



HP 12792B/C 8-Channel Asynchronous Multiplexer Subsystem

User's Manual

**Software Technology Division
11000 Wolfe Road
Cupertino, CA 95014-9804**

NOTICE

The information contained in this document is subject to change without notice.

HEWLETT-PACKARD MAKES NO WARRANTY OF ANY KIND WITH REGARD TO THE MATERIAL, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Hewlett-Packard shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Hewlett-Packard assumes no responsibility for the use or reliability of its software on equipment that is not furnished by Hewlett-Packard.

This document contains proprietary information which is protected by copyright. All rights are reserved. No part of this document may be photocopied, reproduced, or translated to another language without the prior written consent of Hewlett-Packard Company.

RESTRICTED RIGHTS LEGEND

Use, duplication, or disclosure by the Government is subject to restrictions as set forth in subparagraph (c) (1) (ii) of the Rights in Technical Data and Computer Software clause at DFARs 252.227.7013.

Copyright © 1983, 1985, 1993 by Hewlett-Packard Company

Printing History

The Printing History below identifies the edition of this manual and any updates that are included. Periodically, update packages are distributed that contain replacement pages to be merged into the manual, including an updated copy of this printing history page. Also, the update may contain write-in instructions.

Each reprinting of this manual will incorporate all past updates; however, no new information will be added. Thus, the reprinted copy will be identical in content to prior printings of the same edition with its user-inserted update information. New editions of this manual will contain new information, as well as all updates.

To determine which manual edition and update is compatible with your current software revision code, refer to the Manual Numbering File or the Computer User's Documentation Index. (The Manual Numbering File is included with your software. It consists of an "M" followed by a five digit product number.)

First Edition	.....	Jan 1983	.....
Update 1	.....	Jan 1985	.....	Software Revision Code 2440
Reprint	.....	Jan 1985	.....	Update 1 incorporated
Second Edition	.....	Jun 1993	.....	Add references to HP 12792C

Preface

This manual is designed as a technical reference for the Hewlett-Packard 12792B/C 8-Channel Asynchronous Multiplexer Subsystem for M/E/F-Series HP 1000 Computers. The Multiplexer interface is an efficient, high performance interface for multiplexed terminal/device applications. It enhances terminal communications by offering a low cost per channel, high speed, high performance alternative to other point-to-point interface offerings.

This manual is intended for users knowledgeable in FORTRAN and the RTE-IVB or RTE-6/VM Operating System. The following is a brief description of the content of each chapter.

- Chapter 1 provides general information concerning the multiplexer subsystem and its inter-relationships with HP 1000 products.
- Chapter 2 outlines the control functions used to perform data transfers to and from external devices, in addition to the control functions necessary to accomplish I/O control. Examples are provided for each control request.
- Chapter 3 covers using the features of the multiplexer and error handling/recovery.
- Chapter 4 is directed at the advanced programmer who is experienced with Assembly language. It provides you with a tutorial on device driver writing.
- Chapter 5 explains the interfacing requirements for using a non-HP device in the multiplexer subsystem.

Table of Contents

Chapter 1 Overview

Chapter 2 User Interface

General Considerations	2-1
Request Code	2-1
Control Word	2-2
Function Code	2-2
LU Number	2-2
I/O Requests	2-2
Standard I/O EXEC Calling Sequences	2-5
EXEC Calls from Macro	2-6
EXEC Calls from FORTRAN	2-7
EXEC Calls from Pascal	2-8
EXEC Call Parameters	2-11
Control Requests to the MUX	2-11
Device Initialization	2-12
Interface Driver Control Requests	2-13
Function Code 6B: Dynamic Status	2-13
Function Code 10B: Loop Test	2-14
Function Code 12B: Terminate Receive Buffer	2-15
Function Code 20B: Enable Scheduling	2-17
Function Code 21B: Disable Scheduling	2-17
Function Code 22B: Set Timeout	2-18
Function Code 26B: Flush Input Buffer	2-18
Function Code 27B: Set Program Address	2-19
Function Code 30B: Set Port ID	2-19
Function Code 23B: Type-Ahead Schedule Retry Count	2-21
Function Code 24B: Set ID Segment Address of Modem Alarm Program	2-21
Function Code 25B: Get Terminal Configuration	2-22
Function Code 31B: Connect Modem Line	2-23
Function Code 32B: Disconnect Modem Line	2-25
Function Code 33B: Configure Driver Response	2-30
Function Code 34B: Set Port Configuration	2-31
Function Code 36B: Set Binary Length	2-32
Function Code 37B: Set Read Type	2-33

