After the histogram is generated, TSXPM prints the asterisk prompt again, at which point you may enter the name

of another device/file and produce the histogram again or you may type control-C to return to the keyboard monitor.

Example use of TSXPM:

```
.R TSXPM
*LP:/M:5
Title:PERFORMANCE ANALYSIS OF EIGENVALUE CALCULATION
Base offsets:
>1,1000
>2,2134
>3,5212
>
     (Histogram is produced at this point)
*<CTRL-C>
```

The histogram produced by TSXPM consists of one line per histogram cell. Each line contains the following information: 1) the base module offset number (if offsets were specified); 2) the address range covered by the histogram cell (relative to the module base if base offsets were used); 3) the percentage of the total execution time spent at the address range covered by the histogram cell; 4) a line of stars presenting a graphic representation of the histogram.

13.3 Performance monitor control EMT's

For most applications the method described above can be used to do a performance analysis. However, in special cases (such as analyzing the performance of an overlayed program) it is necessary to have more explicit control over the performance analysis feature as a program is running. The following set of EMTs may be used to control a performance analysis.

13.3.1 Initializing a performance analysis.

This EMT is used to set up parameters that will control a performance analysis. It does not actually begin the analysis. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   0,136
.WORD   base-address
.WORD   top-address
.WORD   cell-size
.WORD   flags
```

where "base-address" is the address of the base of the region to be monitored, "top-address" is the address of the top of the region to be monitored, and "cell-size" is the number of bytes to group in each histogram cell. If 0 (zero) is specified as the cell size, TSX-Plus calculates the cell size to use by dividing the number of bytes in the region being monitored (top-address

minus base-address) by the number of cells available in the histogram data area (specified when TSX-Plus is generated). The "flags" parameter is used to control whether or not I/O wait time is to be included in the analysis. If a value of 1 is specified as the "flags" parameter, I/O wait time is included in the analysis; if a value of 0 (zero) is specified, I/O wait time is not included in the analysis.

Errors:

Code	Meaning
0	Performance analysis being done by some other user.
1	Performance analysis feature not included in TSX-Plus generation.

Example:

```
        .TITLE DEMOPA
        .ENABL LC

;  Demonstrate use of TSX-Plus EMT's to initialize, start, stop, and
;  terminate a performance analysis

        .MCALL  .EXIT,.PRINT,.LOOKUP,.READW,.CLOSE,.TTYOUT
        .GLOBL  PRTOCT                  ;Display an octal word in R0

ERRBYT  = 52                            ;EMT error byte
SPACE   = 40                            ;ASCII 'space'
STAR    = 52                            ;ASCII 'asterisk'

START:  MOV     #INITPA,R0              ;Point to EMT arg block to
        EMT     375                     ;Initialize the performance analysis
        BCC     5$                      ;No error
        MOVB    @#ERRBYT,R0             ;Which error?
        ASL     R0                      ;Convert to word offset
        .PRINT  INIERR(R0)              ;Print the error message
        .EXIT                           ;And depart this world of woe.

5$:     MOV     #STRTPA,R0              ;Point to EMT arg block to
        EMT     375                     ;Start the performance analysis
        BCC     10$                     ;No error
        .PRINT  #STRERR                 ;Start error
        .EXIT                           ;and depart.
10$:

; Dummy section of code to do some I/O and computation for analysis
BEGIN:  .LOOKUP #AREA,#0,#FILNAM
        MOV     #10,R1
; Disk I/O
1$:     .READW  #AREA,#0,#BUFFER,#256.,#0
        SOB     R1,1$
        .CLOSE  #0
```

```
; Terminal I/O
        .PRINT  #BUFFER
; Compute bound
        MOV     #123456,R3
2$:     MOV     #12345,R0
        CLR     R1
        DIV     #345,R0
        SOB     R3,2$
ENDB:
NCELLS  = <<ENDB-BEGIN>/2>              ;Number of cells in histogram

        MOV     #STOBLK,R0              ;Point to EMT arg block to
        EMT     375                     ;Stop the performance analysis
        BCC     15$                     ;Check for error return
        .PRINT  #STOERR                 ;Only one error - PA not initialized
        .EXIT                           ;and leave.

15$:    MOV     #HALBLK,R0              ;Put HALTPA block address in R0
        EMT     375                     ;Terminate the performance analysis
        BCC     20$                     ;Check for errors
        MOVB    @#ERRBYT,R0             ;Get error type
        ASL     R0                      ;Convert to word offset
        .PRINT  HLTERR(R0)              ;Print out proper error message
        .EXIT                           ;And depart.
20$:    TST     HALFLG                  ;Check HALTPA return flag
        BPL     25$                     ;No cell overflow?
        .PRINT  #OVRWRN                 ;Issue overflow warning
25$:    BIT     #1,HALFLG               ;I/O time included?
        BEQ     30$                     ;Skip message if not
        .PRINT  #IOWNOT                 ;Print I/O wait time included msg

; Print a histogram of the performance analysis
30$:    CLR     R3                      ;Set histogram cell counter
35$:    CMP     HSTTBL(R3),#64.         ;Normalize the table for 64. longest
        BHI     40$                     ;Too many counts?
        ADD     #2,R3                   ;Point to next cell
        CMP     R3,#<2*NCELLS>          ;End of table?
        BLE     35$                     ;No, repeat
        BR      50$                     ;All cells less than 64. counts now
40$:    CLR     R3                      ;Re-init. histogram cell counter
45$:    CLC                             ;Divide each cell count by 2
        ROR     HSTTBL(R3)
        ADD     #2,R3                   ;Point to next cell
        CMP     R3,#<2*NCELLS>          ;End of table?
        BLE     45$                     ;No, repeat
        BR      30$                     ;Go check all cells again
50$:    .PRINT  #HSTMSG                 ;Caption histogram
        MOV     #BEGIN,R2               ;Set first analyzed address
        CLR     R3                      ;Init. cell counter
55$:    MOV     R2,R0                   ;Get ready to print it out
```

```
        CALL    PRTOCT                  ;Display analyzed address
        .TTYOUT #SPACE                  ;For formatting
        MOV     HSTTBL(R3),R1           ;Get address use counter
        BEQ     65$                     ;No stars on 0 count
60$:    .TTYOUT #STAR                   ;Print a '*' for each count
        SOB     R1,60$
65$:    .PRINT  #CRLF                   ;Go to next line
        CMP     (R2)+,(R3)+             ;Point to next address and count
        CMP     R3,#<2*NCELLS>          ;End of histogram?
        BLE     55$                     ;No, display next cell
        .EXIT                           ;Else done.

INITPA: .BYTE   0,136                   ;EMT arg block for perform. analysis
        .WORD   BEGIN                   ;Start analysis address
        .WORD   ENDB-2                  ;End analysis address
        .WORD   2                       ;Count 1 address in each cell
        .WORD   1                       ;Include IO wait time.
STRTPA: .BYTE   1,136                   ;Start Performance Analysis EMT block
STOBLK: .BYTE   2,136                   ;EMT arg block to stop perf. analysis
HALBLK: .BYTE   3,136                   ;EMT arg block to release analysis
        .WORD   PRMBUF                  ;PA parameter buffer address
        .WORD   HSTTBL                  ;Histogram Table buffer address
        .WORD   <HSTEND-HSTTBL>         ;Histogram Table buffer length
PRMBUF: .BLKW   3                       ;PA four word parameter buffer
HALFLG: .WORD   0                       ;PA return flags
HSTTBL: .BLKW   <2*NCELLS>+2            ;Histogram table
HSTEND:
AREA:   .BLKW   10                      ;EMT arg block area
BUFFER: .BLKW   256.                    ;Data input buffer
        .WORD   0                       ;Make sure buffer is ASCIZ
FILNAM: .RAD50  /DK DEMOPAMAC/          ;Read this file
INIERR: .WORD   INPRG                   ;Initialize PA error table
        .WORD   NOGEN
HLTERR: .WORD   NOPA                    ;HALTPA Error message table
        .WORD   TOSMAL
        .NLIST  BEX
INPRG:  .ASCIZ  /?INITPA-F-Performance analysis being done by another user./
NOGEN:  .ASCIZ  /?INITPA-F-Performance analysis feature not genned./
NOPA:   .ASCIZ  /?HALTPA-F-This job is not doing a performance analysis./
TOSMAL: .ASCIZ  /?HALTPA-F-Area provided for histogram table too small./
STRERR: .ASCIZ  /?INITPA-F-Performance analysis not initialized yet./
STOERR: .ASCIZ  /?STOPPA-F-Performance Analysis has not been initialized./
OVRWRN: .ASCIZ  /?HALTPA-W-Some histogram cell(s) overflowed during analysis./
IOWNOT: .ASCIZ  | HALTPA-I-I/O wait time included in performance analysis.|
OKDONE: .ASCIZ  / STOPPA-S-Performance Analysis stopped./
HSTMSG: .ASCIZ  /Address        Frequency/
CRLF:   .ASCIZ  <15><12><200>
        .END    START
```

13.3.2 Starting a performance analysis.
This EMT is used to begin the actual collection of performance analysis data. The previous EMT must have been executed to set up parameters about the performance analysis before this EMT is called. The form of the EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   1,136
```

The carry-flag will be set on return from this EMT if performance analysis has not been initialized yet.

Example:

See the example program DEMOPA in the section on initializing a performance analysis.

13.3.3 Stopping a performance analysis.
The following EMT can be used to suspend the data collection for a performance analysis. The data collection can be restarted by using the start-analysis EMT described above. This EMT could, for example, be used to suspend the analysis when an overlay module is loaded that is not to be monitored. The start-analysis EMT would then be used to re-enable the data collection when the overlay of interest is re-loaded. The form of this EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   2,136
```

The carry flag will be set on return from this EMT if performance analysis has not been initialized yet.

Example:

See the example program DEMOPA in the section on initializing a performance analysis.

13.3.4 Terminating a performance analysis.
This EMT is used to conclude a performance analysis. It has the effect of returning into a user supplied buffer the results of the analysis and releasing the performance analysis feature for other users. The form of this EMT is:

```
EMT     375
```

with R0 pointing to the following argument block:

