30
10-28-82
(82)

I-6117

(2)

ornl

ORNL/TM-8507

**OAK
RIDGE
NATIONAL
LABORATORY**

**UNION
CARBIDE**

MASTER

**TSX-Plus for Laboratory Data
Acquisition and Control**

J. M. Keller

ORNL/TM--8507

DE83 001633

**OPERATED BY
UNION CARBIDE CORPORATION
FOR THE UNITED STATES
DEPARTMENT OF ENERGY**

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

Printed in the United States of America. Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road, Springfield, Virginia 22161
NTIS price codes—Printed Copy: A03; Microfiche A01

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Contract No. W-7405-eng-26

Analytical Chemistry Division

TSX-PLUS FOR LABORATORY DATA ACQUISITION AND CONTROL

J. M. Keller

Date Published - October 1982

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37830
operated by
UNION CARBIDE CORPORATION
for the
DEPARTMENT OF ENERGY

THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

CONTENTS

Abstract	1
Introduction	1
Useful Routines for Data Acquisition and Instrument Control	3
Accessing the I/O Page	3
Control of Program Swapping	7
Program Communication with TSX-Plus	9
Detached Job Facility of TSX-Plus	11
Interrupt Routines under TSX-Plus	13
Conclusion	18
Appendix A. Subroutines for I/O Page Access	19
Appendix B. Subroutines for Control of Program Swapping	26
Appendix C. Subroutines for Program Communications	30
Appendix D. Subroutines for Support of the TSX-Plus Detached Job Facility	34

TSX-PLUS FOR LABORATORY DATA ACQUISITION AND CONTROL

J. M. Keller

ABSTRACT

TSX-Plus* is a multi-user operating system for PDP-11† and LSI-11† computers, which offers many of the features available with the DEC RSX-11M.† For present users of RT-11† who wish to upgrade to a multi-user operating system, TSX-Plus offers several advantages over RSX-11M, such as lower cost and software compatibility with RT-11. TSX-Plus maintains a similarity with RT-11 by employing the RT-11 utility programs and device drivers; also, the RT-11 monitor commands are a subset of the TSX-Plus commands. Laboratory applications of TSX-Plus are discussed, and a set of FORTRAN callable subroutines, which are useful for data acquisition and hardware control, are presented. Also, the use of hardware interrupt and trap instructions (software interrupt) under TSX-Plus are discussed.

INTRODUCTION

TSX-Plus is a general purpose, time-sharing operating system for Digital Equipment Corporation (DEC) PDP-11 and LSI-11 computers. TSX-Plus will run on any PDP-11 or LSI-11 computer that has memory management facilities and at least 96 kbytes of memory. The functionality of the DEC RT-11 operating system is retained under TSX-Plus for up to twenty concurrent time-sharing users. However, TSX-Plus is not an RT-11 emulator; rather, TSX-Plus supports RT-11 service calls as its basic mode of operation. TSX-Plus interfaces with standard RT-11 device handlers, supports RT-11 utility programs (i.e., PIP, DUP, DIR, etc.) and CCL commands (i.e., COMPILE, EXECUTE, etc.), and provides a super set of RT-11 keyboard commands. In general, it will appear to a user under TSX-Plus, that an RT-11 single job monitor is operating.

*Available from S&H Computers, Nashville, TN (615/327-3670).

†Trademark of Digital Equipment Corp. (DEC).

A time-sharing system is a multiprogrammed computer that allows its multiple users to share system resources in such a fashion that each user thinks he is getting individual attention. The system is multiprogrammed in that several user programs (or jobs) may reside concurrently in memory at any given time. Each program receives a quantum of computer time, called a time slice, during which it can perform computations. Should the job use up its time slice or reach a point where further computations are not possible (i.e., I/O information is needed), the CPU will be turned over to another program. This transfer is handled rapidly since the next program to gain access to the CPU will already be in memory.

The time-shared operation of a computer implies sharing the computer's time and space resources on a dynamic, and hence temporary, basis. Several user programs may be memory resident while others may be in the process of being loaded from or to auxiliary mass storage. If memory is not large enough to hold all the user programs or jobs and data (which is usually the case), it will be necessary to swap user information in and out from the auxiliary storage upon demand. The swapping requirement implies the use of a high-speed mass storage device, the minimum of which is a floppy disk system. However, it is preferable to employ mass storage that is faster and has a larger storage capacity than a floppy disk. The DEC RL01 or RL02 system or one of the newer Winchester disk systems is an example of mass storage that is more suitable for the swapping requirements.

Another feature of the TSX-Plus is its ability to handle real-time programming, which is a necessity for applications involving hardware control and data acquisition. Real-time systems are designed for handling data in a time that is consistent with the response time demanded by the process that generates the information. Such systems operate in a multiprogrammed environment with a real-time monitor controlling and supervising a large number of memory- or disk-resident programs and tasks. This supervision allows the tasks to share memory and disk space, I/O device handlers, and resource allocation and use. The execution of the many tasks is determined by software priorities, hardware interrupts, timing algorithms, and requests from other tasks.

TSX-Plus offers the option of requiring users to log on the system. The log-on feature allows the system manager to allocate account numbers and

pass words to the system users. This not only gives the system manager the option of monitoring system use but also provides a degree of security to the system. For the protection of system software and critical data, the access to mass storage devices and other system resources can be limited. The degree of access to the system is controlled by the system manager and is based upon the user's account number. System access can also be based upon the terminal or line number used for communication with the system. This feature is useful in preventing novice users from damaging system software by locking a user to a specific application program and in preventing an experienced user from inadvertently disrupting instrument control or data acquisition by accessing the I/O page.

The purpose of this paper is to present a set of routines that employ a subset of the available EMTs under TSX-Plus that will allow a FORTRAN programmer with the facilities to control and read data from the real world. Also, several routines that support the message communication facilities between jobs and the detached job facility are presented. The routines will provide the TSX-Plus user with examples of employing the EMT routines, a feature that is lacking in the TSX-Plus documentation. A knowledge of FORTRAN and a basic understanding of RT-11 are assumed for the following discussions.

USEFUL ROUTINES FOR DATA ACQUISITION AND INSTRUMENT CONTROL

Data acquisition and instrument control require access to the device status and control registers that reside in the I/O page (address 160000-177777) on PDP-11 and LSI-11 computers. A normal TSX-Plus time-sharing job cannot access the I/O page; however, TSX-Plus provides the facilities necessary to read and write to this area. By providing a number of emulator trap (EMT) service routines, TSX-Plus not only allows the MACRO-11 programmer to access the I/O page but also provides many useful facilities for program design and development.

ACCESSING THE I/O PAGE

Six routines (all FORTRAN callable) that allow the programmer access to the I/O page are presented. A source listing of these routines is provided

in Appendix A and includes the routines BITCLR, BITSET, IOPEEK, IOPOKE, MAPIO, and UNMAP. These routines are coded in MACRO-11 and can be called by either a FORTRAN or another MACRO-11 program.