Chapter 3 Using the MUX

Normal Mode	3-1
Type-Ahead	3-1
Program Scheduling	3-3
Common Type-Ahead Modes	3-4
No Type-Ahead Mode	3-4

Full Type-Ahead Mode	3-4
Type-Ahead with Scheduling Mode	3-5
Type-Ahead with Flush on Break Mode	3-5
Error Recovery	3-6
I/O Status	3-6
Failure Analysis	3-8
Read Errors	3-8

Chapter 4 Device Driver Writing

Device Driver/Interface Driver Concept	4-1
Reasons for Device Driver/Interface Driver Use	4-1
Interface Tasks	4-2
Interface Driver Tasks	4-2
Interface Control	4-2
Operating System Interface	4-2
Device Driver Tasks	4-3
HP Implementations of Device Drivers	4-3
Line Printer Device Driver DDV12	4-3
Block Mode Terminal Device Driver DDV05	4-3
Device Driver Interface	4-4
Device Drivers for the HP 12792B/C Multiplexer	4-4
Restrictions and Requirements	4-4
System Abort Requests	4-4
Interface Definitions	4-5
Return to the Interface Driver	4-5
Device Driver EQT Extent	4-6
A-Register	4-6
B-Register	4-8
EQT Entries	4-8
Selected EQT Definitions and Uses	4-9
Device Driver Address Table	4-11
Location and Size of Device Drivers	4-12
Case Study: A Device Driver Writing Example	4-13
Task Definition	4-13
Margin Setup	4-13
Cursor Position	4-13
Cursor Tracking	4-13
Minor Tasks	4-13
Device Driver Operation	4-14
Operation Flow	4-14
Set Up Device Driver EQT Extent Pointers	4-17
EQT Setup on First Entry	4-18
Subchannel Determination	4-18
Output a Setup String to the Terminal	4-19
Perform the Original User Request	4-20
Read Cursor Position	4-21
Final Completion Return to Interface Driver	4-21
Device Driver Address Table	4-21
Sample Device Driver Listing	4-22

Chapter 5 Device-Specific Considerations

Handshaking	5-1
DDV12 Line Printer Driver	5-2
DDV05 Terminal Driver	5-2
Black Box Considerations	5-2
Dumb Devices	5-3
Modems	5-3
Cartridge Tape Units	5-4
Control Request	5-5

Appendix A Device Equipment Table

Appendix B Device Driver Interfaces

HP 26xx Screen Mode Device Driver	B-1
DDV05 User Interface for HP 26xx Terminals	B-1
Subchannel Assignment	B-1
Control Request Definition	B-2
Control Function 11B: Line Spacing	B-2
Control Function 25B: Update Terminal Configuration	B-2
Input/Output Requests	B-2
HP 7310 Line Printer Device Driver	B-3
Write Request Processing	B-3
Control Request Processing	B-4

List of Illustrations

Figure 1-1	Example Multiplexer Configuration	1-2
Figure 2-1	ICNWD Function Code Bits	2-3
Figure 2-2	Valid Terminators	2-4
Figure 2-3	Read Request Function Codes	2-4
Figure 2-4	Write Request Function Codes	2-5
Figure 4-1	Device Driver Flowchart	4-15

Tables

Table 2-1	Control Request Function Codes	2-12
Table 2-2	Set Read Type (Function 37B) Parameter Description	2-33
Table 3-1	I/O Status Request Returns	3-7
Table A-1	Equipment Table Entry	A-1

Overview

The Hewlett-Packard 12792B/C 8-Channel Multiplexer Subsystem for HP 1000 M/E/F-Series computers provides multiple communications channels through a single microprocessor-based interface. The multiplexer significantly off-loads routine communication management overhead from the computer for higher speed operation compared to the speed achieved when a separate I/O card is used for each channel. The HP 12792B/C is referred to as the multiplexer, or MUX, in this manual unless its complete name is more appropriate.

For configuration and user information on the HP 12792C MUX using the Revision D firmware, refer to the *RTE-6/VM Serial Driver Reference Manual*, part number 92084-90050. Chapter 1 of that manual contains a comparison between the Revision D MUX and the MUX revision described in this manual. The Revision D MUX firmware is ordered as an option to the HP 12792C.

The multiplexer is used to route data from one of eight I/O devices to a common destination in direct wired installations. It may also be used with the Systems Modem (consisting of the HP 37214A Systems Modem Card Cage and one or more modem cards) to provide up to seven high-quality modem ports (one MUX port is used for the systems modem controller card).