```
.BYTE   3,136
.WORD   parameter-buffer
.WORD   histogram-buffer
.WORD   buffer-size
```

where "parameter-buffer" is the address of a 4 word buffer into which will be stored some parameter values describing the analysis that was being performed, "histogram-buffer" is the address of the buffer that will receive the histogram count values, and "buffer-size" is the size (in bytes) of the histogram buffer area.

The values returned in the parameter buffer consist of the following 4 words: 1) base address of the monitored region; 2) top address of the monitored region; 3) number of bytes per histogram cell; 4) control and status flags. The control and status flags are a set of bits that provide the following information:

Flag	Meaning
1	I/O wait time was included in the analysis.
100000	Some histogram cell overflowed during the analysis.

The data returned in the histogram buffer consists of a vector of 16-bit binary values, one value for each cell in the histogram. The first value corresponds to the histogram cell that starts with the base address of the region that was being monitored.

Errors:

Code	Meaning
0	This job is not doing a performance analysis.
1	Area provided for histogram count vector is too small.

Example:

See the example program DEMOPA in the section on initializing a performance analysis.

14. TSX-Plus RESTRICTIONS

14.1 System service call (EMT) differences between RT-11 and TSX-Plus

The following list describes the differences in the way TSX-Plus implements some RT-11 system service calls (EMTs). If an EMT is not listed, it provides the same functions as described in the RT-11 Programmer's Reference Manual.

.ABTIO Action depends on setting of IOABT system parameter. If IOABT is set to 1 then .ABTIO operates the same as RT-11 and calls handler abort entry points. If IOABT is set to 0 then .ABTIO does not call handler entry points, but instead does a .WAIT on all channels. The default method of handling I/O abort requests is chosen during TSX-Plus system generation with the IOABT parameter. The I/O abort handling method may also be changed while TSX-Plus is running with the SET IO [NO]ABORT keyboard command.

.CDFN User jobs may not define more than 20 channels. If a .CDFN EMT is done, all channels are purged if a .CHAIN is done. If .CDFN is not done, channels are not purged across a chain.

.CHCOPY Not implemented.

.CNTXSW Not implemented.

.DEVICE REALTIME privilege is required to use this EMT.

.FETCH Returns in R0 the address specified for the handler load area. All TSX-Plus device handlers are resident, hence the .FETCH EMT performs no operation. If the device handler specified was not loaded during TSX-Plus initialization, then an error code of 0 is returned.

.FORK May be used in device handlers but not in user jobs.

.GTJB The job number returned in word 1 of the result area is two times the TSX-Plus line number. That is, the first line specified in the system generation will be number 2, the second 4, etc. Words 8 through 12 of the result area are not altered by this EMT.

.GVAL Not all of the fixed offsets documented by RT-11 are supported by TSX-Plus. Additional negative offsets are available to obtain TSX-Plus system values. See Chapter 7 for more information on .GVAL.

.HRESET Action depends on setting of IOABT system generation parameter. If IOABT is set to 1 then .HRESET calls handler abort entry points. If IOABT is set to 0 then .HRESET does not call handler entry points but instead does a .WAIT on all channels. Messages queued on named message channels are not canceled. Otherwise, this EMT operates the same as under RT-11.

.INTEN May be used in device handlers but not in user jobs.

Restrictions

.LOCK The TSX-Plus file management module (USR) is always "resident" and the .LOCK EMT is ignored.

.MTxxxx Multi-terminal control EMT's (.MTIN, .MTOUT, .MTPRNT, etc.) are not supported.

.MTPS The processor priority level may not be changed from user mode, hence this macro performs no operation. TSX-Plus provides a special real-time EMT to set the processor priority.

.MWAIT Not supported. See the chapter that describes inter-job message communication.

.PEEK Non-privileged jobs may use .PEEK to access cells within the simulated RMON (addresses 160000 to 160626) although the .GVAL EMT is a recommended alternative. Jobs with MEMMAP privilege may use .PEEK to access the I/O page or low memory cells in kernel space. References to addresses in the virtual address range of the simulated RMON (160000 to 160626) are always directed to RMON rather than the I/O page.

.POKE Non-privileged jobs may use .POKE to access cells within the simulated RMON (addresses 160000 to 160626) although the .PVAL EMT is a recommended alternative. Jobs with MEMMAP privilege may use .POKE to access the I/O page or low memory cells in kernel space. References to addresses in the virtual address range of the simulated RMON (160000 to 160626) are always directed to RMON rather than the I/O page.

.PROTECT Not supported. See the chapter on real-time programming for information about how to connect an interrupt to a TSX-Plus job.

.QSET TSX-Plus uses an internal pool of I/O queue elements for all jobs hence it is not necessary to define additional I/O queue elements in order to perform overlapped I/O. The .QSET EMT is ignored. On return, R0 contains the address specified for the start of the new elements.

.RCVD Not supported. See the chapter that describes inter-job message communication.

.RELEAS This EMT is ignored. Refer to .FETCH.

.SETTOP Returns the job limit in R0 but does not actually expand or contract the allocated job region. The job region allocation can be changed by use of the MEMORY keyboard command or the TSX-Plus specific EMT for this purpose.

.SDAT Not supported. See the chapter that describes inter-job message communication.

.SFPA This EMT functions the same as RT-11. It must be used if a job is going to use the floating-point unit.

.SDTTM OPER privilege is required to use this EMT.

.SPFUN SPFUN privilege is required to use this EMT.

.SRESET Messages queued on named message channels are not canceled. Otherwise, this EMT operates the same as under RT-11.

.SYNCH May be used in handlers but not in user jobs. When used in a handler, the number of the TSX-Plus job that is being synchronized with must be stored in word 2 of the SYNCH block.

.TLOCK This EMT is ignored.

.TTINR Only honors bit 6 in the Job Status Word (TCBIT$) if a SET TT NOWAIT command has been issued, or the running program has send the "U" program controlled terminal option to the system, or the program was R[UN] with the /SINGLECHAR switch.

.TTOUTR Returns with the carry bit set if the terminal output buffer is full. The following conditions must be met:

1. The .TTOUTR EMT must be used rather than .TTYOUT.
2. The instruction following the .TTOUTR must not be [BCS .-2].
3. Bit 6 must be set in the job status word.
4. The program must be run in single-character activation mode or with the NOWAIT attribute set.

.UNLOCK This EMT is ignored.

.UNPROT Not supported. See the chapter on real-time programming for information about how to connect an interrupt to a TSX-Plus job.

A full list of RT-11 compatible and TSX-Plus specific EMTs is included in Appendix D. The list indicates the level of support TSX-Plus provides for each RT-11 compatible EMT.

14.2 Programs Not Supported by TSX-Plus

Most programs which run under RT-11 will run under TSX-Plus without change.

The TSX-Plus program debugging facility (see Appendix I) should be used rather than ODT.

The FORMAT program may not be used under TSX-Plus.

The BATCH RT-11 facility is not supported by TSX-Plus.

The logical subset disk feature is provided internally to TSX-Plus and therefore does not use the LD pseudo-device handler.

The single line editor feature is provided as an optional system overlay region with TSX-Plus and does not use the SL pseudo-device handler.

The VM handler supplied with TSX-Plus was written specially for use with TSX-Plus and is not the same as the DEC VM handler.

The QUEUE package (QUEUE and QUEMAN) is not supported by TSX-Plus.

The RESORC utility is not supported.

14.3 Special program suggestions

Certain programs use system resources in ways which may not seem obvious or cause behavior which is not expected. Some of those features are described in this section to facilitate their use with TSX-Plus.

14.3.1 DIBOL:

When DIBOL programs are run under TSX-Plus they must use SUD rather than TSD. Several components of the DIBOL system also use I/O channel numbers above 15 (decimal). Reducing the TSGEN parameter NUCHN from the default of 20. can result in the error ?INI-E3 or ?INI-E4 when using DIBOL or its utilities. This can be resolved either by patching SUD or the utility to use lower channel numbers or by regenerating TSX-Plus to permit use of higher channel numbers. Set the TSGEN parameter NUCHN to 20., reassemble TSGEN, and relink TSX-Plus.

Keep in mind that record locking does not automatically occur when DIBOL is used with TSX-Plus and unless the appropriate TSX-Plus record locking calls are made there is a danger of file corruption. Appendix B describes subroutines which may be linked into DIBOL programs to provide access to TSX-Plus record locking and inter-program messages. Do not use the DIBOL SEND statement, use an equivalent XCALL MSEND instead.

14.3.2 DU device handler:

The DU device handler is used to access several types of devices, including large disks (like the RA-80). Because the RT-11 directory structure cannot support disk block numbers larger than 65535, this restricts the size of disks which may be used with RT-11 and TSX-Plus. Some devices using the MSCP protocol through the DU handler may be partitioned into several smaller devices to alleviate the block number problem. In order to use such devices with TSX-Plus, first boot RT11XM, partition DU as desired using the SET command, and finally copy the handler (now with the appropriate options set) to use with TSX-Plus. A typical sequence of commands might look like:

```
BOOT SY:RT11XM
SET DU0 UNIT=0,PORT=0,PART=0
SET DU1 UNIT=0,PORT=0,PART=1
SET DU2 UNIT=0,PORT=0,PART=2
SET DU3 UNIT=0,PORT=0,PART=3
SET DU4 UNIT=1
BOOT SY:RT11SJ
COPY/SYS SY:DUX.SYS SY:DU.TSX
R TSX
```

14.3.3 IND .ASKx timeouts:

When using the IND control file processor, the .ASKx directives provide an optional timeout parameter. This parameter causes IND to proceed when no terminal response is obtained before the designated timeout period. When using .ASKx timeouts under TSX-Plus, it is necessary to SET TT NOWAIT to permit IND to proceed when the timeout period expires.

14.3.4 FORTRAN virtual arrays:

When the object-time system for FORTRAN-IV is generated, three options are available relating to use of virtual arrays: NOVIR, VIRP, or VIRNP. If virtual arrays are to be used at all, either VIRP or VIRNP must be selected. Under RT11SJ, the VIRNP option is commonly selected. This causes FORTRAN virtual array handling to directly manipulate the memory management registers in the I/O page. Clearly, in a multi-user environment, like TSX-Plus, this is not advisable. The VIRP option is used with RT11XM and must also be selected for use with TSX-Plus. TSX-Plus must also be generated with PLAS support; see your system manager. If the wrong type of virtual array support is selected, various types of FORTRAN errors may occur, including virtual array initialization failures.

FORTRAN-IV uses PAR 7 to map to virtual arrays. (Page Address Register 7 maps virtual addresses 160000 to 177777.) TSX-Plus normally maps a job's PAR 7 to a simulated RMON so that older programs which require direct access to fixed offsets in RMON may operate without modification. When a program requires direct access to the I/O page to manipulate device registers, that is commonly done by mapping PAR 7 to the I/O page. This can either be done with the /IOPAGE switch to the R[UN] command or with a TSX-Plus EMT. Mapping PAR 7 to the I/O page only conflicts slightly with direct RMON access since the parameters available there may also (and should be) obtained with the .GVAL request (SYSLIB ISPY function). However, because use of FORTRAN virtual arrays also affects PAR 7 mapping, mapping PAR 7 to the I/O page causes more severe problems when programs must have both virtual arrays and direct I/O page access. The solution to this is to map some other part of the job's virtual address space to the I/O page. TSX-Plus provides an EMT to map any part of a job's address space to any physical region, including the I/O page. See Chapter 11 for information on mapping to a physical region to resolve the virtual array vs. I/O page conflict. Note that mapping to the I/O page or to physical memory requires MEMMAP privilege.

14.3.5 MicroPower/Pascal:

Various program components of MicroPower/Pascal (TM of Digital Equipment Corporation) should be run as virtual programs. That is, they should run without direct RMON access. Under TSX-Plus, this permits them to obtain a virtual job address space of a full 64Kb. TSX-Plus must also be generated to allow 64Kb jobs. To define the Pascal compiler and the PASDBG and MIB programs as virtual jobs, use the SETSIZ program (see Appendix A) to allow a 64Kb memory partition for them. For example:

```
.R SETSIZ
*SY:PASDBG/T:64.
*^C
```

14.3.6 Overlaid programs:

TSX-Plus permits programs to open I/O channels 0 through 23 (octal). However, the overlay handler uses channel 17 (octal). Therefore, overlaid programs should not use I/O channel 17 (octal).

14.3.7 VTCOM:

The communication program VTCOM supplied with RT-11 is used for connecting a terminal on one computer system as a virtual terminal on another computer system and for file transfers between two systems. The XM version of VTCOM (VTCOM.SAV, not VTCOM.REL) must be used with TSX-Plus, and this requires that TSX-Plus be generated to include PLAS (XM) support. This is controlled by the TSGEN parameter SEGBLK. If no other use is planned for PLAS regions, then a SEGBLK size of 100. is more than adequate to support VTCOM. Under RT-11, VTCOM uses the XL device handler for the low-level interface protocol. Under TSX-Plus, the CL facility replaces the XL handler and provides more flexibility in use of communication lines. CL units may either be designated as dedicated CL lines and used only as I/O devices, or may be used to "take over" inactive time-sharing lines. Either type of CL unit may be used with VTCOM. However, whichever CL unit is attached to the remote computer (possibly through a modem) must be assigned the device name XL (XC on the Pro 350) so that VTCOM can access it. The designated CL unit should also be set NOLFOUT. To avoid interference between two persons attempting to access the same CL unit at the same time (and thereby causing great confusion) the designated CL unit should also be allocated for exclusive use. The following example command file indicates how a time-sharing line may be "taken over" and used with the VTCOM program.

```
SET CL0 LINE=6      !Take over time-sharing line
ASSIGN CL0 XL       !Assign for VTCOM
ALLOCATE XL         !Prevent multi-user collisions
SET XL NOLFOUT      !Inhibit line feed transmission
R VTCOM             !Part of RT-11 5.01 distribution
!Communicate with remote system
DEALLOCATE XL       !Let others use CL0
DEASSIGN XL         !Clean up assignment
SET CL0 LINE=0      !Re-enable time-sharing line
```

Appendix A -- SETSIZ PROGRAM

The SETSIZ program can be used to store into a SAV file information about how much memory space should be allocated for the program when it is executed. SETSIZ can also be used to set the "virtual job" flag in the job status word (JSW) for a program.

There are three ways that the amount of memory allocated to a job can be controlled:

1. The TSX-Plus EMT with function code 141 (described in Chapter 7) may be used by a running program to dynamically set the job's size.

2. If a size is specified in a SAV file (by use of the SETSIZ program) the specified amount of memory is allocated for the program when it is started.

3. If no size is specified in the SAV file, the size specified by the last MEMORY keyboard command is used.

Note that the .SETTOP EMT does not alter the amount of memory space allocated to a job but can be used by a running program to determine the amount of memory allocated.

The effect of the SETSIZ program is to store into location 56 of block 0 of the SAV file the number of K-words of memory to allocate for the program when it is run (the LINK "/K:n" switch can also be used to do this). This value has no effect when the SAV file is run under RT-11 but causes TSX-Plus to allocate the specified amount of memory when starting the program.

If a size value is specified in a SAV file, it takes precedence over the size specified by the last MEMORY keyboard command. The TSX-Plus EMT with function code 141 may still be used to dynamically alter the memory allocation while the program is running.

Most programs allocate memory in two ways: 1) a static region that includes the program code and data areas of fixed size; 2) a dynamic region that is allocated above the static region -- usually the .SETTOP EMT is used to determine how much dynamic space is available to the program. The size of the static region for a program is fixed at link time. If the program is overlaid the static region includes space for the largest overlay segment as well as the program root. Location 50 in block 0 of the SAV file is set by the linker to contain the address of the highest word in the static region of the program.

The amount of memory space to be allocated for a SAV file can be specified to the SETSIZ program in either of two ways: 1) as the total amount of memory for the program which includes space for the static plus dynamic regions; or 2) as the amount of memory for the dynamic region only, in which case SETSIZ automatically adds the size of the static region.

A.1 Running the SETSIZ program

The SETSIZ program is started by use of the command

```
R SETSIZ
```

it responds by displaying an asterisk to prompt for a command line. The form of the command line is:

```
*filespec/switch:value
```

Where "filespec" is a file specification of the standard form dev:name.ext with the default device being "DK" and the default extension being "SAV".

If a file specification is entered without a switch, SETSIZ displays information about the size of the SAV file and the SAV file is not altered.

SETSIZ also displays the following status message if the SAV file is flagged as being a virtual image.