One can access the I/O page with a program executing under TSX-Plus in two ways. The efficient technique is to access the device control registers directly by mapping the I/O page to the program's virtual address region (160000-177777). A call to the routine MAPIO performs this function for either the FORTRAN or MACRO programmer. With the I/O page mapped to the user's area standard RT-11 system library routines, IPEEK and IPOKE can be employed by the FORTRAN programmer to access device control registers, and the MACRO programmer can employ standard techniques to access these registers. The complement to the MAPIO routine is the UNMAP routine. The UNMAP routine will map the program's virtual address region (160000-177777) to the simulated resident monitor (RMON) — default status for the TSX-Plus program.

If a TSX-Plus program requires access to offsets inside the RMON, the MAPIO routine cannot be employed. For this case, TSX-Plus provides EMTs to peak, poke, bit-set, and bit-clear registers in the I/O page.

The subroutines IOPEEK and IOPOKE allow a program to access the I/O page without requiring the job's virtual address region to be mapped to the I/O page. To a FORTRAN programmer, the function and calling format for IOPEEK and IOPOKE is identical to the RT-11 system library subroutines IPEEK and IPOKE. The IOPEEK subroutine allows a program to read the contents of a word in the I/O page. The FORTRAN call format is

I = IOPEEK (address)

or

CALL IOPEEK (address, I) ,

where address is the actual octal address in virtual memory to be read, and the contents of this address are returned in the integer variable I.

The IOPOKE subroutine permits a program to write data into a memory cell within the I/O page. The FORTRAN call format is

CALL IOPOKE (address, value),

where address is the octal location that the contents of value will be stored. An example of employing IOPEEK and IOPOKE is presented in Program 1.

Program 1

```

FORTRAN IV      V02.5-2      TUE 15-JUN-82 13:24:29
0001      PROGRAM PROG1
          C
          C      THIS PROGRAM DEMONSTRATES THE USE OF IOPEEK
          C      AND IOPOKE UNDER TSX-PLUS.
          C
          C      THE PROGRAM OUTPUTS A LINE OF CHARACTERS
          C      (A-Z) TO A LINE PRINTER.
          C
0002      INTEGER*4 XCSR,XBUF
0003      DATA XCSR,XBUF/"176504","176506/
0004      CALL IOPOKE(XBUF,"14)                !SEND <FF> TO LP
          C
          C      OUTPUT CHARACTERS A-Z
          C
0005      DO 20 I=1,26
          C      WAIT FOR TRANSMIT READY TO SET
0006      5  IF(IOPEEK(XCSR).NE."200)GO TO 5
0008      CALL IOPOKE(XBUF,"100+I)            !TYPE A-Z ON LP
0009      20  CONTINUE
0010      CALL IOPOKE(XBUF,"12)                !SEND <CR>
0011      25  IF(IOPEEK(XCSR).NE."200)GO TO 25
0013      CALL IOPOKE(XBUF,"15)                !SEND <LF>
0014      END

```

Program 1 outputs a line feed (octal 14, line 4), the characters A-Z (line 5-9), and a carriage return (line 10) to a line printer. The octal address in the I/O page for the line printer's transmit status register and buffer is defined in line 3. Line 6 is present to make sure the last character transmitted to the line printer is received before the next character is transmitted by doing an IOPEEK at the line printer status register and waiting until the transmit ready bit is set.

The subroutines BITCLR and BITSET also provide the means for a programmer to access the I/O page. The BITCLR allows one to clear various bits within the contents of an address. The FORTRAN call format is

```
CALL BITCLR (address, value),
```

where address is the octal address in the I/O page to which the bits defined by the argument value will be cleared (set to zero).

The subroutine BITSET is the compliment to BITCLR and allows the programmer to set various bits within the contents of an address in the I/O page. The FORTRAN call format is

```
CALL BITSET (address, value),
```

where address is the octal address in the I/O page to which the bits defined by value will be set (set to one). An example of employing BITSET is given in Program 2.

Program 2

```

FORTRAN IV      V02.5-2    TUE 15-JUN-82 13:24:29

0001      PROGRAM PROG2
           C
           C      THIS PROGRAM DEMONSTRATES THE USE OF IOPEEK
           C      AND BITSET UNDER TSX-PLUS.
           C
           C      THE PROGRAM OUTPUTS A LINE OF CHARACTERS
           C      (A-Z) TO A LINE PRINTER.
           C
0002      INTEGER*4 XCSR,XBUF
0003      DATA XCSR,XBUF/"176504","176506/
0004      CALL BITSET(XBUF,"14)                !SEND <FF> TO LP
           C
           C      OUTPUT CHARACTERS A-Z
           C
0005      DO 20 I=1,26
           C      WAIT FOR TRANSMIT READY TO SET
0006      5  IF(IOPEEK(XCSR).NE."200)GO TO 5
0008      CALL BITSET(XBUF,"100+I)      !TYPE A-Z ON LP
0009      20  CONTINUE
0010      CALL BITSET(XBUF,"12)          !SEND <CR>
0011      25  IF(IOPEEK(XCSR).NE."200)GO TO 25
0013      CALL BITSET(XBUF,"15)          !SEND <LF>
0014      END

```

Program 2 is identical to Program 1 except that the IOPOKE has been replaced with a call to BITSET at lines 4, 8, 10, and 13.

Although it appears that IOPOKE and BITSET perform the same function, they are different. If an IOPOKE is executed, the contents of the address are replaced by the subroutine argument. Consider the following FORTRAN code:

```
CALL IOPOKE ("176000","200)
CALL IOPOKE ("176000","10)
I = IOPEEK ("176000)
```

The value of "I" would equal octal 10. If a BITSET is executed, only the bits defined by the BITSET argument are changed:

```
CALL IOPOKE ("176000","200)
CALL BITSET ("176000","10)
I = IOPEEK ("176000)
```

The value of "I" would equal octal 210.

Since the BITSET routine changes only the bits defined by the argument, one might ask why example Program 2 works the same as Program 1. Output to the transmit buffer of the serial interface employed for this example is a special case. When one writes a value to the transmit buffer (XBUF), the character represented by the octal value is output to the line printer. Once the character is printed, the transmit buffer is empty or equal to zero. In other words, the transmit buffer has no memory of its previous contents since it is always equal to zero after the character is printed.

CONTROL OF PROGRAM SWAPPING

TSX-Plus is a multi-user system, which implies that a number of programs may be memory resident concurrently. If the memory required by the programs exceeds the available memory, it is necessary to swap programs between memory and disk. In time-critical applications, where a program must respond to an interrupt in real-time, it may be necessary for the

routines to be locked into memory to avoid swapping. When a program is locked into memory, the space occupied by the program is no longer available for the multi-user environment; therefore, care should be exercised when locking large programs into memory

TSX-Plus provides two EMT facilities for locking a program into memory. The two FORTRAN callable routines, which employ the EMTs, are listed in Appendix B. The first subroutine LOCKLO will move the program to the low end of memory before locking it. This transfer to low memory is performed so that the available free memory is not fragmented. The FORTRAN call format is

CALL LOCKLO

and is normally employed when a program will be locked in memory for a long period of time. Since the LOCKLO routine may involve program swapping, it can be a relatively slow form of locking.

The second subroutine for locking a program into memory is JLOCK, which has a FORTRAN call format of

CALL JLOCK .