Modem operation is asynchronous full-duplex at rates up to 1200 baud. It also supports auto-answer for all seven ports. The subsystem includes local analog loop-back capability to check the integrity of the modem links.

An example MUX configuration is shown in Figure 1-1.

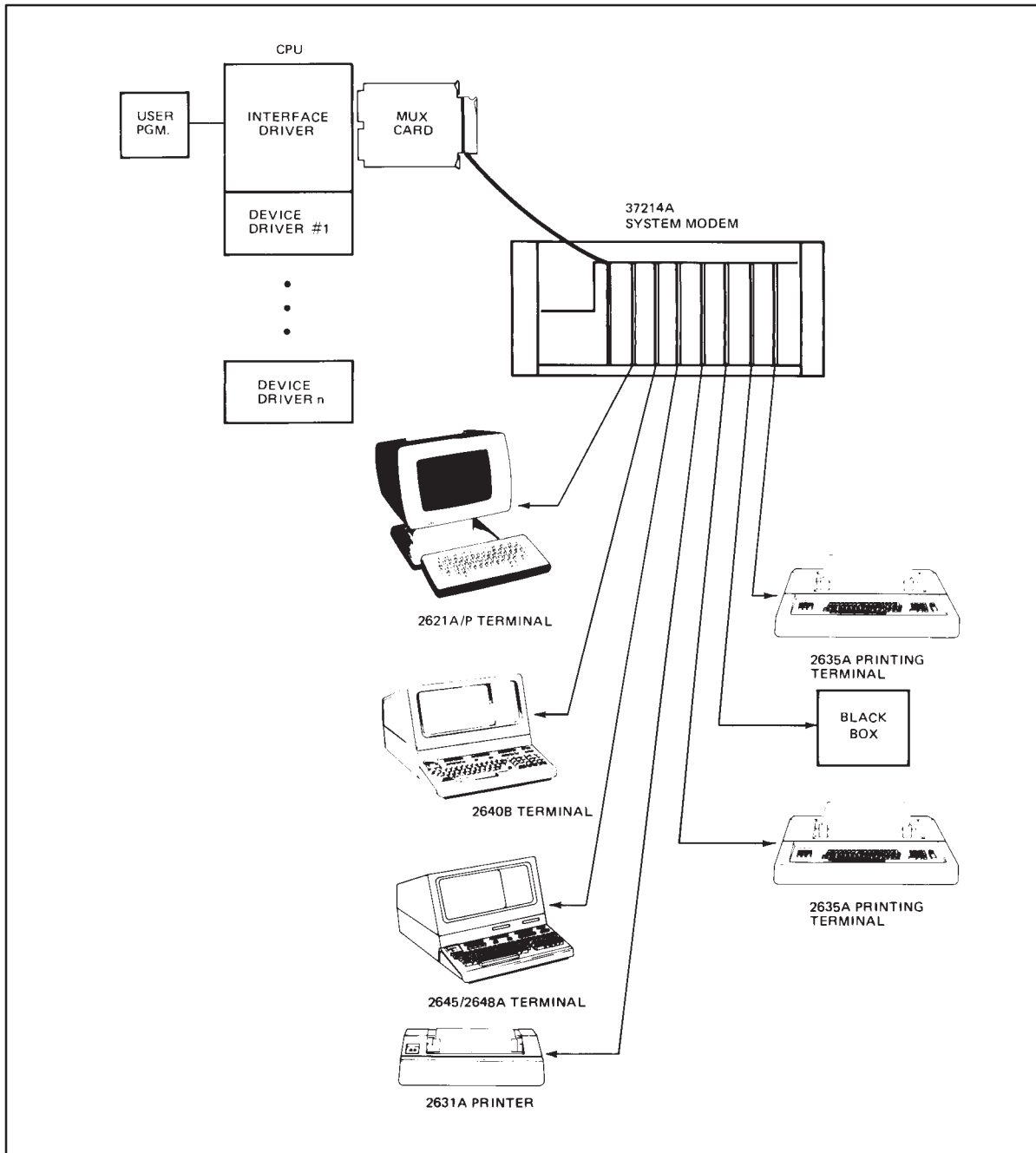


Figure 1-1. Example Multiplexer Configuration

The HP 12792B/C can be used with Hewlett-Packard devices that communicate with the CPU with I/O specifications that meet RS-232-C or RS-423-A EIA (Electronic Industries Association) standards and that are compatible with the available software drivers in the HP 1000 computers. The commonly used devices are terminals and printers. Furthermore, users may write their own device drivers to handle any special control required by the device or where an HP driver is not available.