```
Virtual-image flag is set
```

The virtual message is displayed if either of the following two conditions exist for the SAV file:

1. Bit 10 (mask 2000) is set in the job status word (location 44) of the SAV file.

2. Location 0 of the SAV file contains the RAD50 value for "VIR".

These are the same two conditions that cause TSX-Plus to recognize the SAV file as being a virtual image when it is started.

Examples:

```
.R SETSIZ
*TSTPRG
Base size of program is 22Kb
Size of allocation space is 28Kb
*SY:PIP
Base size of program is 10Kb
Size of allocation space is 22Kb
*PROG1
Base size of program is 31Kb
No allocation size specified in SAV file
Virtual-image flag is set
```

A.2 Setting total allocation for a SAV file

The "/T" switch is used to specify the total amount of memory space to be allocated for a program when it is run. The form of the /T switch is "/T:value." where "value" is the number of K-bytes of memory to allocate. Note that a decimal point must be specified with the value if it is entered as a decimal value.

If the "/T" switch is used without a value, the effect is to clear the TSX-Plus size allocation information in the SAV file.

Examples:

```
.R SETSIZ
*SY:PIP/T:18.
*TSTPRG/T:32.
*PROG1/T
```

A.3 Setting amount of dynamic memory space

The "/D" switch is used to specify the amount of dynamic memory space to be reserved for a program. The SETSIZ program calculates the total amount of space to allocate for the program by adding the static size (stored in location 50 of the SAV file by LINK) to the specified dynamic size. The form of the /D switch is "/D:value." where "value" is the number of K-bytes of dynamic memory space to reserve. If a program does not use any dynamic memory space, the /D switch may be used without an argument value to cause the total memory space allocation to be set equal to the static size of the program. FORTRAN programs use dynamic space for I/O buffers and the exact amount required depends on the number of I/O channels used. However, 4 Kb of dynamic memory space seems to be adequate for most FORTRAN programs.

Examples:

```
.R SETSIZ
*SY:PIP/D:11.
*TSTPRG/D:4.
*PROG1/D
```

A.4 Setting virtual-image flag in SAV file

The "/V" switch is used to cause SETSIZ to set the virtual-image flag in the SAV file. This flag is bit 10 (mask 2000) in the job status word (location 44) of the SAV file.

Setting this flag indicates that the program will not directly access RMON, although it may do so indirectly by use of the .GVAL and .PVAL EMT's. The significance with regard to TSX-Plus is that it allows the program to use more than 56 Kb (if that much memory is also allowed by use of a MEMORY command). The virtual-image flag should not be set unless you are sure the job does not need direct access to the RMON area.

Appendix B -- DIBOL TSX-Plus SUPPORT SUBROUTINES

A set of subroutines is provided with TSX-Plus to perform DIBOL record locking and message transmission functions. DIBOL ISAM files are not supported by TSX-Plus. These subroutines may not be used with DBL, which provides most of their functionality separately. Note that if these TSX-Plus features are to be used, they must be enabled when the TSX-Plus system is generated.

B.1 Record locking subroutines

The record locking subroutines coordinate access to a common file being shared and updated by several TSX-Plus users. The five subroutines parallel the operation of the DIBOL statements: OPEN, CLOSE, READ, WRITE and UNLOCK. The normal DIBOL I/O statements cannot be used to perform record locking under TSX-Plus.

Opening the file

The first subroutine is used to open a shared file in update mode. The form of the call is:

```
XCALL FOPEN(chan,devlbl,errflg)
```

where

chan = A decimal expression that evaluates to a number in the range 1-15. This is the channel number used in associated calls to FREAD, FWRIT, FUNLK and FCLOS subroutines.

devlbl = The name of an alphanumeric literal, field or record that contains the file specification in the general form: dev:filnam.ext

The file size must not be specified with the file name. An optional "/W" switch may be appended to the file name to cause the "WAITING FOR dev:file" message to be printed.

errflg = A numeric variable capable of holding at least two digits into which is stored an indication of the result of the FOPEN call. The following values are returned:

Value	Meaning
0	No error. File is open and ready for access.
17	File name specification is invalid.
18	File does not exist or channel is already open.
72	Too many channels are open to shared files. Re-gen TSX-Plus and increase the value of MAXSFC parameter.
73	Too many shared files are open. Re-gen TSX-Plus and increase the value of MAXSF parameter.

The FOPEN subroutine should only be used to open files that will be updated by several users. The normal DIBOL OPEN READ/WRITE sequence should be used for other files. Several files may be opened for update by calling FOPEN with different channel numbers. The ONERROR DIBOL statement does not apply to these record locking subroutines. Instead the "errflg" argument is used to indicate the outcome of the operation.

Locking and reading a record

The FREAD subroutine is used to lock and read a record. The form of the call is:

XCALL FREAD(chan,record,rec #,'T' or 'W',errflg)

where

chan = Decimal expression in the range 1-15 that identifies a channel previously opened by FOPEN.

record = Name of the record or alphanumeric field in which the record read is to be placed.

rec # = Decimal expression that specifies the sequence number of the record to be read. This value must be between 1 and the total number of records in the file. It may be larger than 65535.

'T'/'W' = If 'T' is specified as the fourth parameter, FREAD will return a value of 40 in errflg if the requested record is locked by some other user. If 'W' is specified, FREAD will wait until the record is unlocked by all other users and will never return the record-locked error code.

errflg = Decimal variable into which is stored one of the following values:

Value	Meaning
0	No error. Record has been locked and read.
1	End-of-file record has been read.
22	I/O error occurred on read.
28	Invalid record number (possibly beyond end of file).
40	Record locked by another user. (Only returned if 'T' is specified as fourth argument.)
71	Channel was not opened by calling FOPEN, or channel not open.
72	Request to lock too many blocks in file. Re-gen TSX-Plus and increase value of MXLBLK parameter.

The FREAD subroutine functions like the DIBOL READ statement. However, whereas the DIBOL READ statement always returns an error code (40) if the requested record is locked, FREAD offers the user a choice: If 'T' is specified as the fourth argument to FREAD, a code of 40 will be returned in errflg if the record is already locked. If 'W' is specified as the fourth argument and the record is locked, FREAD does not return an error code, but rather waits until the requested record is unlocked. It is much more efficient to wait for a locked record by using the 'W' option rather than re-executing the FREAD with the 'T' option. It may be desirable to perform the first FREAD using the 'T' option. If the record is locked a "WAITING FOR RECORD..." message can be displayed on the user's console and another FREAD can be issued with the 'W' option to wait for the record. On return from this FREAD the "WAITING" message can be erased.

Note that although record locking is requested on a record-by-record basis, the actual locking is done on a block-within-file basis. (A block contains 512 characters). The result of this is that a record is locked if any record contained in the same block(s) as the desired record is locked.

Once a record is locked and read using FREAD, the record remains locked until the program performs one of the following operations:

1. Issues an FWRIT to the channel from which the record was read.
2. Issues another FREAD to the channel.
3. Issues an FUNLK to the channel.
4. Issues an FCLOS to the channel.
5. Terminates execution by use of the STOP statement or because of an error.

The same set of rules that apply to the DIBOL READ statement apply to FREAD.

Writing a record

The FWRIT subroutine is called to write a record to a shared file. The form of the call is:

```
XCALL FWRIT(chan,record,rec #,errflg)
```

where

chan = Channel number associated with the file.

record = Name of the record or alphanumeric field that contains the record to be written.

rec # = Decimal expression that specifies the sequence number of the record to be written. It may be larger than 65535.

errflg = Decimal variable into which is stored one of the following values:

Value	Meaning
0	No error.
22	I/O error occurred during write or channel is not open.
28	Bad record number specified.

The FWRIT subroutine writes the indicated record to the file then unlocks any blocks that were locked by the program. FWRIT appends a <CR><LF> to the end of the written record as does the DIBOL WRITE statement. The rules for the DIBOL WRITE statement also apply to FWRIT.

Unlocking records

The FUNLK subroutine is used to unlock records that were locked by calling FREAD. The form of the call is:

```
XCALL FUNLK(chan)

chan =    Channel number.
```

Closing a shared file

The FCLOS subroutine is called to close a channel that was previously opened to a shared file by calling FOPEN. The form of the call is:

```
XCALL FCLOS(chan)

chan =    Channel number.
```

FCLOS unlocks any locked records and closes the file. Other users accessing the file are unaffected. After calling FCLOS, the channel may be reopened to some other file.

Record Locking Example

In the following example a program performs the following functions:

1. Opens a shared file named "INV.DAT" on channel 2.
2. Reads a record whose record number is stored in RECN into the field named ITEM and waits if the record is locked by another user.
3. Updates the information in the record.
4. Rewrites the record to the same position in the file.
5. Closes the shared file.

```
XCALL FOPEN(2,'INV.DAT',ERRFL)
XCALL FREAD(2,ITEM,RECN,'W',ERRFL)
;<update record>
XCALL FWRIT(2,ITEM,RECN,ERRFL)
XCALL FCLOS(2)
```

Modifying programs for TSX-Plus

It is a straightforward process to modify DIBOL programs to use the TSX-Plus record locking subroutines. OPEN, CLOSE, READ, WRITE, and UNLOCK statements that apply to shared files must be replaced by the appropriate subroutine calls. Error conditions must be tested by IF statements following the subroutine calls rather than by using the ONERROR statement.

B.2 Message communication subroutines

Three subroutines are included in the DIBOL support package to allow programs to transfer messages to each other. When running under TSX-Plus these subroutines must be used instead of the DIBOL SEND and RECV statements.

Message Channels

Messages are transferred to and from programs by using TSX-Plus "Message Channels". A message channel accepts a message from a sending program, stores the message in a queue associated with the channel and delivers the message to a receiving program that requests a message from the channel. Message channels are totally separate from I/O channels. The total number of message channels is defined when TSX-Plus is generated.

Each active message channel has associated with it a one to six character name that is used by the sending and receiving programs to identify the channel. The names associated with the channels are defined dynamically by the running programs. A message channel is said to be "active" if any messages are being held in the queue associated with the channel or if any program is waiting for a message from the channel. When message channels become inactive they are returned to a free pool and may be reused by another program.

The DIBOL SEND command directs a message to a program by using the name of the receiving program. Under TSX-Plus, a sending program transmits a message using an arbitrary channel name. Any program may receive the message by using the same channel name when it requests a message.

Sending a Message

The MSEND subroutine is called to queue a message on a named channel. If other messages are already pending on the channel the new message is added to the end of the list of waiting messages. The form of the call is:

```
XCALL MSEND(chan,message,errflg)
```

where

chan = alphanumeric literal or variable that contains the channel name (1 to 6 characters).

message = alphanumeric or decimal literal, field or record that contains the message to be sent.

errflg = decimal variable into which will be stored one of the following values:

Value	Meaning
0	No error. Message has been sent.
1	All message channels are busy. (Re-gen TSX-Plus and increase the value of MAXMC parameter).
2	Maximum allowed number of messages are being held in message queues. (Re-gen TSX-Plus and increase the value of MAXMSG parameter).

Note that the maximum message length that may be transferred is defined during system generation by the MSCHRS parameter. If a message longer than this is sent, only the first part of the message will be delivered.

Checking for Pending Messages

The MSGCK subroutine may be called to determine if any messages are pending on a named channel. The form of the call is:

```
XCALL MSGCK(chan,message,errflg)
```

where

chan = alphanumeric literal or variable that contains the name of the channel (1 to 6 characters).

message = alphanumeric or decimal field or record where the received message is to be placed.

errflg = decimal variable into which will be stored one of the following values:

Value	Meaning
0	No error. A message has been received.
3	No message was queued on the named channel.

If a received message is shorter than the receiving message field the remainder of the field is filled with blanks. If the message is longer than the field, only the first part of the message is received.

Waiting for a Message

The MSGWT subroutine is used by a receiving program to suspend its execution until a message is available on a named channel. It is much more efficient for a program to wait for a message by calling MSGWT rather than repeatedly calling MSGCK. The form of the call is:

```
XCALL MSGWT(chan,message,errflg)
```

where the arguments have the same meaning as for MSGCK, and the following values may be returned in errflg.

Value	Meaning
0	No error. A message has been received.
1	All message channels are busy.

Message Examples

In the following example a program sends a message to another program by using a message channel named "SORT" and then waits for a reply to come back through a message channel named "REPLY".

```
XCALL MSEND('SORT','DK:PAYROL.DAT',ERRFL)
IF(ERRFL.NE.0)GO TO ERROR
XCALL MSGWT('REPLY',MSGBF,ERRFL)
IF(ERRFL.NE.0)GO TO ERROR
```

B.3 Using the subroutines

The subroutines described above are part of the MACRO program called "DTSUB.MAC". Once assembled, the object file for DTSUB (DTSUB.OBJ) may be linked with DIBOL programs that use the record locking or message facilities. An example of a LINK command is shown below.

```
.R LINK
*PROG=PROG,DTSUB,DIBOL
```

B.4 Miscellaneous functions

Determining the TSX-Plus line number

The TSLIN subroutine can be called to determine the number of the TSX-Plus time-sharing line from which the program is being run. Real lines are numbered consecutively starting at 1 in the same order they are specified when TSX-Plus is generated. Detached job lines occur next and subprocesses are numbered last.

The form of the call of TSLIN is:

```
XCALL TSLIN(lnum)
```

where "lnum" is a numeric variable capable of holding at least two digits into which is stored the TSX-Plus line number value.

Appendix C -- FILTIM PROGRAM

In addition to the date of creation of a file, TSX-Plus also stores file creation times in device directories. At the time a file is closed, the current time of day is automatically stored in the sixth word of the directory entry for that file. Under RT-11, this word is unused for permanent files and contains the job and channel number for tentative file entries. In order to represent the time as a positive 16-bit value, the time is converted to an integer representing the number of 3 second intervals since midnight. For example, if a file were closed at 11:13:22, then the sixth word of the permanent directory entry for that file would contain 13467 (32233 octal).