The JLOCK subroutine simply locks the program into the memory space that is occupied when the EMT is executed. This form of program locking has the advantage of being extremely fast, since no program swapping is required; however, the free memory space may be noncontiguous. The subroutine JLOCK should be employed only for applications that require the program to be locked for a relatively short period of time.

A third EMT for control of program swapping provided by TSX-Plus allows one to unlock a program from memory. This EMT is available to the FORTRAN programmer through the subroutine UNLOCK; the FORTRAN call format is

CALL UNLOCK .

When a program is locked into memory, it will remain locked until the program ends or the unlock EMT is executed.

PROGRAM COMMUNICATION WITH TSX-PLUS

TSX-Plus provides a useful facility that allows running programs to communicate with each other via named message channels. Three EMTs are provided to support the message communication facility for the assembly language programmer. Included in Appendix C are corresponding FORTRAN callable subroutines for each EMT.

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. Associated with each active message channel is a one-to-six character name that is used by the sending and receiving programs to identify the channel. Once a message is queued on a channel, that message will remain in the queue until some program receives it or until the TSX-Plus system is restarted. This allows a program to leave a message for another program that will run later.

To put a message on a named channel, the subroutine MSEND is employed. FORTRAN call format is

```
CALL MSEND (chan. name, message) ,
```

where chan. name is a one-to-six character name for the message channel to be employed and the message is a one-to-sixty-four-byte ASCII string. 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 does not wait for the message to be accepted by a receiving program, and since the message is saved in an internal buffer, the sending program is free to destroy its message on completion of the subroutine.

Two routines are available for receiving messages from a named message channel. The first routine is MRECV; the FORTRAN call format is

```
CALL MRECV (chan. name, iarray, IFLAG)
```

or

```
IFLAG = MRECV (chan. name, iarray) ,
```


where chan. name is the message channel to check for a pending message, iarray is a 64-byte array to receive the message, and IFLAG is the message status flag (IFLAG = 1 if message was received, IFLAG = 0 if no message is pending). If no message is pending, IFLAG is cleared and the program is allowed to continue execution.

The second routine for receiving messages is MRECVW, and the FORTRAN call format is

```
CALL MRECVW (chan. name, iarray) ,
```

where chan. name and iarray are defined the same as for MRECV. The main difference in this message-receiving routine and the previous one is that the MRECVW will suspend program execution until a message becomes available on a named channel.

An example of employing the message communication facility of TSX-Plus is presented in Program 3 and Program 4.

Program 3

```

FORTRAN IV      V02.5-2    TUE 15-JUN-82 13:24:36

0001      PROGRAM PROG3
           C
           C      THIS PROGRAM ALONG WITH PROG4.FOR DEMONSTRATES
           C      THE MESSAGE COMMUNICATION FACILITY OF TSX-PLUS.
           C
0002      BYTE MSG2(19)
0003      DATA MSG2/'M','E','S','S','A','G','E',' ','2',
1' ','0','N',' ','C','H','A','N','0','2'/
0004      CALL MSEND('CHAN01','MESSAGE 1 ON CHAN01')
0005      CALL MSEND('CHAN02',MSG2)
0006      END

```

Program 4

```

FORTRAN IV      V02.5-2    TUE 15-JUN-82 13:24:39

0001      PROGRAM PROG4
           C
           C      THIS PROGRAM RECEIVES TWO MESSAGES FROM THE
           C      PROGRAM PROG3. SEVERAL FORMS OF THE RECEIVE
           C      MESSAGE SUBROUTINES ARE DEMONSTRATED.
           C

```

Program 4 (continued)

```

0002      BYTE ARRAY(64)
          C
          C      THIS CALL SUSPENDS PROGRAM EXECUTION UNTIL
          C      THE MESSAGE IS RECEIVED.
          C
0003      CALL MRECVW('CHAN01',ARRAY)
0004      CALL PUTSTR(7,ARRAY,'0',IERR)          !PRINT MESSAGE
          C
          C      THIS CALL WILL NOT SUSPEND EXECUTION. IF THE
          C      VALUE OF IFLAG=1 A MESSAGE WAS RECEIVED, IF
          C      IFLAG=0 NO MESSAGE WAS QUEUED ON THE NAMED
          C      CHANNEL. THIS SUBROUTINE CAN ALSO BE CALLED AS
          C      A FUNCTION SUBROUTINE E.G.,
          C
          C      IFLAG=MRECV('CHAN02',ARRAY)
          C
          C
0005      CALL MRECV('CHAN02',ARRAY,IFLAG)
0006      CALL PUTSTR(7,ARRAY,'0',IERR)          !PRINT MESSAGE
0007      END

```

When Program 3 is executed, two messages are placed on the named channel: "CHAN01" and "CHAN02." These two messages will remain queued until Program 4 is run. When Program 4 is executed, the two messages are removed from the queue and printed at the user's terminal.

DETACHED JOB FACILITY OF TSX-PLUS

Detached jobs operate similarly to a "batch" facility: generally, input to a detached job comes from a command file. However, a detached job can send and receive data via the message communication facility of TSX-Plus. The detached job facility of TSX-Plus allows the time-sharing user to initiate execution of several simultaneously executing jobs. Although the DETACH keyboard command can be used to start a detached job, an EMT is also provided to allow an executing program to start a detached job. The FORTRAN callable subroutine IDTACH is listed in Appendix D, and the FORTRAN call format is

```
CALL IDTACH (file name, job)
```

or

```
JOB = IDTACH (file name),
```

where file name is a command file that starts the detached job, and job is an integer variable in which the job number assigned to the detach job is returned. Care should be employed in defining the file name because the subroutine does not allow the use of logical device assignments. For example,

```
JOB = IDTACH ('DY0:FILNAM.EXT')
```

is acceptable; however, 'DK:FILNAM.EXT' would not execute correctly. The default file extension is .COM.

A running detached job may be aborted by calling the subroutine KILL. The subroutine KILL is listed in Appendix D, and the FORTRAN call format is

```
CALL KILL (job) ,
```

where job is the job number obtained from the call to IDTACH. Programs 5 and 6 demonstrate the use of the subroutine IDTACH.