Device drivers are simply subroutines of the interface driver that are used to modify user requests and make them compatible with a specific device. The interface driver, on the other hand, is basically responsible for the transfer of information between the user programs, the appropriate device driver, and the interface card.

Each channel of the multiplexer has a device driver associated with it. The device driver performs the device-specific formatting of data, which includes control characters for device requirements. When an EXEC call is issued from the user program, the interface driver passes it to the device driver. At this point the device driver can break up the user request into a series of interface requests. For example, the device driver can instruct the interface driver to wait for a buffer and inform the interface driver of the buffer's destination. The information is taken from the appropriate channel buffer and sent to the destination indicated by the device driver.

Up to 14 device drivers may be used, each of which can be associated with one or more devices attached to one of the MUX cards in the system. HP supplies three device drivers with the HP 12792B/C product, DDV05 (HP 26xx terminal screen mode device driver with CTU support), DDT05 (HP 26xx without CTU support), and DDV12 (HP 2631/2635/7310 line printer device driver), and two interface drivers, DVM00 (with modem support) and DVT00 (without modem support).

Each MUX interface card contains 16K bytes of random access memory (RAM), of which 8K bytes are allocated for channel buffers. This 8K byte portion of memory is divided so that each channel contains four 254-byte buffers, two for transmission and two for reception. Each MUX card provides two on-board programmable baud rate generators that control channel transmission speeds ranging from 50 to 19.2K baud. The total aggregate throughput must not exceed 78.6K baud. This card may be inserted anywhere in the backplane of the CPU, unless there is a privileged interrupt fence. In this case the interface card should be inserted above the fence. If the MUX card is to be used in an I/O extender, the optional DCPC must be installed.

The maximum number of physical devices that will be supported in the multiplexer subsystem is 61. There are 63 available EQTs in the system, but one EQT should be reserved for the system console and one for the disk. The multiplexer does not offer system console support.

To increase the throughput of the MUX card, Direct Memory Access (DMA) is used. The MUX requires that DCPC be installed in the system CPU and in any I/O extender box that contains a MUX card. If all DMA channels are busy and none can be allocated to the terminal/device channel within a 160-millisecond timeout period, the interface driver performs the read/write function on a word-by-word basis. The word-by-word transfers are broken into 64-character blocks.

The HP 12828A Multiplexer Panel contains eight RS-232-C ports. The multiplexer panel is connected to the MUX card and can be at the CPU (with the standard cable) or up to 91 meters (300 feet) away from the CPU with custom cabling. RS-232-C compatible devices can then be connected to the multiplexer panel by cables less than 39.7 meters (50 feet) in length. The MUX supports asynchronous full-duplex modems through the systems modem (HP 37214A Card Cage and modem cards).

User Interface

General Considerations

This section describes the driver as seen by the user. Standard I/O EXEC calls are used to transfer data to and from external I/O devices in addition to performing various I/O control operations. Input, output, and control requests to the multiplexer are generally in the form of RTE EXEC calls while control requests can be initiated either from EXEC calls or by using the FMGR or CI CN command. EXEC calls can be made from Assembly language programs or from higher level languages such as FORTRAN and Pascal.

Request Code

Parameter ICODE identifies the type of EXEC call request. There are eight types of EXEC calls described in this manual; four normal I/O EXEC calls and four Class I/O EXEC calls.

Standard EXEC Code Parameters:

ICODE = 1 Read Request
ICODE = 2 Write Request
ICODE = 3 Control Request
ICODE = 13 I/O Status Request

Class I/O EXEC Code Parameters:

ICODE = 17 Read Request
ICODE = 18 Write Request
ICODE = 20 Write/Read Request
ICODE = 19 Control Request

Control Word

Control word (ICNWD) contains a five-bit function code and the logical unit (LU) number of the device to which the user request is directed. It is structured as follows (refer to Figure 2-1 for the definition of bits 10 through 6):

15		10		6	5		0							
0	0	0	0	0	X	A	K	V	M	L	L	L	L	L
					Function Code					LU Number				

Function Code

The octal value of the required function code is provided for each of the request descriptions in the following sections. You may choose any of the methods described in this chapter to set the value of bits 10 through 6 of control word ICNWD. For example, if the function code value is octal 6, add 600B to the value of the LU number.

The MUX driver examines the value of the function code to determine the action taken by the interface driver in the processing of I/O or device control. The requests will vary depending on the function codes described below. These function codes are used whenever an EXEC 1 (Read), EXEC 2 (Write), or EXEC 3 (Control) call is made, although the bit meanings differ between read and write requests. Refer to Figure 2-1 for ICNWD bit names.