```
11 hr * 60 min/hr * 60 sec/min / 3 sec/interval = 13200
        13 min    * 60 sec/min / 3 sec/interval =   260
                    22 sec     / 3 sec/interval =     7
                                                   -----
                                                   13467
```

An EMT to obtain file directory information, including file creation times is provided by TSX-Plus. An EMT is also provided to set the file creation time value into file directory entries. See Chapter 7 for information on use of these EMTs.

The DIR utility provided with RT-11 does not interpret file creation time information as set by TSX-Plus, so a utility program (FILTIM) is provided with TSX-Plus to obtain this information. The FILTIM program should be copied from the distribution medium to the system device SY:. It may then be run either explicitly (R FILTIM) or implicitly as a system program (FILTIM). Although FILTIM does not accept wildcard file specifications, it will accept up to 6 file specifications. The default device is DK: and the default extension is MAC. A device specification also applies to subsequent file specifications which do not explicitly include a device. Files created under RT-11 or before this feature was implemented in TSX-Plus will have a creation time of 00:00:00.

Example:

```
.FILTIM CKACT,TPRMAN.TXT,MAN:CH13.DPS,APPC.DPS,RK0:FILTIM
DK:CKACT.MAC        3P  31-May-83  00:00:00    184
DK:TPRMAN.TXT      835  17-Jul-83  22:15:33  14226
MAN:CH13.DPS        35  18-Jul-83  08:31:42   3570
MAN:APPC.DPS         5  18-Jul-83  15:54:48   3605
RK0:FILTIM.MAC      23  18-Jul-83  11:24:57   4240
```

Note that the default device "DK" is used for CKACT and is carried over to the next file specification, and that the default file type is "MAC". The logical device "MAN" is used for the next two file specifications until the device specification, "RK0". And again, the default extension for RK0:FILTIM is "MAC".

Warning: Due to the method used by PIP for copy operations, file creation times are not preserved during copy operations, although the date is handled correctly. When copying a file with PIP, the destination file will acquire the time the copy is made as its creation time. The EMT to set file times, described in Chapter 7, may be used to set the correct time in the new file.

Appendix D -- RT-11 & TSX-Plus EMT CODES

D.1 TSX-Plus RT-11 Compatible EMTs

EMT	Code	Chan	Name	Description
340	-		.TTINR	Get character from terminal
341			.TTYOUT	Send character to terminal
342			.DSTATUS	Get device information
343	-		.FETCH/.RELEAS	Load/Unload device handlers
344			.CSIGEN	Call command string interpreter
345			.CSISPC/.GTLIN	Get command line
346	0		.LOCK	Lock USR in memory
347	0		.UNLOCK	Allow USR to swap
350			.EXIT	Return to monitor
351			.PRINT	Display string at terminal
352	-		.SRESET	Software reset
353	0		.QSET	Increase I/O queue size
354	-		.SETTOP	Set program upper limit
355			.RCTRLO	Reset CTRL-O
357	-		.HRESET	Stop I/O then .SRESET
374		0	.WAIT	Wait for I/O completion
374		1	.SPND	Suspend mainline program
374		2	.RSUM	Resume mainline program
374		3	.PURGE	Free a channel
374		4	.SERR	Inhibit abort on error
374		5	.HERR	Enable abort on error
374		6	.CLOSE	Close channel
374	0	7	.TLOCK	Try to lock USR
374		10	.CHAIN	Pass control to another program
374	*	11	.MWAIT	Wait for message
374		12	.DATE	Get current date
374	-	13	.ABTIO	Abort I/O in progress
375		0	.DELETE	Delete a file
375		1	.LOOKUP	Open existing file
375		2	.ENTER	Create file
375		3	.TRPSET	Intercept traps to 4 and 10
375		4	.RENAME	Rename a file
375		5	.SAVESTATUS	Save channel information
375		6	.REOPEN	Restore channel information
375		7	.CLOSE	Close channel
375		10	.READ[C][W]	Read from channel to memory
375		11	.WRIT[C][E][W]	Write from memory to channel
375		12	.WAIT	Wait for I/O completion
375	*	13	.CHCOPY	Open channel to file in use
375		14	.DEVICE	Load device registers on exit
375	-	15	.CDFN	Define extra I/O channels
375	-	20	.GTJB	Get job information

EMT Codes

EMT	Code	Chan	Name	Description
375	21		.GTIM	Get time of day
375	22		.MRKT	Schedule completion routine
375	23		.CMKT	Cancel mark time
375	24		.TWAIT	Timed wait
375 *	25		.SDAT[C][W]	Send data to another job
375 *	26		.RCVD[C][W]	Receive data from another job
375	27		.CSTAT	Return channel information
375	30		.SFPA	Trap floating point errors
375 0	31	0	.PROTECT	Control interrupt vector
375 0	31	1	.UNPROTECT	Release interrupt vector
375	32		.SPFUN	Special device functions
375 *	33		.CNTXSW	Context switch
375	34	0	.GVAL	Get monitor offset value
375 -	34	1	.PEEK	Get low memory value
375	34	2	.PVAL	Change monitor offset value
375 -	34	3	.POKE	Change low memory value
375	35		.SCCA	Inhibit CTRL-C abort
375	36	0	.CRRG	Create an extended memory region
375	36	1	.ELRG	Eliminate an extended memory region
375	36	2	.CRAW	Create a virtual address window
375	36	3	.ELAW	Eliminate a virtual address window
375	36	4	.MAP	Map virtual window to XM region
375	36	5	.UNMAP	Get window mapping status
375	36	6	.GMCX	Obtain window status
375 *	37	0	.MTSET	Set terminal status
375 *	37	1	.MTGET	Get terminal status
375 *	37	2	.MTIN	Get character from terminal
375 *	37	3	.MTOUT	Send character to terminal
375 *	37	4	.MTRCTO	Reset CTRL-O
375 *	37	5	.MTATCH	Lock terminal to job
375 *	37	6	.MTDTCH	Release terminal from job
375 *	37	7	.MTPRNT	Display string at terminal
375 *	37	10	.MTSTAT	Get system status
375	40		.SDTTM	Set date and time
375	41		.SPCPS	Change mainline control flow
375	42		.SFDAT	Change file date
375	43		.FPROT	Change file protection

Notes:

*	Not supported, will cause error.
0	Treated as NOP.
-	Minor differences, see Chapter 14.

D.2 TSX-Plus Specific EMTs

EMT	Code	Chan	Name	Description
375	101		UNLALL	Unlock all blocks
375	102		LOCKW	Wait for locked block
375	103		TLOCK	Try to lock a block
375	104		SNDMSG	Send message on named channel
375	105		GETMSG	Get message from named channel
375	106		WATMSG	Wait for message on named channel
375	107	0	SPLFRE	Get number of free spool blocks
375	110	0	TSXLN	Get line number
375	111	0/1	ACTODT	Reset/set ODT activation mode
375	113		UNLOCK	Unlock a block
375	114	0	TTOBLK	Send block of text to terminal
375	115	0	TTIBLK	Get block of text from terminal
375	116	0	CKTTIE	Check for terminal input errors
375	117	0	SETTTO	Set terminal read time-out
375	120	0/1	HIEFF	Reset/set high-efficiency mode
375	121		CKWSHR	Check for writes to shared file
375	122		SAVSHR	Save shared file information
375	123	0	CKACT	Check for activation characters
375	125		SHRFIL	Declare file for shared access
375	127	0	SEND	Send message to another line
375	132	0	STRTDJ	Start a detached job
375	132	1	STATDJ	Check detached job status
375	132	2	ABRTDJ	Abort a detached job
375	133	0	DCLBRK	Establish break sentinel control
375	133	1	TTICPL	Set terminal input completion routine
375	134	0	MOUNT	Mount a directory structure
375	135	0	DISMNT	Dismount a directory structure
375	136	0	INITPA	Initiate performance analysis
375	136	1	STRTPA	Start monitoring performance
375	136	2	STOPPA	Stop monitoring performance
375	136	3	HALTPA	Terminate performance analysis
375	137	0	TTYPE	Get terminal type
375	140	0	PHYADD	Convert virtual to physical address
375	140	1	PEEKIO	Peek into the I/O page
375	140	2	POKEIO	Poke into the I/O page
375	140	3	BISIO	Bit-set into the I/O page
375	140	4	BICIO	Bit-clear into the I/O page
375	140	5	MAPIOP	Map PAR7 to the I/O page
375	140	6	MAPMON	Map PAR7 to simulated RMON
375	140	7	LOKLOW	Lock job into lowest memory
375	140	10	UNLOKJ	Unlock job from memory
375	140	11	ATTVEC	Attach to interrupt vector
375	140	12	RELVEC	Release interrupt vector
375	140	13	LOKJOB	Lock job without re-positioning

EMT	Code	Chan	Name	Description
375	140	14	STEALS	Get exclusive system access
375	140	15	RTURNS	Relinquish exclusive system access
375	140	16	SETPRI	Set user mode priority level
375	140	17	MAPPHY	Map to physical memory
375	140	20	ATTSVC	Attach interrupt service routine
375	140	21	SCHCMP	Schedule completion routine
375	141	0	MEMTOP	Control size of job
375	143	0	USERTS	Associate with run-time system
375	143	1	MAPRTS	Map run-time system into job
375	144	0	JSTAT	Get job status information
375	145		FILINF	Get file directory information
375	146		SFTIM	Set file creation time
375	147	0/1	GSUNAM	Get/set user name
375	150	0	SJBPRI	Set job execution priority
375	151		SPHOLD	Set spooler HOLD/NOHOLD
375	152	0	SELOPT	Select terminal option
375	153	0	NONINT	Set [non]interactive job status
375	154	0	STTSPD	Set line baud rate
375	155	0	GETCL	Assign CL unit to a line
375	156	0	ALCDEV	Allocate a device for exclusive use
375	156	1	DEALOC	Deallocate a device from exclusive use
375	156	2	TSTALC	Test device exclusive use allocation
375	157	0	MONJOB	Start monitoring job status
375	157	1	NOMONJ	Stop monitoring job status
375	157	2	STAMON	Broadcast status to monitoring jobs
375	160	0	GETCXT	Acquire another job's file context
375	161	0	MAKWIN	Create a refreshable process window
375	161	1	SELWIN	Select current process window
375	161	2	DELWIN	Delete a process window
375	161	3	SPNWIN	Suspend window processing
375	161	4	RSMWIN	Resume window processing
375	161	5	PRTWIN	Print window contents (via WINPRT)

Appendix E -- SUBROUTINES USED IN EXAMPLE PROGRAMS

E.1 PRTOCT - Print an octal value

The following subroutine accepts a value in R0 and prints the 6 digit octal representation of that value at the terminal.

```
        .TITLE  PRTOCT
        .ENABLE LC

; Print octal value of the word in R0

        .MCALL  .PRINT
        .GLOBL  PRTOCT

PRTOCT: MOV     R1,-(SP)        ;Save R1-R3 on the stack
        MOV     R2,-(SP)
        MOV     R3,-(SP)
        MOV     #EOW,R2         ;Point to end of 6 char output buffer
        MOV     #6,R3           ;Set up counter for 6 chars
1$:     MOV     R0,R1           ;Set up mask for low 3 bits (1s digit)
        BIC     #177770,R1      ;Get low 3 bits
        ADD     #'0,R1          ;Convert to ASCII
        MOVB    R1,-(R2)        ;Fill octal digits in from end
        CLC
        ROR     R0
        ASH     #-2,R0          ;Shift out bits just converted
        SOB     R3,1$           ;Repeat for 6 chars
        .PRINT  #CHARS          ;Display result at console
        MOV     (SP)+,R3        ;Restore registers R1-R3
        MOV     (SP)+,R2
        MOV     (SP)+,R1
        RETURN
CHARS:  .BLKB   6               ;6 char output buffer
EOW:    .ASCII  <200>           ;No CR terminator for .PRINT
        .EVEN
        .END
```

E.2 PRTDEC - Print a decimal value

The following subroutine accepts a value in R0 and prints the decimal representation of that value at the terminal with no leading zeroes.

```
        .TITLE  PRTDEC
        .ENABL  LC
;
; Print the decimal value of the word in R0
;
        .MCALL  .PRINT
        .GLOBL  PRTDEC
;
PRTDEC: MOV     R1,-(SP)        ;Save R1 and R2
```

```
        MOV     R2,-(SP)
        MOV     #BUFEND,R2      ;Point to end of output buffer
        MOV     R0,R1           ;Set up for DIV
1$:     CLR     R0              ;Clear high word for DIV
        DIV     #10.,R0         ;Get least significant digit
        ADD     #'0,R1          ;Make remainder into ASCII
        MOVB    R1,-(R2)        ;Save digit in output buffer
        MOV     R0,R1           ;Set up for next DIV
        BNE     1$              ;Until nothing left
        .PRINT  R2              ;Display number at the terminal
        MOV     (SP)+,R2        ;Restore R1 and R2
        MOV     (SP)+,R1
        RETURN
        .BLKB   5               ;5 char output buffer
BUFEND: .BYTE   200             ;No CR terminator for .PRINT
        .EVEN
        .END
```

E.3 PRTDE2 - Print a 2 digit decimal value

The following subroutine accepts a value in R0 and prints the decimal representation of it at the terminal. The value must be in the range of 0 to 99.

```
        .TITLE  PRTDE2
        .ENABLE LC

; Print a 2-digit decimal value from R0

        .MCALL  .PRINT
        .GLOBL  PRTDE2

PRTDE2: MOV     R1,-(SP)
        MOV     R2,-(SP)
        MOV     R3,-(SP)
        MOV     R0,R1           ;Get copy of char in R1
        MOV     #<BUFFER+2>,R2  ;Point to buffer
        MOVB    #200,(R2)       ;Set end for .PRINT
        MOV     #2,R3
2$:     CLR     R0              ;Clear high word for DIV
        DIV     #10.,R0         ;Get low digit
        ADD     #'0,R1          ;Convert low digit to ASCII
        MOVB    R1,-(R2)        ;Put digit in char buffer
        MOV     R0,R1           ;Roll quotient for next DIV
        SOB     R3,2$           ;Two digits only
        .PRINT  #BUFFER         ;Display the result
        MOV     (SP)+,R3
        MOV     (SP)+,R2
        MOV     (SP)+,R1
        RETURN
```

```
BUFFER: .BLKB   6
        .EVEN
        .END
```

E.4 PRTR50 - Print a RAD50 word at the terminal

The following subroutine accepts a one word RAD50 value in R0 and prints its ASCII representation at the terminal.