Program 5

```

FORTRAN IV      V02.5-2      TUE 15-JUN-82 13:25:10

0001      PROGRAM PROG5
           C
           C      THIS PROGRAM DEMONSTRATES THE USE OF DETACHED
           C      JOBS AND THE JOB COMMUNICATION FACILITY OF
           C      TSX-PLUS.
           C
           C      THIS PROGRAM REQUIRES TWO OTHER FILES:
           C
           C      PROG5.COM
           C      PROG6.SAV
           C
           C      THE COMMAND FILE PROG5.COM STARTS THE PROGRAM
           C      PROG6 WITH A <RUN DEV:PROG6>. CREATE THE COM-
           C      MAND FILE WITH DEV: = TO A PHYSICAL DEVICE THAT
           C      MATCHES YOUR SYSTEM. DEV: CANNOT BE A LOGICAL
           C      DEVICE.
0002      BYTE ARRAY(64)
           C
           C      CHANGE THE DEVICE ASSIGNMENT TO MATCH YOUR
           C      SYSTEM CONFIGURATION.
           C
0003      JOB=IDTACH('VD3:PROG5.COM')
0004      TYPE 10,JOB

```

Program 5 (continued)

```

0005 10  FORMAT(5X,'DETACHED JOB # : ',I3)
0006      CALL MRECVW('CHAN01',ARRAY)
0007      CALL PUTSTR(7,ARRAY,'0',IERR)
0008      END

```

Program 6

FORTRAN IV V02.5-2 TUE 15-JUN-82 13:25:12

```

0001      PROGRAM PROG6
          C
          C      THIS PROGRAM RUNS AS A DETACHED JOB UNDER TSX-PLUS
          C      AND IS STARTED BY PROG.SAV FROM A COMMAND FILE
          C      PROG5.COM.
          C
0002      BYTE ARRAY(64)
0003      CALL MSEND('CHAN01','TEST OF DETACHED AND MESSAGE EMT OK')
0004      END

```

INTERRUPT ROUTINES UNDER TSX-PLUS

The TSX-Plus real-time support facility provides the means for processing hardware interrupts and trap instructions. The development of interrupt-driven completion routines under TSX-Plus is somewhat different than for RT-11 in that the .INTEN, .PROTECT, and .SYNCH programmed requests are not employed. Also, the RTI (return from interrupt) employed with RT-11 is replaced with an RTS PC (return from subroutine). A TSX-Plus EMT is provided for connecting a completion routine to a hardware interrupt or trap instruction. The EMT allows one to load the address of the completion routine in the interrupt vector address and assign a priority to the interrupt.

The interrupt priority assigned to a completion routine is used by TSX-Plus to schedule the routine for execution. The available priority levels are 0 to 7. The 0 priority is a special case in that conditions for time-sharing between jobs continues to take place. When employing priorities greater than 0, an executing completion routine will lock out all time-sharing users until the processing is complete or a system wait state is encountered. In a system wait state, such as waiting for the completion of an I/O operation, the completion routine loses its high priority and will subsequently run as a normal time-sharing job. When employing interrupt

routines under TSX-Plus, the programmer must keep in mind that a higher priority completion routine for one job will interrupt only a lower priority completion routine being executed by another job. A higher priority completion routine will not interrupt a lower priority completion routine for the same job.

An example of employing hardware interrupts is presented in Program 7.

Program 7

```

.TITLE WAITFO
ROUTINE TO WAIT A SPECIFIED TIME

FORTRAN CALL FORMAT:

        CALL WAITM(COUNT)           MILLISECONDS
              OR
        CALL WAITS(COUNT)           SECONDS

MACRO CALL FORMAT:

MSEC:          MOV     COUNT,R1
               JSR     PC,MWAIT

SFC:          MOV     COUNT,R1
               JSR     PC,SWAIT

.MCALL .DEVICE, .SPND, .RSUM

SPECIFY ADDRESS AND VECTOR FOR KW11P CLOCK

KCSR=172540           ;CLOCK CSR
KBUF=KCSR+2           ;COUNTER LOAD/PRESET BUFFER
KCTR=KCSR+4           ;COUNTER READ REGISTER
KVEC=104              ;CLOCK INTERRUPT VECTOR

WAITM:: MOV      @2(R5),R1      ;GET CLOCK COUNTS
MWAIT:: MUL      #10.,R1       ;MULT. COUNTS BY 10
        MOV      R1,@#KBUF     ;LOAD CLOCK COUNTER
        MOV      #103,R3      ;SET CLK TO 10 MHZ
        BR       SETUP

WAITS:: MOV      @2(R5),R1      ;GET CLOCK COUNTS
SWAIT:: MUL      #60.,R1       ;MULT. COUNTS BY 60
        MOV      R1,@#KBUF     ;LOAD CLOCK COUNTER
        MOV      #105,R3      ;SET CLK TO 60 HZ
SETUP:  MOV      #AREA,R0      ;SETUP INTERRUPT VECTOR
        EMT      375
        .DEVICE #AREA1,#ADDR  ;CLEAR INTERRUPT IN CASE OF ABORT
        MOV      R3,@#KCSR     ;ENABLE INTERRUPT

```

Program 7 (continued)

```

WAIT:  .SPND                      ;START CLOCK
      MOV      #0,@#KCSR          ;SUSPEND OPERATION UNTIL INT.
      RTS      PC                 ;DISABLE CLOCK INTERRUPT
AREA:  .BYTE    11,140            ;RETURN
      .WORD    KVEC               ;EMT ARGUMENT AREA FOR INTERRUPT
      .WORD    INSERV            ;INTERRUPT VECTOR
      .WORD    5                 ;ADDRESS OF INT. ROUTINE
      .WORD    2                 ;INT. PRIORITY
AREA1: .BLKW    2                 ;EMT AREA FOR .DEVICE
ADDR:  .WORD    KCSR,0,KVEC,0,0
;
;      INTERRUPT COMPLETION ROUTINE
;
INSERV: .RSUM                      ;RESUME EXECUTION
      RTS      PC                 ;RETURN FROM INTERRUPT
      .END

```

Program 7 is a FORTRAN callable subroutine that employs the KW11P programmable real-time clock to provide accurately timed delays under TSX-Plus. The units of time for a delay may be either milliseconds or seconds, depending upon the global entry label used by the FORTRAN call. The FORTRAN call format is

CALL WAITM (count)

for a millisecond delay and

CALL WAITs (count)

for a second delay. The argument count is the number of specified time units to suspend program execution. Because of the time-slicing environment of TSX-Plus, the minimum delay that can be used for WAITM is approximately 20 milliseconds. Part of the reason for this relatively large minimum delay time is due to TSX-Plus service routine for the line time clock. The line-time clock interrupts the system every 1/60 of a second. The TSX-Plus completion routine for the line-time clock must not only update the system time and date but also handle the allocation of a time-slice to a time-sharing user. The extra code that is required by the line-time clock service

routine under TSX-Plus results in a decrease in program speed when compared with RT-11. Also, the line-time clock service routine may create problems for time-critical applications that are not connected to a completion routine.

Since a trap instruction is effectively an interrupt generated by software and it is handled in the same manner as a hardware interrupt under TSX-Plus, several trap instructions that are vectored at different locations are available to the MACRO-11 programmer. The available instructions include BPT (break-point trap, vector = 14g), IOT (I/O trap, vector = 20g), EMT (emulator trap, vector = 30g), and TRAP (vector = 34g). The EMT trap instruction is employed extensively by both RT-11 and TSX-Plus; therefore, general use of the EMT instruction is not recommended. The TRAP instruction is used by FORTRAN for error processing and should not be employed by programs linked to FORTRAN routines. Although the BPT and IOT instructions are available for general use, the BPT instruction should be avoided if one of the debugging aids is employed. An example of using a break-point trap instruction under TSX-Plus is provided in Program 8.

Program 8

```

.TITLE  PRUG8.MAC
;
; PROGRAM TO DEMONSTRATE THE USE OF A
; TRAP INSTRUCTION UNDER TSX-PLUS
;
      .MCALL  .PRINT,.EXIT
PROG8: MOV    #AREA,R0          ;SET UP INTERRUPT
      EMT     375
      .PRINT  #MESS1
      BPT                      ;EXECUTE TRAP INSTRUCTION
      .PRINT  #MESS2
      .EXIT                               ;STOP
MESS1: .ASCIZ  <12><15>/MESSAGE #1/
MESS2: .ASCIZ  <12><15>/MESSAGE #2/
MESS3: .ASCIZ  <12><15>/MESSAGE #3/
      .EVEN
;
; ARGUMENT AREA FOR INTERRUPT EMT
;
AREA:  .BYTE   11,140
      .WORD   14          ;BPT VECTOR
      .WORD   INT         ;ADDRESS OF COMPLETION ROUTINE
      .WORD   1           ;PRIORITY

```

Program 8 (continued)

```

;
;      COMPLETION ROUTINE FOR TRAP INSTRUCTION
;
INT:  .PRINT  #MESS3
      RTS     PC          ;RETURN
      .END     PROG8

```

The execution of Program 8 results in the output of three lines of text to the user's terminal,

```

MESSAGE #1
MESSAGE #3
MESSAGE #2

```

The second line of output (MESSAGE #3) is a result of the BPT instruction.

Although the trap instruction is rarely employed by most programmers, it is a valuable asset in a time-sharing environment. For laboratory applications involving control of instrumentation, there may be times when an error condition requires immediate attention. Some control applications require a section of code that cannot tolerate the time-slicing state of TSX-Plus. Both of the examples are problems for which a trap instruction may provide a solution by locking out time-sharing users until the trap service routine is completed.

A final point for discussion concerning hardware interrupts and trap instructions is the use of FORTRAN completion routines. A FORTRAN subroutine can be attached to a trap instruction (BPT or IOT) or a hardware interrupt by including in the first line of the MACRO-11 completion routine the instruction

```
JSR PC, FILNAM ,
```

where FILNAM is the name of the FORTRAN subroutine. Do not use the RT-11 system library routine INTSET to establish a FORTRAN subroutine as an interrupt completion routine.

CONCLUSION

TSX-Plus is an attractive alternative to DEC's RSX-11M, especially for present users of RT-11, since upgrade to a multi-user system with TSX-Plus could be achieved at a fraction of the cost for RSX-11M. Also, most programs developed under RT-11 are transportable to TSX-Plus with little or no modifications. One final advantage of TSX-Plus is that implementation of the operating system is simple and much less involved than a system generation for RSX-11M. For most cases with TSX-Plus, the system generation options can be modified, and a new system compiled and linked in a matter of minutes.

General use of RT-11 for instrument control and data acquisition effectively dedicates the computer to the instrument. Employing a multi-user system for laboratory applications provides a much more efficient use of system resources. A multi-user system, such as TSX-Plus, allows one to concurrently control multiple instruments and use system resources for software development.

Applications involving simultaneous control of several instruments may require a modular computer configuration. Such a computer system would consist of a main computer operating under a multi-user environment with a satellite microcomputer dedicated to each instrument for control and data acquisition. The main computer could then serve as the supervisor in a local network of several computers. The supervisor computer would send commands to and receive data from satellite processors and in addition would handle all calculations, file and data management, and data reporting. With this type of laboratory computer system, the concurrent execution of many time critical routines could operate without conflict. In addition to the instrument control aspect, laboratory personnel would also have access to the computer for general use.

In conclusion, TSX-Plus can be employed in a multifunction laboratory environment and meet most required functions for instrument control, data acquisition, and data management. A good starter system for a laboratory, which could be easily expanded, would include a DEC LSI-11/23 with 22-bit addressing memory management, 256-kbyte memory, and a 10-30 Mbyte Winchester disk for mass storage. Two good choices for the satellite microcomputers are the Rockwell AIM-65 and the new DEC FALCON SBC-11/21.

Appendix A. Subroutines for I/O page access

BITCLR

BITSET

IOPEEK

IOPOKE

MAPIO

UNMAP

```

.TITLE BITCLR

;
;
; SUBROUTINE TO CLEAR BITS FROM A FORTRAN
; PROGRAM UNDER TSX-PLUS.
;
;
; FORTRAN CALL:
;
;         CALL BITCLR(ADDRESS,VALUE)
;
;
.MCALL .PRINT,.GVAL
.GLOBL BITCLR

OFFSET  =-10

BITCLR: TST      (R5)+          ;SKIP ARGUMENT COUNT
MOV      @(R5)+,R2            ;GET ADDRESS
MOV      @(R5)+,R1            ;GET BITCLR VALUE
.GVAL    #AREA2,#OFFSET
CMP      R0,#1                ;PAR 7 MAPPED ?
BEQ      PAR7                 ;YES THEN PAR7
MOV      R2,@#AREA+2          ;MOVE ADDR TO EMT ARGUMENT AREA
MOV      R1,@#AREA+4          ;MOVE VALUE TO EMT ARGUMENT AREA
MOV      #AREA,R0             ;POINT R0 AT ARGUMENT AREA
EMT      375
BCS      ERR                  ;BRANCH ON ERROR
BR        RETURN              ;RETURN
PAR7:    BIC      R1,(R2)       ;CLEAR BITS
BR        RETURN
ERR:      CMPB    #0,@#52       ;DETERMINE EMT ERROR
BEQ      ERR1
BR        ERR2
ERR1:     .PRINT  #ERROR1
BR        RETURN
ERR2:     .PRINT  #ERROR2

RETURN:   RTS      PC          ;RETURN
;
;
; ERROR MESSAGES
;
;
ERROR1:   .ASCIZ  <12><15>/ERROR:(BITCLR) NO OPERATOR PRIVILEGE FOR JOB/<12><15>
ERROR2:   .ASCIZ  <12><15>/ERROR:(BITCLR) UNDEFINED ERROR ??/<12><15>
.EVEN
;
;
; ARGUMENT AREA FOR EMT'S
;
;
AREA:     .BYTE   4,140        ;ARGUMENT FOR BITCLR FUNCTION
          .WORD   0            ;SAVE SPACE FOR ADDRESS
          .WORD   0            ;SAVE SPACE FOR VALUE
AREA2:    .BLKW   2            ;EMT ARGUMENT BLOCK FOR .GVAL
          .END

```

```

AREA:      .BYTE      3,140          ;ARGUMENT FOR BITSET FUNCTION
          .WORD      0              ;SAVE SPACE FOR ADDRESS
          .WORD      0              ;SAVE SPACE FOR VALUE
AREA2:     .BLKW      2              ;EMI ARGUMENT BLOCK FOR .GVAL
          .END