```
        .TITLE  PRTR50
        .ENABL  LC
;
;  Display the RAD50 value of a word passed in R0
;
        .MCALL  .TTYOUT
        .GLOBL  PRTR50
PRTR50: MOV     R1,-(SP)        ;Need place to store last char
        MOV     R4,-(SP)        ;Need R4 and R5 for DIV
        MOV     R5,-(SP)
        MOV     R0,R5           ;Get copy of r0 into dividend
        CLR     R4              ;Zero high word for DIV
        DIV     #50,R4          ;Extract last char
        MOV     R5,R1           ;Save last char (remainder)
        MOV     R4,R5           ;Move quotient for next DIV
        CLR     R4              ;Zero high word for second DIV
        DIV     #50,R4          ;Get first and second chars
        .TTYOUT R50TBL(R4)      ;Display first char (quotient)
        .TTYOUT R50TBL(R5)      ; and second char (remainder)
        .TTYOUT R50TBL(R1)      ; and last char
        MOV     (SP)+,R5        ;Restore registers
        MOV     (SP)+,R4
        MOV     (SP)+,R1
        RETURN
        .NLIST  BEX
R50TBL: .ASCII  / ABCDEFGHIJKLMNOPQRSTUVWXYZ$. 0123456789/
        .EVEN
        .END
```

E.5 R50ASC - Convert a RAD50 string into an ASCIZ string

The following subroutine accepts a pointer in R0 to an argument block containing pointers to a RAD50 input string and an output buffer to hold the ASCII equivalent of the RAD50 string, and a word containing the number of characters to be converted.

```
        .TITLE  R50ASC
;
;  Convert RAD50 value into ASCII
;  Output buffer must be at least 3 characters extra long
;
        .GLOBL  R50ASC
        .DSABL  GBL
R50ASC: MOV     R1,-(SP)        ;Pointer to input buffer
        MOV     R2,-(SP)        ;Pointer to output buffer
        MOV     R3,-(SP)        ;Number of chars to convert
        MOV     R4,-(SP)        ;Dividend low word and quotient
        MOV     R5,-(SP)        ;Dividend hi word and remainder
        MOV     (R0)+,R1        ;Fetch input buffer address
        MOV     (R0)+,R2        ;Output buffer address
        MOV     (R0),R3         ;Number of chars to convert
        TST     R3              ;Any chars to convert?
        BLE     2$              ;Branch if not
1$:     ADD     #3,R2           ;Point to end of 3 char set
        MOV     (R1)+,R5        ;Fetch RAD50 value
        CLR     R4              ;Set up for divide
        DIV     #50,R4          ;Get first char
        MOVB    R50TBL(R5),-1(R2) ;Put 3/3 into output buffer
        MOV     R4,R5           ;Set up for divide
        CLR     R4
        DIV     #50,R4          ;Convert next char
        MOVB    R50TBL(R5),-2(R2) ;Put 2/3 into output buffer
        MOVB    R50TBL(R4),-3(R2) ;Put 1/3 into output buffer
        SUB     #3,R3           ;Converted 3 chars this round
        BGT     1$              ;Branch if more chars left to convert
2$:     ADD     R3,R2           ;Locate last real char
        CLRB    (R2)            ;Make output string ASCIZ
        MOV     (SP)+,R5
        MOV     (SP)+,R4
        MOV     (SP)+,R3
        MOV     (SP)+,R2
        MOV     (SP)+,R1
        RETURN
        .NLIST  BEX
R50TBL: .ASCII  / ABCDEFGHIJKLMNOPQRSTUVWXYZ$. 0123456789/
        .EVEN
        .END
```

E.6 DSPDAT - Print a date value at the terminal

The following subroutine accepts a date value in R0 and prints the date representation at the terminal.

```
        .TITLE  DSPDAT
        .ENABL  LC

; Print a date value from R0

        .MCALL  .PRINT
        .GLOBL  DSPDAT,PRTDEC

MONMSK  = 036000
DAYMSK  = 001740
YRMSK   = 000037

DSPDAT: MOV     R1,-(SP)
        MOV     R0,R1           ;Get copy of date in R1
        BIC     #^CDAYMSK,R0    ;Mask in only day bits (5-9)
        ASH     #-5,R0          ;Shift down
        CALL    PRTDEC          ;Print it out
        MOV     R1,R0           ;Get fresh copy of date
        BIC     #^CMONMSK,R0    ;Use only month bits (10-13)
        ASH     #-7,R0          ;Shift down to index into month table
        ADD     #MONTBL,R0      ;Point into table
        .PRINT  R0              ;Display the month
        MOV     R1,R0           ;Fresh copy again
        BIC     #^CYRMSK,R0     ;Use only year bits
        ADD     #72.,R0         ;Year since 1972
        CALL    PRTDEC          ;Display the year
        MOV     (SP)+,R1
        RETURN

        .NLIST  BEX
MONTBL: .ASCII  /-NON-/<200><0><0>
        .ASCII  /-Jan-/<200><0><0>
        .ASCII  /-Feb-/<200><0><0>
        .ASCII  /-Mar-/<200><0><0>
        .ASCII  /-Apr-/<200><0><0>
        .ASCII  /-May-/<200><0><0>
        .ASCII  /-Jun-/<200><0><0>
        .ASCII  /-Jul-/<200><0><0>
        .ASCII  /-Aug-/<200><0><0>
        .ASCII  /-Sep-/<200><0><0>
        .ASCII  /-Oct-/<200><0><0>
        .ASCII  /-Nov-/<200><0><0>
        .ASCII  /-Dec-/<200><0><0>
        .EVEN
        .END
```

E.7 DSPTI3 - Display a 3-second format time value

The following subroutine accepts a special 3-second time value in R0 and prints the time value at the terminal.

```
        .TITLE  DSPTI3
        .ENABL  LC

; Display special 3-sec format time value from R0

        .MCALL  .TTYOUT
        .GLOBL  DSPTI3,PRTDE2

DSPTI3: MOV     R1,-(SP)
        MOV     R0,R1           ;Set up for divide
        CLR     R0
        DIV     #20.,R0         ;Get # of 3-SEC'S since midnight
        MOV     R1,-(SP)        ;Put on stack
        ASL     R1              ;2X 3-SEC'S
        ADD     R1,(SP)         ;Plus 1X gives 3X = seconds
        MOV     R0,R1           ;Get rest of time
        CLR     R0              ;Set up for next divide
        DIV     #60.,R0         ;Get number of minutes
        MOV     R1,-(SP)        ;And save on stack
        CALL    PRTDE2          ;What's left is hours, display
        .TTYOUT #':
        MOV     (SP)+,R0        ;Recover minutes
        CALL    PRTDE2          ;Display minutes
        .TTYOUT #':
        MOV     (SP)+,R0        ;Recover seconds
        CALL    PRTDE2
        MOV     (SP)+,R1
        RETURN
        .END
```

E.8 ACRTI3 - Convert a time value to special 3-second format

The following subroutine accepts a time value from the terminal and converts it to a special 3-second internal format. The value is returned in R0.

```
        .TITLE  ACRTI3
        .ENABL  LC

; Accept a time from the keyboard and return it in
; a special 3-second format in R0

        .GLOBL  ACRTI3

ACRTI3: MOV     R1,-(SP)
```

```
        MOV     R2,-(SP)
        MOV     R3,-(SP)
        CLR     HOURS           ;Make sure it's reentrant
        CLR     MINITS
        CALL    GETNUM          ;Accrue decimal hours
        BCS     2$              ;Return with error
        MUL     #<60.*20.>,R3   ;Convert hours to 3-sec periods
        MOV     R3,HOURS        ;Save hours in 3-sec units
        TST     NUMERR          ;Did we hit end of input?
        BNE     1$              ;Yes, return value
        CALL    GETNUM          ;Accrue decimal minutes
        BCS     2$              ;Return with error
        MUL     #20.,R3         ;Convert minutes to 3-sec periods
        MOV     R3,MINITS       ;Save minutes in 3-sec units
        TST     NUMERR          ;End of input?
        BNE     1$              ;Yes, return value
        CALL    GETNUM          ;Accrue decimal seconds
        BCS     2$              ;Return with error
        CLR     R2              ;Convert seconds into 3-sec periods
        DIV     #3,R2           ;Quotient stays in R2
1$:     ADD     MINITS,R2       ;Add in 3-secs from minutes
        ADD     HOURS,R2        ;Add in 3-secs from hours
        MOV     R2,R0           ;Return it in R0
        CLC                     ;Say no error
        BR      3$              ;Return
2$:     SEC                     ;Say there was an error
3$:     MOV     (SP)+,R3
        MOV     (SP)+,R2
        MOV     (SP)+,R1
        RETURN
GETNUM: CLR     NUMERR          ;Say no error yet
        CLR     R3              ;Initialize number
1$:     MOVB    (R0)+,R1        ;Get next digit into R1
        CMPB    R1,#'0          ;Less than '0?
        BLT     2$              ;Not a digit
        CMPB    R1,#'9          ;Greater than '9?
        BGT     2$              ;Not a digit
        MUL     #10.,R3         ;Shift previous digits
        SUB     #'0,R1          ;Convert current digit to binary
        ADD     R1,R3           ;And include in number
        BR      1$              ;Get digits til next separator
2$:     CMPB    R1,#':          ;Is it a legal separator?
        BEQ     3$              ;Yes, return
        INC     NUMERR          ;Say it may be end
        TSTB    R1              ;Was it a nul (end of input string)?
        BEQ     3$              ;Yes, return
        SEC                     ;No, say invalid input
        RETURN                  ;Error return
3$:     CLC                     ;No error
        RETURN
```

```
HOURS:  .WORD   0
MINITS: .WORD   0
NUMERR: .WORD   0
        .END
```

Appendix F -- TSX-Plus USER ERROR MESSAGES

Several different categories of errors can generate messages, ranging from errors which are fatal to the operating system to something as simple as an incorrect file specification. Errors are identified by the name of the program which recognized the error and one or more lines of descriptive information. Errors identified by utility programs are identified by the name of the utility (e.g., ?PIP-F, ?DUP-F, ?KED-F) and may or may not abort the program. For more information about utility program error messages, consult the appropriate RT-11 manual (RT-11 System Message Manual, RT-11 System Utilities Manual, RT-11 Keypad Editor User's Guide, etc.). Errors which are fatal to the TSX-Plus operating system (identified as ?TSX-F) report error conditions for which time-sharing users are not usually responsible and usually cannot correct. TSX fatal errors should be reported to the system manager who should consult the TSX-Plus System Manager's Guide for more information. Errors which are not fatal to the operating system but which indicate a user mode error are reported as monitor errors. This Appendix describes TSX-Plus monitor error messages.

All user mode fatal monitor error messages have the syntax:

```
?KMON-F-" message "

     or

?MON-F-" message "
```

where the "?KMON-F" form is used if the error occurs while using the keyboard monitor and the "?MON-F" form is used for errors which occur within a user program.

Warning messages have the form:

```
?KMON-W-" message "
```

In some cases, the message is only informational rather than indicating an error. In these cases, the message is of the form:

```
?KMON-I-" message "
```

Error messages are consistent with RT-11 usage insofar as possible. Monitor error messages unique to TSX-Plus are described below. Consult the RT-11 System Message Manual for monitor errors not described here.

A line number must be specified with the SEND command
: This error message is printed if line number is not specified with the SEND command. See the description of the SEND command for more information about options related to the line number.

ALLOCATE privilege is required for this command
: ALLOCATE privilege is required to be able to allocate or deallocate devices.

Ambiguous command
: Too few characters of a command keyword have been entered to allow the command to be uniquely identified. For example, this error would result if "CO" were entered as a command since CO could be an abbreviation for either COPY or COMPILE.

Ambiguous option
: Not enough characters were specified to distinguish between options.

ASSIGN table full
: Maximum number of logical assignments (25 per user) exceeded. SHOW ASSIGNS and DEASSIGN unnecessary logical assignments.

Attempt to increase MAXPRIORITY above current value
: Maximum job priority may be restricted by the system manager. It may be reduced, but it may not be increased during a time-sharing session.

Cannot change privileges for another job
: The SET PROCESS command cannot be used to change the privileges for any job other than your own.

Cannot change name of another job
: The SET PROCESS command cannot be used to change the name of any job other than your own.

Cannot find spool file with specified ID
: There is no spool file in the queue with an ID number that matches the ID specified with the SPOOL command.

Cannot find SY:CCL.SAV to process CCL command
: The CCL.SAV program has been deleted from the system disk. This program is required to process some keyboard commands. Reboot the system and copy CCL.SAV from your TSX-Plus distribution disk to the system disk while you are running under RT-11.

Cannot find SY:TSODT.REL file
: The relocatable copy of the TSX-Plus ODT debugging program was not found on the system device. Copy the file "TSODT.REL" from the distribution medium to SY.

Cannot find SY:TSXUCL.SAV
A command was attempted to be interpreted as a user-defined command, but the TSXUCL program could not be found. Copy TSXUCL.SAV from the distribution to SY.

Cannot open alignment file
The alignment file specified in a SPOOL align command cannot be opened.

Cannot open logoff command file
A logoff command file which was specified during job start-up could not be found while logging the job off.

Cannot open spool device
The spooler cannot access the spool device. Verify the device name used in the SPOOL macro during TSX-Plus generation and check for correct device assignments.

Cannot open system accounting file
The file SY:ACCESS.TSX cannot be found during logon or logoff. This file is created by the system manager.

Character length must be 7 or 8 bits
The value specified for the number of bits in a character with the BITS=value qualifier on a SET TERMINAL or SET CL command must be 7 or 8.

Closing log file
If a device on which a terminal output log file is open is initialized or squeezed, the log file is first closed.

Command file nesting too deep
Maximum depth of command file nesting exceeded. The depth of command file nesting allowed depends on the number and length of parameter strings. Three levels are possible even with long strings and as many as seven levels are possible with no parameters. See Chapter 3 for more information on command files.

Command file not found
The specified command file was not found. See Chapter 2 for an explanation of command interpretation including default devices, and Chapter 3 for more information on command files.

Command file parameter string too long
Total number of characters in parameter string exceeds the maximum allowed length of 60 characters. See Chapter 3.

Command string too complicated
: The command string expansion is too large for the internal CCL buffer. Reduce the complexity of the command string. The SET CCL TEST command may be used to examine the expanded command string generated by high level commands.

Command syntax error
: The command entered was recognized as a system command but the form of the command (i.e., its syntax) does not match the expected form. Check the description of the command.

Date unknown
: The current date is not known. The date should be set by the operator by use of the DATE keyboard command.

DEBUG privilege is required to use debugging facilities
: DEBUG privilege must be granted in order to be able to use any of the system debugging facilities.

DETACH privilege is required to use detached jobs
: DETACH privilege must be granted in order to be able to use the detached job facility.

Device full
: There is insufficient free space available to open a file.

Device is allocated to another user
: An attempt has been made to access a device that is currently allocated to another user by use of the ALLOCATE command.

Device is allocated to job nn
: The device you are trying to access is allocated to job nn. The device must be deallocated before you may access it.

Device is being used by job nn
: Job nn has a channel open to a device that you are trying to ALLOCATE, INITIALIZE, SQUEEZE, or SET. These commands may only be used when no one else is accessing the device.

Device is mounted by another job
: The INITIALIZE and SQUEEZE commands are invalid if the device is MOUNTed by any other user. This minimizes the opportunity for data corruption when other users may be writing to a device. See the INITIALIZE and SQUEEZE commands for motivation.

Device is still mounted by other users
: This informational message is displayed when a DISMOUNT request is issued for a device which is also MOUNTed by other users. See the INITIALIZE and SQUEEZE commands for motivation.

Device must be allocated before use
: The system manager has specified that the device you are attempting to access must be allocated to a job by use of the ALLOCATE command before it can be accessed by the job. Use the ALLOCATE command to allocate the device to your job.

Device name is required
: A device name must be specified with the INITIALIZE, SQUEEZE, and FORMAT commands.

Device or file is access restricted
: User does not have access privilege to requested device or file. The system manager may restrict user access to individual devices and files.

Directory I/O error
: A device directory failed internal consistency checks. Devices must have valid RT-11 format directories for use with TSX-Plus. This error may also occur when attempting to use 22-bit addressing with DMA devices when the handler or hardware does not support 22-bit addressing.

Directory overflow
: All empty file entries in the directory for a device have been used up. The maximum number of file entries may be specified when you initialize a device. See the description of the INITIALIZE command for information about specifying the number of file entries in the directory.

Error creating window to access key region
: An error occurred while creating a virtual memory (PLAS) region window to access user-defined key information. Check your sysgen and make sure PLAS support is included (SEGBLK parameter must be non-zero).

File not found
: The specified file was not found on the specified device.

Floating point trap
: A floating point operation trap occurred and job had not done a .SFPA operation to specify a floating point trap processing routine.

Handler active -- Can't update running copy
: An attempt was made to perform a SET command on a device handler which was in use. If the handler is idle when the SET is issued, the change will be made, otherwise, the running copy of the handler is not altered. Reissue the command when the handler is not active.

Handler not installed. Set applied to handler disk file only.
: A SET command has been issued to a device handler that exists on the disk (SY:xx.TSX file) but which is not installed in the running TSX-Plus system. The SET has been applied to the disk file copy of the handler.

ID qualifier required with SUSPEND or RESUME
: You must use the /ID qualifier on the SET PROCESS command to specify which job is to be suspended or resumed.

Illegal use of wildcards
: Wildcards may not be specified for (part of) this command.

IND already active
: The IND program cannot be run from within a command file which is being executed under control of the IND program.

IND is not available
: The IND.SAV program was not on the system disk during TSX-Plus start-up. IND is provided with RT-11 version 5 and later.

Install table full
: An attempt has been made to install a program but there is no free space in the install table. Resysgen TSX-Plus and increase the value of the NUIP parameter, or delete some program from the install table.

Installed program cannot be on a logical disk
: When the INSTALL command is used to add a program to the installed-program table, the physical device name where the program file is located is entered into the table. It is not legal for an installed program to be located on a logical (subset) disk.

Invalid address as EMT argument
: An address specified in a monitor call was odd or was not within the job's address space. The value returned as the abort location is the address of the instruction or the EMT that caused the error.

Invalid boot device
: An invalid device was specified with the BOOT command.

Invalid channel
: An invalid channel number was used with an EMT.

Invalid command. Expected numeric value missing
: A numeric parameter value is missing from a command that requires it.

Invalid command. Expected octal value missing
: A numeric parameter (expressed in octal) is missing from a command that requires it.

Invalid date
: An invalid value was specified as a date.

Invalid device
An invalid or unrecognizable device name was specified.

Invalid EMT
An invalid or unsupported function code was specified in an EMT argument block.

Invalid EMT argument
An invalid value was specified in an EMT argument block. Frequently this is caused by specifying an odd address where an even address is required -- such as for the address of a completion routine.

Invalid file name
An invalid file name was specified. Check for typing errors, names too long, and correct file specification format.

Invalid key name
A DEFINE/KEY command has been issued to specify a new key definition but the name of the key (e.g., KP0, PF1, etc.) is not recognized.

Invalid line number
An invalid line number was specified for a KILL or DETACH command.

Invalid logical disk name
Logical subset disks must be mounted as LD0 through LD7.

Invalid multiple value on option
More than one parameter was specified for an option which only accepts one.

Invalid option
An invalid or unrecognized option keyword has been specified with a command.

Invalid or uninitialized directory
A disk device must contain a valid RT-11 format directory to be accessed by any operation other than INITIALIZE. Logical subset disks must be initialized before first use. This error may also occur when attempting to use 22-bit addressing with a DMA device and either the device handler or hardware does not support 22-bit addressing.

Invalid or unrecognizable device
A device name was specified which is not recognized by the system. This could happen if a logical device name was used without assigning the logical name to a physical device.

Invalid printer type
The type of the printer specified with the TYPE qualifier for the SET PRINTWINDOW command is not recognized. See the description of the SET PRINTWINDOW command for a list of valid device type names.

Invalid SAV file
: A file specified with an R or RUN command failed internal consistency checks. The file may be damaged. An incorrect file type may have been specified - the default type is "SAV".

Invalid speed value
: An invalid speed has been specified with a command used to set a line's transmit/receive speed. The valid speed values are: 50, 75, 110, 134.5, 150, 300, 600, 1200, 1800, 2000, 2400, 3600, 4800, 7200, 9600, and 19200.

Invalid start address for program
: The start address for the program was outside of the program's memory bounds or on an odd address. A MACRO program may have an incorrect starting address specified with the .END directive. The file may be damaged. An incorrect file type may have been specified - the default is "SAV".

Invalid string specification
: A character string parameter which was specified with some command qualifier was not properly enclosed in quotation marks. Either quotation marks (") or apostrophies (') may be used to enclose character string parameters but the same character must be used to start and end the value.

Invalid time
: An invalid time value was specified with the TIME command.

Invalid to specify /NOECHO with /NOTERMINATE
: You may not specify both the /NOECHO and /NOTERMINATE qualifiers together.

Invalid unit number
: An out of range unit number was specified with a SET CLn command. The valid unit numbers range from 0 (zero) up to the highest CL unit specified when the system was generated.

Kernel mode trap within TSX-Plus
: A kernel mode trap error usually indicates the operating system image has been corrupted due to hardware or software failure. Record the full error message and report the error to the system manager. This error can also be generated by attempting to access a non-existent memory address with the real-time EMT's to access the I/O page.

Line is active
: The specified line or job is still active.

Line is already being used as a CL unit
: An attempt has been made to assign a CL unit to a line that already has another CL unit assigned to it. You may disassociate a CL unit from a line by assigning the CL unit to another line or to line 0 (zero) which disassociates it from any line.

Line is gagged
Messages cannot be sent to lines which have SET TT GAG unless those lines are waiting in TSKMON for a command.

Line is in use by a time-sharing user
An attempt has been made to assign a CL unit to a line on which a time-sharing user is logged in. The time-sharing user must log off before you can assign the CL unit to the line.

Line not logged on
The specified line number does not currently have a logged on user or job.

Line too long
The expanded CCL command was too long. Commands are expanded into the chain data area, locations 500 - 777. See the SET CCL TEST command.

Log file overflow
An error was reported while writing to the terminal output log file. This is most commonly an attempt to write past end-of-file. Make more room on the output device, specify a file size with the SET LOG command, or use the SET LOG NOWRITE option to reduce the volume of log file output.

Logical Disk support was not generated into system
Attempts to MOUNT a logical subset disk are not valid unless support for logical subset disks was selected when generating TSX-Plus.

Logical disks must be nested in order of increasing unit #
When a file residing within a logical subset disk is to be mounted as another logical subset disk, it must be assigned a higher number than the outer level logical subset disk. For example, the following command is invalid: MOUNT LD1 LD3:MYDISK; whereas the following is acceptable: MOUNT LD3 LD1:MYDISK.

Max allowed number of devices already mounted
The number of device directories which may be cached is defined during system generation. DISMOUNT devices on which caching is no longer needed or consult the system manager.

Max windows already in use
The maximum number of process windows that can be supported by the system are already in use. Regenerate the system and increase the value of the MAXWIN sysgen parameter, or delete some existing windows.

Maximum authorized priority is nn
You have requested that your execution priority be set to a value greater than you are authorized for.

Maximum allowed number of devices already allocated
: The table that is used to keep track of allocated devices is full. Resysgen TSX-Plus and increase the value of the MAXALC parameter.

Maximum legal value is nnnn
: A numeric parameter has been specified which exceeds the maximum allowed value.

Maximum number of keys already defined
: The maximum number of keys that each user can defined is controlled by the KEYMAX sysgen parameter. Resysgen TSX-Plus and increase the value of this parameter. The maximum allowed value for KEYMAX is 60.

MEMMAP privilege is required to run this program
: MEMMAP privilege is required to run the program because it accesses a restricted area of memory (usually the I/O page). Either the user who wishes to run the program must be given MEMMAP privilege or the program must be installed with MEMMAP privilege.

Memory size change not allowed in non-swapping TSX system
: Jobs may not change size dynamically unless job-swapping was enabled during system generation. Consult the system manager.

Missing equal sign
: The equal sign was missing on a SET device command.

NFSWRITE privilege is required for this command
: NFSWRITE privilege must be granted to you in order to be able to use this command.

No defined operator's console
: No operator console was defined during system generation. Form mount requests and messages using the OPERATOR command are sent to the operator console.

No free detached job lines
: The maximum number of detached job lines is specified during system generation. Either wait for a job to terminate, stop one by use of the DETACH/KILL command, or ask the system manager to increase the number of detached lines.

No user-defined keys are allowed
: The system was generated with the KEYMAX parameter set to 0 (zero). This disallows any user key definitions. If you wish to define keys, resysgen TSX-Plus and set KEYMAX to a non-zero value.

Not enough memory to run program
: A file was too large (or the size specified in the SAV image was too large) to fit in the space allocated to the job. See Appendix A for more information on program size specifications. Use overlay segments or chain requests to reduce the program size. Use the MEMORY command to request more memory for your job. Note that you cannot use the MEMORY command in a non-swapping environment; see the system manager.

OPER privilege is required to perform this operation
: The user must be grated OPER privilege in order to use the command that failed.

Overlay error
: An I/O error has occurred while reading a program overlay segment.

Password may not exceed 20 characters
: The system password specified with the SET SYSPASSWORD command must not exceed 20 characters in length.

Performance monitor is in use by user number nn
: The performance monitor facility is already in use. Only one job may use it at a time.

Port device must be a CL or C1 unit
: The device specified with the SET HOST/PORT=device command must be a CL or C1 unit such as CL2 or C13.

Printer type is ambiguous
: The printer type name specified is abbreviated too shortly so that it is ambiguous.

Priority value must be in the range ...
: Job priority may not be set less than 0, nor higher than the maximum allowed priority.

Program debugger was not included when system was generated
: A request was made to run a program with the TSX-Plus program debugging facility (i.e., RUN/DEBUG program) but the debugging facility was not included when the system was generated.

Program not installed
: The program specified with the INSTALL command is not currently in the install table. Use the SHOW INSTALL command to display the names of the programs that are currently installed.

Prompt string too long
: Prompt strings may not be longer than 8 characters.

PSWAPM privilege is required to lock programs in memory
: PSWAPM privilege is required to lock a program in memory while it is running.

Save file I/O error
: An I/O error occurred while reading the SAV file. Check that the disk is still on line. It is also possible that the SAV file or the directory is damaged.

SEND privilege is required for this command
: SEND privilege must be granted to you in order to be able to send messages to other jobs.

SETNAM privilege is required for this operation
: The user must be granted SETNAM privilege to use the command that failed.

SL was not included at system generation
: The SET SL ON command may not be issued unless support for the single line editor was selected when generating TSX-Plus.

SL width is fixed at 80
: Under TSX-Plus, the single line editor command buffer length is fixed at 80 characters and may not be changed with the SET SL width=nn command.

Spool file is full
: The spool file is currently full. Additional space will become free as currently queued files are printed. If you wish to increase the spool file size, regenerate TSX-Plus and increase the value specified with the SPOOL macro.

Spooler in single file mode
: The spooler has been set so that it will pause between each file that is printed. See the description of the SPOOL command for information about setting this mode.

Spooler waiting for form mount
: A message to mount a new form has been printed at the operators console and the spooler is waiting for a form to be mounted before it will proceed with printing. See the description of the SPOOL command for information about specifying form names.

Stack overflow
: The stack allocated within the program (usually below location 1000) has overflowed. Take the appropriate action based on the nature of the program to increase its stack space.

String too long
: A character string parameter specified with the command exceeds the maximum legal length. See the description of the command to determine the maximum legal length.

SYSGBL privilege is required to use windows
: In order to use process windows you must have SYSGBL privilege in order to create a named global memory region in which the window image is stored.

SYSPRV privilege is required to perform this operation
: The user must be granted SYSPRV privilege in order to use the command that failed.

System was not generated to support performance monitoring
: Performance monitoring is an optional feature that must be included during system generation. See the system manager.

Table overflow
: Too many devices/files have been specified in the ACCESS command. See the system manager.

TERMINAL privilege is required to perform this operation
: The user must be granted TERMINAL privilege in order to be allowed to use the command that failed.

Terminal type must be set to VT100, VT200 or VT52
: The SET SL ON command may only be issued if the current terminal type is VT100, VT200 or VT52. Other terminal types are not supported by the single line editor.

This CL unit is currently busy
: An attempt has been made to assign a CL unit to a line and the CL unit is currently busy processing an I/O operation.

This CL unit is not currently assigned to a line
: A SET CL command has been issued to set some option for a CL unit and the CL unit is not assigned to a communications line.

This command only legal in startup command file
: The ACCESS and SET LOGOFF commands are only valid in startup command files.

This operation not legal with SY (system) device
: The device which was booted when starting TSX-Plus may not be initialized or squeezed while running TSX-Plus. If it is necessary to initialize or squeeze this device, do so while running RT-11.

Too many completion routines
: You have attempted to connect too many completion routines to interrupt vectors. The number of interrupt vectors that can be connected to completion routines is determined during system generation. See the system manager.

Too many files

The command interpreter uses standard command string format: up to 6 input files and 3 output files. Reduce the number of file specifications accordingly.

Too many parameters to command file

TSX-Plus command files accept a maximum of six parameters. See Chapter 3.

Trap to 4
Abort location = nnnnnn

An execution trap has occurred to location 4. This trap is caused by (1) attempting to address an odd location by an instruction that requires an even address; or (2) attempting to access an invalid memory location (i.e., outside the valid range of addresses for your job).

Trap to 10
Abort location = nnnnnn

A reserved or unimplemented instruction has been executed. This can be caused by executing a floating point instruction on a machine that does not have a floating point unit.

Trap to 14
Abort location = nnnnnn

Invalid breakpoint trap executed. The abort location provided is the address of the instruction following the trap. In order to use breakpoint, the program must store the PC and PS for the breakpoint service routine in locations 14 and 16.

Trap to 20
Abort location = nnnnnn

Invalid IOT instruction executed. The abort location provided is the address of the instruction following the trap. In order to use an IOT instruction, a program must store the PC and PS of the IOT service routine in locations 20 and 22.

Trap to 24
Abort location = nnnn

A hardware power failure trap has occurred. This indicates that either the system power is being interrupted or a hardware error exists that is causing the system to think a power interruption has occurred.

Trap to 34
Abort location = nnnnnn

Invalid TRAP instruction executed. The abort location provided is the address of the instruction following the trap. In order to use a TRAP instruction, a program must store the PC and PS of the TRAP service routine in locations 34 and 36.

TSCEN was modified without relinking TSKMON
: Whenever a new TSX-Plus system generation is done, both TSX and TSKMON must be relinked. See the system manager.

Unable to allocate memory for virtual overlays
: The system failed to successfully allocate extended memory regions when trying to run a program with virtual overlays. Unlock jobs from memory or increase the PLAS region swap file size.

Unable to attach to region
: The name of a memory region specified with the REMOVE command does not correspond to any existing global or local memory region for the job.

Unable to create memory region for window
: An error has occurred while attempting to create a global memory region to hold window information. Make sure memory region (PLAS) support is generated into the system (SEGBLK parameter must be non-zero). Use a SHOW REGIONS command to see how many regions have already been created. This error can also occur if there is insufficient contiguous physical memory space available to create the region.

Unable to create memory region for key definitions
: An error has occurred while attempting to create a local named memory region to hold user key definitions. Try increasing the value of the SEGBLK sysgen parameter.

Unable to eliminate region
: An error has occurred while attempting to delete a memory region. Use the SHOW REGIONS command to make sure the region is not being used by another job.

Unable to open file
: The file specified with the command that failed could not be opened. Either it does not exist, or it is on a different device than specified, or you do not have the proper authorization to access the file.

Unable to open log file
: The system reported an error when attempting to create a file for terminal output logging. Check the file specification, verify that there is room and that the output device is not write protected.

Unimplemented option
: A command option has been specified which is not currently implemented by TSX-Plus.

Unrecognizable command
: TSX-Plus could not find a system command, a user-defined command, or a command file with that name. See Chapter 2 for more information on command interpretation.

User command interface program not available
The system could not locate the file specified with the command: SET KMON UCI[=filnam]. Check the file specification. The default file is SY:UKMON.SAV.

USR called from completion routine
You cannot call system service routines that use TSUSR from a completion routine. This includes: .LOOKUP, .ENTER, .RENAME, .DELETE, .CLOSE, .DSTATUS, .SFDAT, and .FPROT.

USR err #n
All of the following USR errors result from consistency checks performed in closing a tentative file (creating a permanent file). These are usually indicative of a strange hardware condition, such as exchanging or squeezing a disk while a file is open.

USR err # 1
TSUSR can't find tentative file entry for specified file on close.

USR err # 2
File length in channel block is not equal to length in file entry.

USR err # 3
Highest block number written is greater than file length.

USR err # 4
Empty file entry doesn't follow tentative file entry.

USR err # 5
Tentative file entry status was lost during close operation. This is usually an indication of hardware failure.

Value required for option
A command was issued that required a value for an option, but no value was specified. Reissue the command correctly.

Window support not available
The system was generated with the MAXWIN sysgen parameter set to 0 (zero). Regenerate the system and assign a non-zero value to MAXWIN if you wish to use windows.

You are not authorized for that privilege
You have attempted to grant yourself a privilege that you were not authorized to use. SETPRV privilege is required to allocate privileges beyond those that are authorized.

You are not authorized to access that job
GROUP privilege is required to affect a job that has the same project number but a different programmer number than your own. WORLD privilege is required to affect a job that has a different project number. WORLD privilege is also required to affect system detached jobs.

You are not authorized to write to that device or file
The system manager may restrict access to individual devices or files. See the system manager.

?CCL-W-This command may interfere with other users
This warning is issued by CCL on INITIALIZE and SQUEEZE commands to warn you that other users using that device might be dismayed by what you are about to do. See the warning with the SQUEEZE command.

Appendix G -- LOGICAL SUBSET DISKS

Logical subset disks provide a method of logically partitioning a large disk into smaller units which can themselves be treated as directory structured devices. This is done by creating a (relatively large) file on a physical device and then creating a device directory and files within that file. The resulting pseudo device which is created within the file on the mother device is called a logical subset disk. Logical subset disks may also be nested. That is, one logical subset disk may be contained within another logical subset disk. This nesting may continue up to seven levels of logical subset disks within other logical subset disks. Logical subset disks may be initialized, squeezed, and have files created, opened, closed and deleted. They may also be assigned logical device names (e.g. OUT:, DK:, ABC:). Several keyboard commands are used to manipulate logical subset disks: DISMOUNT, MOUNT, SET LD and SHOW SUBSETS.

Support for logical subset disks is built into the kernel of TSX-Plus. Therefore, it is not necessary to use the LD device handler and logical subset disks may be used under TSX-Plus with either version 4 or version 5 RT-11 utilities.

Logical subset disks are given the device names LD0 through LD7. Each user may use all eight logical subset disks at any time. That is, if one user has mounted LD0 then any other user may also use LD0 simultaneously and they need not (and usually will not) refer to the same file containing the logical subset disk. If logical subset disks are nested, then the device numbers must increase with the level of nesting. For example, LD0 may contain a file to be mounted as LD1. However, a file contained within LD1 may never be mounted as LD0.

The typical sequence of operations when using logical subset disks is to: 1) create a file on a physical disk device; 2) mount that file as a logical subset disk; 3) initialize the new logical subset disk; 4) proceed to use it as any other disk device (except that it cannot be physically handled independently of the surrounding real disk). Subsequent uses of the logical disk only require that the disk be remounted. The file need not be recreated, nor the logical subset disk reinitialized.

The following example shows a typical sequence of commands which might be used to initiate use of a new logical subset disk.