```

```
.TITLE IOPEEK
```

```
SUBROUTINE FOR TSX-PLUS TO REPLACE IPEEK
```

```
FORTTRAN CALL:
```

```
I=IOPEEK(ADDRESS)
```

```
OR
```

```
CALL IOPEEK(ADDRESS,I)
```

```
.MCALL .PRINT,.GVAL  
.GLOBL IOPEEK,IPEEK
```

```
OFFSET =-10
```

```
IOPEEK: .GVAL    #AREA2,#OFFSET  
        CMP      R0,#1          ;PAR 7 MAPPED ?  
        BEQ      PAR7          ;YES THEN PAR7  
        MOV      (R5)+,R3       ; GET ARGUMENT COUNT  
        MOV      @(R5)+,R2      ; GET ADDRESS  
        MOV      R2,@#AREA+2   ; MOVE ADDR TO EMT ARGUMENT AREA  
        MOV      #AREA,R0      ; POINT R0 AT ARGUMENT AREA  
        EMT      375  
        BCS      ERR          ; BRANCH ON ERROR  
        BR       RETURN        ;RETURN  
PAR7:   JSR      PC,IPEEK      ;CALL SYSLIB IPEEK  
        BR       EXIT  
ERR:    CMPB     #0,@#52       ;DETERMINE EMT ERROR  
        BEQ      ERR1  
        BR       ERR2  
ERR1:   .PRINT   #ERROR1  
        BR       RETURN  
ERR2:   .PRINT   #ERROR2  
  
RETURN: CMP      R3,#2         ;SUBROUTINE CALL ?  
        BNE      EXIT          ;NO THEN EXIT  
        MOV      R0,@(R5)      ;YES THEN STORE RESULT  
EXIT:   RTS      PC
```

```
ERROR MESSAGES
```

```
ERROR1: .ASCIZ   <12><15>/ERROR:(IOPEEK) NO OPERATOR PRIVILEGE FOR JOB/<12><15>  
ERROR2: .ASCIZ   <12><15>/ERROR:(IOPEEK) UNDEFINED ERROR ??/<12><15>  
        .EVEN
```

```
ARGUMENT AREA FOR EMT'S
```

```
AREA:   .BYTE    1,140        ;EMT ARGUMENT FOR PEEK FUNCTION  
        .WORD    0           ;SAVE SPACE FOR ADDRESS  
AREA2:  .BLKW    2           ;EMT ARGUMENT BLOCK FOR .GVAL  
        .END
```

[illegible]

```

.TITLE      MAPIO
;
;
SUBROUTINE TO MAP I/O PAGE (PAR 7) TO A JOB'S
VIRTUAL ADDRESS REGION.
;
;
FORTTRAN CALL:
;
;          CALL MAPIO
;
.MCALL .PRINT,.GVAL
.GLOBL MAPIO
;
OFFSET    =-10
;
MAPIO:     .GVAL      #AREA2,#OFFSET
           CMP        R0,#1             ;PAR 7 MAPPED ?
           BEQ        PAR7              ;YES THEN PAR7
           MOV        #AREA,R0
           EMT        375
           BCS        ERR                ;BRANCH ON ERROR
PAR7:      BR         RETURN              ;RETURN
ERR:       CMPB       #0,@#52            ;DETERMINE EMT ERROR
           BEQ        ERR1
           BR         ERR2
ERR1:      .PRINT     #ERROR1
           BR         RETURN
ERR2:      .PRINT     #ERROR2
;
RETURN:    RTS          PC               ;RETURN
;
;
ERROR MESSAGES
;
;
ERROR1:    .ASCIZ     <12><15>/ERROR:(MAPIO) NO OPERATOR PRIVILEGE FOR JOB/<12><15>
ERROR2:    .ASCIZ     <12><15>/ERROR:(MAPIO) UNDEFINED ERROR ??/<12><15>
           .EVEN
;
;
ARGUMENT AREA FOR EMT 375
;
;
AREA:      .BYTE      5,140              ;ARGUMENT FOR MAPIO FUNCTION
AREA2:     .BLKW      2                  ;EMT ARGUMENT AREA FOR .GVAL
           .END

```

```

.TITLE UNMAP
;
;
;
;
;
;
;
SUBROUTINE TO UNMAP I/O PAGE (PAR 7) AND MAP
SIMULATED RMON TO JOB'S VIRTUAL ADDRESS REGION.

FORTRAN CALL:

        CALL UNMAP

.MCALL .PRINT,.GVAL
.GLOBL UNMAP

OFFSET  =-10

UNMAP:  .GVAL    #AREA2,#OFFSET
        CMP      RO,#1          ;PAR 7 MAPPED ?
        BNE      RETURN        ;NO THEN RETURN
        MOV      #AREA,RO
        EMT      375
        BCS      ERR           ;BRANCH ON ERROR
        BR       RETURN        ;RETURN
ERR:    CMPB     #0,0#52        ;DETERMINE EMT ERROR
        BEQ      ERR1
        BR       ERR2
ERR1:   .PRINT   #ERROR1
        BR       RETURN
ERR2:   .PRINT   #ERROR2

RETURN: RTS      PC            ;RETURN
;
;
;
;
;
;
;
ERROR MESSAGES
;
;
;
;
;
;
;
ERROR1: .ASCIZ  <12><15>/ERROR:(UNMAP) NO OPERATOR PRIVILEGE FOR JOB/<12><15>
ERROR2: .ASCIZ  <12><15>/ERROR:(UNMAP) UNDEFINED ERROR ??/<12><15>
        .EVEN
;
;
;
;
;
;
;
ARGUMENT AREA FOR EMT 375
;
;
;
;
;
;
;
AREA:   .BYTE    6,140          ;ARGUMENT FOR UNMAP FUNCTION
AREA2:  .BLKW     2             ;EMT ARGUMENT AREA FOR .GVAL
        .END

```


THIS PAGE
WAS INTENTIONALLY
LEFT BLANK

Appendix B. Subroutines for control of program swapping

JLOCK
LOCKLO
UNLOCK

```

;
; .TITLE JLOCK
;
; ROUTINE TO LOCK A JOB IN MEMORY UNDER TSX-PLUS
; WITHOUT REPOSITIONING IT.
;
; FORTRAN CALL:
;
; CALL JLOCK
;
; .MCALL .PRINT
; .GLOBL JLOCK
JLOCK: MOV #AREA,R0
      EMT 375
      BCS ERR ;BRANCH ON ERROR
      BR RETURN ;RETURN
ERR: CMPB #0,@#52 ;DETERMINE EMT ERROR
     BEQ ERR1
     BR ERR2
ERR1: .PRINT #ERROR1
     BR RETURN
ERR2: .PRINT #ERROR2

RETURN: RTS PC ;RETURN

;
; ERROR MESSAGES
;
ERROR1: .ASCIZ <12><15>/ERROR:(JLOCK) NO OPERATOR PRIVILEGE FOR JOB/<12><15>
ERROR2: .ASCIZ <12><15>/ERROR:(JLOCK) UNDEFINED ERROR ??/<12><15>
      .EVEN
;
; ARGUMENT AREA FOR EMT 375
;
AREA: .BYTE 13,140
      .END

```

```

;
; .TITLE LOCKLO
;
; ROUTINE TO LOCK A JOB IN LOW MEMORY UNDER TSX-PLUS.
;
; FORTRAN CALL:
;
; CALL LOCKLO
;
;
; .MCALL .PRINT
; .GLOBL LOCKLO
LOCKLO: MOV #AREA,RO
; EMT 375
; BCS ERR ;BRANCH ON ERROR
; BR RETURN ;RETURN
ERR: CMPB #0,@#52 ;DETERMINE EMT ERROR
; BEQ ERR1
; BR ERR2
ERR1: .PRINT #ERROR1
; BR RETURN
ERR2: .PRINT #ERROR2

RETURN: RTS PC ;RETURN
;
; ERROR MESSAGES
;
;
ERROR1: .ASCIZ <12><15>/ERROR:(LOCKLO) NO OPERATOR PRIVILEGE FOR JOB/<12><15>
ERROR2: .ASCIZ <12><15>/ERROR:(LOCKLO) UNDEFINED ERROR ??/<12><15>
; .EVEN
;
; ARGUMENT AREA FOR EMT 375
;
AREA: .BYTE 7,140
; .END

```

```

;
; .TITLE  UNLOCK
;
; ROUTINE TO UNLOCK A JOB UNDER TSX-PLUS THAT WAS
; LOCKED INTO MEMORY WITH JLOCK OR LOCKLO.
;
; FORTRAN CALL:
;
;          CALL UNLOCK
;
; .MCALL  .PRINT
; .GLOBL  UNLOCK
UNLOCK:  MOV    #AREA,R0
;          EMT    375
;          BCS    ERR          ;BRANCH ON ERROR
;          BR     RETURN       ;RETURN
ERR:     CMPB   #0,0#52        ;DETERMINE EMT ERROR
;          BEQ    ERR1
;          BR     ERR2
ERR1:    .PRINT #ERROR1
;          BR     RETURN
ERR2:    .PRINT #ERROR2
;
RETURN:  RTS     PC           ;RETURN
;
; ERROR MESSAGES
;
ERROR1:  .ASCIZ  <12><15>/ERROR:(UNLOCK) NO OPERATOR PRIVILEGE FOR JOB/<12><15>
ERROR2:  .ASCIZ  <12><15>/ERROR:(UNLOCK) UNDEFINED ERROR ??/<12><15>
;          .EVEN
;
; ARGUMENT AREA FOR EMT 375
;
AREA:    .BYTE   10,140
;          .END

```

Appendix C. Subroutines for program communications

MSEND
MRECV
MRECVW

.TITLE MSEND

THIS ROUTINE IS FOR THE TRANSMITT MODE OF
A JOB COMUNICATION FACILITY UNDER TSX-PLUS

FORTRAN CALL:

CALL MSEND(CHAN.NAME,MESSAGE)

.MCALL .PRINT
.GLOBL MSEND

NLEN =100 ;MESSAGE LENGTH(64 CHARACTERS)

```
MSEND:  TST      (R5)+      ;SKIP ARGUMENT COUNT
        MOV      (R5)+,R1  ;GET CHANNEL NAME
        MOV      (R5)+,R2  ;GET MESSAGE NAME
        MOV      R1,@#AREA+2 ;MOVE CHAN.NAME TO EMT ARGUMENT AREA
        MOV      R2,@#AREA+4 ;MOVE MESSAGE ADDR.TO ARGUMENT AREA
        MOV      #AREA,R0  ;POINT R0 AT ARGUMENT AREA
        EMT      375
        BCS      ERR      ;BRANCH ON ERROR
        RTS      PC       ;RETURN
```

```
ERR:    CMPB     #1,@#52    ;CHECK EMT ERROR
        BEQ      ERR1
        CMPB     #2,@#52
        BEQ      ERR2
        CMPB     #4,@#52
        BEQ      ERR3
        BR       ERR4
```

```
ERR1:   .PRINT   #ERROR1    ;PRINT ERROR MESSAGES
        RTS      PC
```

```
ERR2:   .PRINT   #ERROR2
        RTS      PC
```

```
ERR3:   .PRINT   #ERROR4
        RTS      PC
```

```
ERR4:   .PRINT   #ERROR8
        RTS      PC
```

```
ERROR1: .ASCIZ   <12><15>/ERROR:(MSEND) ALL MESSAGE CHANNELS BUSY/<12><15>
ERROR2: .ASCIZ   <12><15>/ERROR:(MSEND) MAX. # OF MESSAGES IN QUEUE/<12><15>
ERROR4: .ASCIZ   <12><15>/WARNING:(MSEND) TRANSMITTED MESSAGE TO LONG/<12><15>
ERROR8: .ASCIZ   <12><15>/ERROR:(MSEND) UNDEFINED ERROR ??/<12><15>
        .EVEN
```

EMT ARGUMENT AREA

```
AREA:   .BYTE    0,104      ;SEND MESSAGE ARGUMENT
        .WORD    0          ;SAVE SPACE FOR CHANNEL NAME
        .WORD    0          ;SAVE SPACE FOR MESSAGE ADDRESS
        .WORD    NLEN       ;SAVE SPACE FOR BYTE COUNT
        .END
```

```

.TITLE MRCV
;
; THIS ROUTINE IS FOR THE RECEIVE MODE OF A
; JOB COMMUNICATION FACILITY UNDER TSX-PLUS
;
; FORTRAN CALL:
;
; CALL MRCV(CHAN.NAME,MESSAGE,IFLAG)
;
; OR
;
; IFLAG=MRCV(CHAN.NAME,MESSAGE)
;
; IFLAG = 1      IF MESSAGE WAS RECEIVED
; IFLAG = 0      IF NO MESSAGE QUEUED
;
.MCALL .PRINT
.GLOBL MRCV
;
NLEN      =100      ;LENGTH OF MESSAGE(64 CHARACTERS)
;
MRCV: MOV      (R5)+,R3      ;GET ARGUMENT COUNT
      MOV      (R5)+,R1      ;GET CHANNEL NAME
      MOV      (R5)+,R2      ;GET MESSAGE ADDRESS
      MOV      R1,@#AREA+2    ;MOVE CHAN.NAME TO EMT ARGUMENT AREA
      MOV      R2,@#AREA+4    ;MOVE MESSAGE ADDR. TO ARGUMENT AREA
      MOV      #AREA,R0      ;POINT R0 AT ARGUMENT AREA
      EMT      375
;
; DETERMINE IF MESSAGE WAS RECEIVED
      CMPB     #0,@#52      ;NO ERROR, MESSAGE WAS RECEIVED
      BEQ      IFLG1
      CMPB     #3,@#52      ;NO MESSAGE WAS QUEUED ON
      BEQ      IFLG0      ; NAMED CHANNEL
;
      CMPB     #4,@#52      ;CHECK FOR EMT ERRORS
      BEQ      ERR1      ;CHECK EMT ERROR CODE
      BR       ERR2
;
IFLG1: MOV      #1,R0      ;SET IFLAG = 1
      BR       RETURN
;
IFLG0: MOV      #0,R0      ;SET IFLAG = 0
      BR       RETURN
;
; PRINT ERROR MESSAGES
ERR1:  .PRINT   #ERROR4
      BR       RETURN
ERR2:  .PRINT   #ERROR8
;
RETURN: CMP      R3,#3      ;SUBROUTINE CALL ?
      BNE      EXIT      ;NO THEN EXIT
      MOV      R0,@(R5)    ;YES THEN SAVE IFLAG
;
EXIT:  RTS      PC
;
; ERROR MESSAGES
;
ERROR4: .ASCIZ  <12><15>/WARNING:(MRCV) MESSAGE LONGER THAN BUFFER/<12><15>
ERROR8: .ASCIZ  <12><15>/ERROR:(MRCV) UNDEFINED ERROR ??/<12><15>
      .EVEN
;
; EMT ARGUMENT AREA
AREA:  .BYTE    0,105      ;RECEIVE MESSAGE ARGUMENT
      .WORD    0          ;SAVE SPACE FOR CHANNEL NAME
      .WORD    0          ;SAVE SPACE FOR MESSAGE ADDRESS
      .WORD    NLEN      ;SPACE FOR BYTE COUNT (64 CHAR.)
      .END

```


.TITLE MRECVW

THIS ROUTINE IS FOR THE RECEIVE MODE OF A
JOB COMMUNICATION FACILITY UNDER TSX-PLUS

THIS ROUTINE WILL SUSPEND JOB EXECUTION
UNTIL THE MESSAGE IS RECEIVED.