```
CREATE DL1:MYDISK.DSK/ALLOCATE:500.
MOUNT LD0: DL1:MYDISK
INITIALIZE/NOQUERY LD0:
     .
     .
     .
DISMOUNT LD0:
```

In order to use this new logical disk at a later time, it would only be necessary to issue the MOUNT command:

```
MOUNT LD0: DL1:MYDISK DK:
```

The default (and recommended) file type for files intended to contain logical subset disks is .DSK.

When logical subset disks are mounted, information about them can be obtained with the SHOW SUBSETS command. For example:

```
.SHOW SUBSETS
LD0 --> DL1:MYDISK.DSK[500]
```

To remove a logical subset disk from use, use the dismount command. For example:

```
ASSIGN DL1 DK
DISMOUNT LD0:
```

Note that the disk files containing logical subset disks are automatically marked as protected files. In order to delete them, they must first be unprotected.

It is possible with logical subset disks to create some unusual situations and conflicts. For example, it is possible to mount a logical subset disk and then unprotect and delete the file which contained it. This condition would be marked with an asterisk (*) with the SHOW SUBSETS command. In addition, the SET LD CLEAN command can be used to force the system to compare, verify and correct the information in its internal logical subset disk tables if possible. Obviously, the system will not go back and recreate deleted files. An implicit SET LD CLEAN is done each time the DUP utility is called (e.g. with the INITIALIZE and SQUEEZE commands).

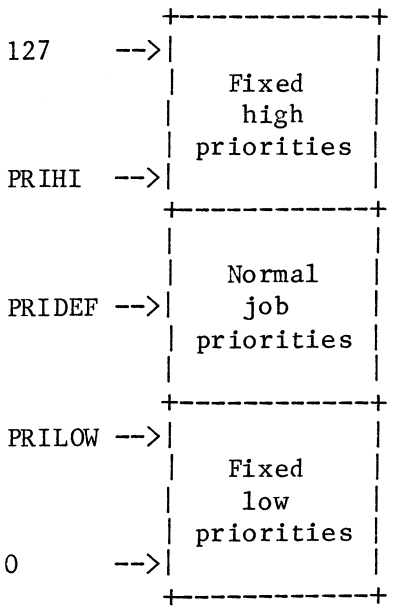
For more information on the details of the commands used with logical subset disks, see the descriptions in Chapter 2 of the following commands: DISMOUNT, MOUNT, SET LD, and SHOW SUBSETS.

Appendix H -- JOB EXECUTION PRIORITIES

TSX-Plus jobs may be assigned execution priorities to control their scheduling relative to other jobs. The priority values range from 0 to 127. The maximum execution priority that may be assigned to a job can be controlled by the system manager by use of the TSAUTH account authorization program or the SET MAXPRIORITY command (see the TSX-Plus System Manager's Guide).

The priority assigned to a job is set by use of the SET PRIORITY keyboard command or the TSX-Plus EMT described in Chapter 7. The current priority for a job and the maximum authorized priority can be displayed by use of the SHOW PRIORITY keyboard command, and may be obtained from within programs with the .GVAL request.

The priority values are arranged in three groups: the fixed-low-priority group consists of priority values from 0 up to the value specified by the PRILOW sysgen parameter; the fixed-high-priority group ranges from the value specified for the PRIHI sysgen parameter up to 127; the middle priority group ranges from (PRILOW+1) to (PRIHI-1). The following diagram illustrates the priority groups:



Job scheduling is performed differently for jobs in the fixed-high-priority and fixed-low-priority groups than for jobs with normal interactive priorities. Jobs with priorities in the fixed-low-priority group (0 to PRILOW) and the fixed-high-priority group (PRIHI to 127) execute at fixed priority values. That is, the priority absolutely controls the scheduling of the job for execution relative to other jobs. The job state does not influence the execution scheduling except as to whether the job is in a ready-to-run state or a wait state. A job with a fixed priority is allowed to execute as long as it wishes until a higher priority job becomes active.

The fixed-high-priority group is intended for use by real-time programs. The fixed-low-priority group is intended for use by very low priority background

tasks. Normal time-sharing jobs should not be assigned priorities in either of the fixed priority groups.

The middle group of priorities from (PRILOW+1) to (PRIHI-1) are intended to be used by normal, interactive, time-sharing jobs. Jobs with these assigned priorities are scheduled in a more sophisticated manner than the fixed-priority jobs. In addition to the assigned priority, external events such as terminal input completion, I/O completion, and timer quantum expiration play a role in determining the effective scheduling priority. For these jobs the job state is the primary factor in determining execution scheduling and the user-assigned job priority only influences the scheduling of jobs in the same state. See Chapter 5 of the TSX-Plus System Manager's Guide for further information about job scheduling.

When a job with a normal priority switches to a subprocess, the priority of the disconnected job is reduced by the amount specified by the PRIVIR sysgen parameter. This causes jobs that are not connected to terminals to execute at a lower priority than jobs that are. This priority reduction does not apply to jobs with priorities in the fixed-high-priority group or the fixed-low-priority group. The priority reduction is also constrained so that the priority of normal jobs will never be reduced below the value of (PRILOW+1).

Appendix I -- PROGRAM DEBUGGER

Programming errors can sometimes be very difficult to identify and correct without a detailed stepwise examination of a program's progress. Some higher level languages, like COBOL-Plus, include a debugging tool that allows such examination. For programs written in MACRO assembly language or when it is desirable to examine a program at the level of individual instructions, TSX-Plus provides a debugging facility with the following features:

1. The debugger is included as an optional system overlay and does not share memory space with the program being debugged. This allows programs up to the full 64Kb virtual address space to be run with the debugger. It can also be used with programs which are mapped to the I/O page or which use overlays, shared run-time systems, or extended memory regions (PLAS regions; virtual arrays or overlays).

2. The debugger does not have to be linked with the program being debugged. It can be invoked when the program is executed by the RUN/DEBUG command.

3. A keyboard command can be issued to permit debugging of any subsequent user program or utility even if the program is not started with the RUN/DEBUG command.

4. Execution of a program can be interrupted at any time by typing control-D. This causes entry to the debugger similar to hitting a breakpoint in the program.

5. The debugger can decode instructions into symbolic assembly language.

6. Program traps to 4 and 10 are caught by the debugger rather than causing a program abort with return to the keyboard monitor, unless the program has issued a .TRPSET EMT.

7. A data "watchpoint" facility is included which can cause an execution break to occur when the value of a monitored data item is changed.

I.1 Debugger requirements

In order to make effective use of the debugger facility, it is necessary to have a link map of the program being debugged. This minimizes the usefulness of the debugger for interpreted languages (e.g. BASIC) and languages with a run-time system (e.g. DIBOL) unless one is interested in debugging the run-time interpreter. For other high-level languages (e.g. FORTRAN and Pascal) the debugger is most useful for small program sections for which the intermediate assembly code is available.

The debugger facility is an optional feature of TSX-Plus, included during system generation. Debugger support must have been selected during system generation (DBGFLG = 1) in order to use this feature.

I.2 Invoking the debugger

The debugger need not be linked with the program being debugged. Programs may either be started under debugger control with the RUN/DEBUG command, or can be interrupted while running by typing control-D if the SET CTRLD DEBUG command has been previously issued.

I.2.1 RUN/DEBUG switch:

A program may be started under control of the debugger with the /DEBUG switch to the RUN command. For example:

```
.R/DEBUG PRGNAM
```

When a program is started under debugger control, the program is loaded and the debugger prompt appears. For example:

```
.RUN/DEBUG PRGNAM

TSX-Plus debugger

DBG:
```

Whenever the debugger is in control, the "DBG:" prompt will appear and the debugger will be ready to accept a command.

On entry to the debugger, the program start address is loaded into R0 and set so that program execution may be initiated with the ";G" command without specifying a starting address. It is usually desirable to set initial values for relocation registers and breakpoints before starting program execution.

I.2.2 Control-D break

Control-D normally only interrupts program execution if the program has been started by the RUN/DEBUG command. However, a keyboard command is available to enable control-D to interrupt a program and pass control to the debugger even if the program was not started under debugger control. (See the description of the SET CTRLD DEBUG command in chapter 2.) If control-D interruption has been enabled, then any program may be interrupted and control transferred to the debugger regardless of whether the program was started under debugger control. The effect is similar to hitting a breakpoint at the current location. The same debugger commands and facilities are available when the debugger is entered this way as when the program is started under debugger control. Note however, that if the SET CTRLD DEBUG command has not been issued prior to starting a program's execution and that program is not started with the RUN/DEBUG command, then control-D will have no special effect on the program and debugger control cannot be obtained without restarting the program. The SET CTRLD DEBUG command is local to each time-sharing line and must be invoked from that line to enable control-D breakpoints in programs which are not started with the RUN/DEBUG command. If a program is started with the RUN/DEBUG command, then control-D may be used to interrupt its execution regardless of whether the SET CTRLD DEBUG command has been issued.

See the "Special notes" section at the end of this appendix for information about interactions of control-D with special terminal mode and special activation characters.

I.3 BPT Instruction

A program which includes a BPT instruction can trigger execution of the system debugger. If a BPT instruction is executed by a program which is not currently associated with the system debugger and location 14 (trap vector for BPT) in the program is 0 (zero), then the system debugger is entered with the instruction that follows the BPT as the current instruction. If a program is already associated with the system debugger (RUN/DEBUG or by a control-D) when the BPT is executed, then the BPT does not cause entry to the debugger.

I.4 Commands

The commands and syntax of the debugging facility are similar to those of RT-11's ODT. However, not all ODT commands are implemented and some additional features are provided. In the following list of debugger commands, angle brackets are used to indicate special terminal keys such as <RETURN>, <TAB> and <LINE FEED>. The angle brackets are not part of debugger command syntax. Many commands accept a numerical value or address, indicated here as value, address, repeat or n. The underlined portion should be substituted with the appropriate number when issuing the command. The value is optional in some cases. All numerical values are assumed to be octal unless terminated by a decimal point. The period character (.) may be used to indicate the current value of the program counter; for example, see the address;nB command to set an instruction breakpoint.

Debugger Commands

address/	Display the contents of the addressed word.
address\	Display the contents of the addressed byte.
value<RETURN>	Store value into the currently open cell. If value is omitted, close the current location without changing its contents.
value<LINE FEED>	Store value into the currently open cell and then advance to the next word or byte. If value is omitted, advance to the next location without changing the value of the current location.
value^	Store value into the currently open cell and then advance to the previous word or byte. If value is omitted, back up to the previous location without changing the contents of the current location.

<BACKSPACE>	Equivalent to up-arrow ("^").
@	Open the cell whose address is specified by the contents of the currently open cell.
_ (underscore)	Open the cell whose address is specified by the contents of the currently open cell plus the current location plus 2.
address[	Open the cell whose address is specified and display its contents as a symbolic instruction. If address is omitted, decode the contents of the currently open cell into symbolic instruction form.
address]	Open the cell whose address is specified and display its contents as a symbolic instruction. If address is omitted and a cell is currently open as an instruction, close the current cell and open the next cell and display its contents in symbolic instruction format. The location of the next cell opened is determined by the number of words used by the instruction in the currently open cell.
value<TAB>	Execute the next instruction in single step mode. It is not necessary to issue the ";1S" command to single step using the TAB key. If value is non-blank, the value is used to calculate the address of the next instruction to be single stepped (similar to ;1S, then value;P). If 0 (zero) is substituted for value before <TAB> is typed and the next instruction is a JSR (CALL), then a temporary breakpoint is set beyond the JSR to catch the return from the called subroutine and the subroutine is executed without single stepping. This can be used to avoid single stepping through subroutines called from code that is being single stepped.
address;nR	Set relocation base register n to address. There are 8 relocation registers, numbered 0 through 7.
nR	Convert the contents of the currently open cell into an offset relative to relocation register n.
n!	Convert the current address to an offset relative to relocation register n.

address;nB — Set an instruction breakpoint at address. There are 8 instruction breakpoints, numbered 0 through 7. To clear a breakpoint, substitute 0 for address. The period character may be used to indicate the current value of the program counter. For example, to set breakpoint 1 at the current address:

```
.;1B
```

address;G — Go to location address and start program execution there.

repeat;P — Proceed from a breakpoint. If repeat is non-blank, do not break again until repeat breakpoints have been hit. If repeat is omitted, proceed until the next breakpoint is hit.

;nS — Set or reset single stepping mode. If n is 1 (or any other non-zero value), begin single step mode. When single stepping, execution will proceed one instruction for each execution of the ";P" command. If n is 0 or is omitted, single stepping mode is cancelled and the program will resume normal execution when the ";P" command is issued. (See also the <TAB> command.)

X — Interpret the contents of the currently open word as a RAD50 value and display it as a three character ASCII string. Up to three characters may be entered after the current value is displayed. The new characters will be converted to a RAD50 value and stored in the current location. Any characters beyond the first three are ignored.

address;valueM — Set a data watchpoint. The word specified by address is monitored. If value is specified, a data watchpoint occurs when the value of the word matches value. It is possible to "watch" only selected bits of the monitored address by setting the mask register (see $M and data watchpoint description below). If value is omitted, a data watchpoint occurs any time the value of the word changes.

I.5 Control-D breakpoints

When a program has been started by the RUN/DEBUG command, its execution can be interrupted at any time by typing control-D. (If the SET CTRLD DEBUG command has been issued, then the program need not have been started under debugger control.) Typing control-D causes the program to stop as though a breakpoint had been encountered at the current location and passes control to the debugger. Any valid debugger command may be issued at this point, and program

execution may be resumed with the ";P" command. If a system service call (EMT) is being executed when control-D is typed, the service call will run to completion and control will be passed to the debugger at the point of return to the program from the EMT.

See the "Special notes" section at the end of this appendix for more information on interactions of control-D with special terminal mode and special activation characters.

I.6 Address relocation

Address values in commands may be specified absolutely or in the form "n,offset", where n is a relocation register number and offset is the offset relative to that relocation register.

When an instruction is decoded into symbolic form, relative addresses are displayed in the form "[n,offset]" as an offset from the nearest relocation register whose value is lower than the address. The format register ($F) can be used to control the display format of addresses.

Only two bits are significant in the $F register, bits 0 and 1. Bit 0 controls the display of instruction address operands, and bit 1 controls the display of location values. Setting either bit causes the corresponding addresses to be displayed in absolute format. Clearing either bit causes the corresponding addresses to be displayed in relative format. Both default to relative format ($F = 0).

Address Display Format

$F	Locations	Operands
0	relative	relative
1	relative	absolute
2	absolute	relative
3	absolute	absolute

I.7 Internal registers

The following special address symbols are used to specify machine registers:

$0 through $5 -- Registers R0 through R5.

$6 -- Register 6, the stack pointer (SP).

$7 -- Register 7, the program counter (PC).

$S -- Processor Status Word.

The following special address symbols are used to specify internal debugger registers:

$M -- Mask register, used with data watchpoints (see below).

$F -- Print format control register (see above).

$B -- Start of instruction breakpoint address registers.

$R -- Start of relocation registers.

I.8 Data watchpoints

The data watchpoint facility is a powerful tool for determining where a particular data cell is being modified. The form of the command used to initiate a watchpoint is:

address;valueM

where address is the address of the word that is to be monitored, and value is an optional parameter that specifies a value to be watched for. If value is omitted, a data watchpoint occurs any time the value of the word changes. If value is specified, a watchpoint only occurs when the value of the word matches the specified value. When a watchpoint occurs, the program counter is pointing past the instruction which modified the word.

A data mask may be specified to select a portion of the word being monitored with the watchpoint. The mask value may be referenced using the register name "$M". Initially the value of the mask is 177777 which causes the entire word contents to be monitored. If some other value is stored in $M, only the bits selected by the mask are monitored.

Use of the data watchpoint facility causes the program to execute very slowly. When a watchpoint is in effect the debugger causes a break to occur on each instruction executed and then checks to see if the monitored data word has changed value. If a watchpoint is in effect but no instruction breakpoints are set, the execution of the program is slowed down by a factor of about 55 (i.e., the program takes 55 times as long to execute). If a watchpoint is in effect and instruction breakpoints are also set, the speed reduction factor is about 80. There is no significant speed reduction when instruction breakpoints are set but no watchpoint is in effect. The best strategy is to set an instruction breakpoint as close as possible to the code which is modifying the data word and then, when that breakpoint is reached, remove the instruction breakpoint, set the data watchpoint, and proceed with execution.

I.9 Symbolic instruction decoding

Symbolic instruction decoding is used to interpret values according to their numerical op codes and convert them into symbolic assembly language format. The display format of address operands is controlled by the $F register. When a breakpoint is reached, the instruction on which the breakpoint was set is displayed in its symbolic form. Specific locations can also be symbolically decoded with the "[" and "]" operators.

The "[" command can be issued to symbolically decode a value which has just been displayed using the "/" command or to symbolically decode the contents of a specific location. The following examples illustrate how this might be done (the commands typed by the user are underlined):

```
DBG:2030/  010246  [  MOV     R2,-(SP)
DBG:3000[    BIT     #2000,[3,100]
```

The "]" operator closes the currently open cell, opens the next cell and displays its contents in symbolic instruction form. The number of words to skip from the currently open cell to the next cell is determined by the number of words used by the instruction in the currently open cell. Thus, the "]" operator is convenient for examining a consecutive set of instructions.

I.10 Special notes

Address location 0 is special to the debugger. For example: symbolic instruction decoding is not done for address 0, and line-feed does not step to the next location after examining location 0.

Since control-D is used by the debugger to dynamically interrupt a program, control-D will not be passed through to a running program even if the program is in special terminal input mode (TTSPC$ bit set in the JSW). If the program is waiting for terminal input when control-D is typed, then it is necessary to type an activation character (usually <RETURN>) before causing a break to occur and passing control to the debugger.

If a program declares control-D as a special activation character, then control-D is always passed to the program and cannot be used to cause a break in that program and pass control to the debugger.

When the debugger is operating in single step mode, normal breakpoints are temporarily removed and are restored when leaving single step mode. A side effect of this is that if the program executes an instruction (such as RTT) which clears the T (trace) bit in the processor status word, then single stepping is lost, breakpoints are not restored and the program continues execution.

Breakpoints set in overlay regions are only valid while that overlay is resident. If another overlay becomes resident, any breakpoints set in the previous overlay are lost and must be reset.

An attempt to set a break-point in a shared run-time region which is mapped as read-only will result in the error:

```
?MON-F-Kernel mode trap within TSX-Plus
Abort location = xxxxxx
```

When examining the processor status word ($S register), keep in mind that only the low 4 bits (condition codes) are significant to the program. The trace bit is used by the debugger. The priority bits are not significant in user mode under TSX-Plus. And, the high 4 bits will always be set, indicating user as both previous and current mode.

If the user program has issued a .TRPSET call, then traps to 4 and 10 are not intercepted by the debugger, but are passed to the user program's trap handling routine.

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