FORTRAN CALL:

CALL MRECVW(CHAN.NAME,MESSAGE)

.MCALL .PRINT
.GLOBL MRECVW

NLEN =100 ;LENGTH OF MESSAGE(64 CHARACTERS)

```
MRECVW: TST      (R5)+      ;SKIP ARGUMENT COUNT
        MOV      (R5)+,R1  ;GET CHANNEL NAME
        MOV      (R5)+,R2  ;GET MESSAGE ADDRESS
        MOV      R1,@#AREA+2 ;MOVF CHAN.NAME TO EMT ARGUMENT AREA
        MOV      R2,@#AREA+4 ;MOVE MESSAGE ADDR. TO ARGUMENT AREA
        MOV      #AREA,R0  ;POINT R0 AT ARGUMENT AREA
        EMT      375
        BCS      ERR       ;BRANCH ON ERROR
        RTS      PC        ;RETURN
```

```
ERR:    CMPB     #1,@#52   ;CHECK EMT ERROR CODE
        BEQ      ERR1
        CMPB     #4,@#52   ;CHECK EMT ERROR CODE
        BEQ      ERR2
        BR       ERR3
```

```
ERR1:   .PRINT   #ERROR1
        RTS      PC
```

```
ERR2:   .PRINT   #ERROR4
        RTS      PC
```

```
ERR3:   .PRINT   #ERROR8
        RTS      PC        ;RETURN
```

```
ERROR1: .ASCIZ   <12><15>/ERROR:(MRECVW) ALL MESSAGE CHANNELS BUSY/<12><15>
ERROR4: .ASCIZ   <12><15>/WARNING:(MRECVW) MESSAGE LONGER THAN BUFFER/<12><15>
ERROR8: .ASCIZ   <12><15>/ERROR:(MRECVW) UNDEFINED ERROR ??/<12><15>
        .EVEN
```

EMT ARGUMENT AREA

```
AREA:   .BYTE    0,106    ;RECEIVE MESSAGE ARGUMENT
        .WORD    0        ;SAVE SPACE FOR CHANNEL NAME
        .WORD    0        ;SAVE SPACE FOR MESSAGE ADDRESS
        .WORD    NLEN     ;SPACE FOR BYTE COUNT (64 CHAR.)
```

.END

Appendix D. Subroutines for support of the TSX-Plus
detached job facility

IDTACH
KILL

.TITLE IDTACH.MAC

THIS ROUTINE IS FOR STARTING A DETACHED JOB UNDER
TSX-PLUS.

FORTTRAN CALL:

```
CALL IDTACH(FILENAME,JOB-NUMBER)
```

OR

JOB=IDTACH(FILENAME)

FILENAME IS A COMMAND FILE THAT STARTS THE DESIRED
DETACHED JOB. THIS ROUTINE ALSO RETURNS THE JOB NUMBER.
WARNING: A DETACHED JOB DOES NOT ASSUME THE LOGICAL
DEVICE ASSIGNMENTS OF THE USER.

USE PHYSICAL DEVICE ASSIGNMENTS:

JOB=IDTACH('DYO:FILNAM.EXT')

FOR EXAMPLE DO NOT USE DK:

DEFAULT .EXT IS .COM

```
.MCALL .PRINT
.GLOBL IDTACH
```

```

IDTACH:  MOV      (R5)+,R3          ;GET ARGUMENT COUNT
         MOV      (R5)+,R1          ;GET ADDRESS OF FILENAME
         MOV      R1,@#AREA+2      ;MOVE FILENAME TO ARGUMENT AREA
         MOV      #AREA,R0         ;POINT R0 AT ARGUMENT AREA
         LMI      375
         BCS      ERR              ;BRANCH ON ERROR
         BR       RETURN           ;RETURN

ERR:      CMPB     #1,@#52          ;DETERMINE EMT ERROR
         BEQ      ERR1
         BR       ERR2

ERR1:     .PRINT   #ERROR1
         BR       RETURN

ERR2:     .PRINT   #ERROR2

RETURN:   CMP      R3,#2            ;SUBROUTINE CALL ?
         BNE      EXIT             ;NO THEN EXIT
         MOV      R0,@(R5)         ;STORE RESULT
         RTS      PC               ;RETURN

EXIT:

```

ERROR MESSAGES

```

ERROR1: .ASCIZ  <12><15>/ERROR:(DETACH) NO FREE DETACHED LINES/<12><15>
ERROR2: .ASCIZ  <12><15>/ERROR:(DETACH) UNDEFINED ERROR ??/<12><15>
        .EVEN

```

EMT ARGUMENT AREA

```
AREA:  .BYTE    0,132
       .WORD    0           ;SAVE SPACE FOR FILNAME
       .END
```

```

      .TITLE  KILL.MAC
      ;
      ; THIS ROUTINE KILLS A DETACHED JOB RUNNING UNDER TSX-PLUS.
      ;
      ; FORTTRAN CALL:
      ;
      ;       CALL KILL(JOB-NUMBER)
      ;
      .MCALL  .PRINT
      .GLOBL  KILL

KILL:  TST      (R5)+          ;SKIP ARGUMENT COUNT
      MOV      @ (R5)+,R1      ;GET JOB-NUMBER
      MOV      R1,@#AREA+2     ;MOVE JOB # TO ARGUMENT AREA
      MOV      #AREA,R0        ;POINT R0 AT ARGUMENT AREA
      EMT      375
      BCS      ERR              ;BRANCH ON ERROR
      RTS      PC              ;RETURN

ERR:   CMPB     #1,0#52         ;DETERMINE EMT ERROR
      BEQ      ERR1
      BR       ERR2
ERR1:  .PRINT   #ERROR1
      RTS      PC
ERR2:  .PRINT   #ERROR2
      RTS      PC

      ;
      ; ERROR MESSAGES
      ;
      ERROR1:  .ASCIZ  <12><15>/ERROR:(KILL) INVALID JOB-NUMBER/<12><15>
      ERROR2:  .ASCIZ  <12><15>/ERROR:(KILL) UNDEFINED ERROR ??/<12><15>
      .EVEN

      ;
      ; EMT ARGUMENT AREA
      ;
      AREA:    .BYTE    2,132
      .WORD    0              ;SAVE SPACE FOR JOB-NUMBER
      .END

```