LU Number

The logical unit (LU) number is the system address for the I/O device to which the user is directing a request. The user's system generation listing enumerates the LU numbers of all I/O devices generated into the system.

For example, if the LU number is decimal 10 and the function is octal 6, the value of ICNWD can be computed:

$$\text{ICNWD} = 10 + 600\text{B} = 612\text{B}$$

The B suffix is used to identify an octal number.

I/O Requests

I/O requests are handled in a variety of ways. These requests are processed differently depending on the value of the function code of the control word. Three basic input functions are controlled by the value of ICNWD.

- editing
- echoing
- terminators

Bit 10 (X Bit)	Transparent Mode Bit; 0 – Disabled 1 – Enabled
Bit 9 (A Bit)	Special Buffer Control Bit; 0 – Disabled 1 – Enabled
Bit 8 (K Bit)	Echo Bit; 0 – Disabled 1 – Enabled
Bit 7 (V Bit)	Honesty Bit; 0 – Disabled 1 – Enabled
Bit 6 (M Bit)	Binary Mode Bit 0 – Disabled 1 – Enabled

Figure 2-1. ICNWD Function Code Bits

When editing is enabled, the control word bits 6 and 10 are set to zero. If a delete key (rub out key) is struck, the contents of the user's receiving buffer is erased. The backspace key deletes only the last character entered, if any. If editing is disabled, the delete and backspace keys would enter a 177B or 10B into the user's on-board buffer.

If a user is inputting data with editing enabled, the interface card will accept the data into the first of the channel's two 254-byte input buffers. The multiplexer handles all the edits. User input and editing can continue until the card's buffers are full or a valid terminator is detected.

At this point, the on-board buffer is off-loaded to the CPU. Once the buffer contents have been moved it cannot be edited. If the first buffer is filled so that the input overflows into the second buffer, the user cannot backspace or delete past its lower boundary into the last byte of the first buffer.

In general, information is supplied to the multiplexer card in a character mode format and echoed back to the user for visual inspection of the buffer. This is not always desirable; the echo feature may be suppressed for passwords and special requests.

The multiplexer card must be able to detect an end-of-record or valid terminator when it is encountered. Figure 2-2 lists the valid terminators used to signal the card to interrupt the CPU and transfer data to the user's program buffer.

Figure 2-3 describes the control word bit combinations used to determine the interface driver's action on a read request. It is here that valid terminators, as well as input editing and echoing are specified. Figure 2-4 describes the valid buffer transfer terminators.

Common Name		Octal Value of Right Byte
carriage return	CR	000015
device control 2	DC2	000022
record separator	RS	000036
end of transmission	EOT	000004

Figure 2-2. Valid Terminators

ICNWD Bit					Action Taken for Read Request
10	9	8	7	6	
0	0	0	x	0	editing enabled echo disabled CR is a valid buffer transfer terminator CNTRL D results is an EOT status condition and a zero-length transmission log (zero-length buffer)
0	0	1	x	0	input editing enabled echo enabled CR is a valid transfer terminator CNTRL D results in an EOT status condition and a zero-length transmission log (zero-length buffer)
0	0	0	x	1	input editing disabled echo disabled data transfer terminates only when the user buffer is full
0	0	1	x	1	input editing disabled echo enabled data transfer terminates only when the user buffer is full
1	0	0	x	0	input editing disabled echo disabled CR is a valid transfer terminator
1	0	1	x	0	input editing disabled echo enabled CR is a valid transfer terminator
*	1	*	x	*	special buffer transfer same as the transfer with bit 9 (special function bit) set to zero but data resident in the card's buffer that exceeds the end of the user buffer is not destroyed. It may be accessed in subsequent buffer transfers. * echo, edit, etc. are defined by bits 6, 8, and 10 above.
x = don't care condition					

Figure 2-3. Read Request Function Codes

ICNWD Bit					Action Taken for Write Request
10	9	8	7	6	
0	x	x	x	0	An ASCII write request will have CR/LF appended to the buffer if the last character in the buffer is not “_”. If the underscore, 00137B, is appended to the user’s buffer it will not be printed.
x	x	x	x	1	The entire buffer is transmitted as is, no characters are appended to the user’s buffer.
1	x	x	x	x	
x = don’t care condition					

Figure 2-4. Write Request Function Codes

There are some areas of I/O request handling that require special mention:

1. Zero-length keyboard entries are not ignored by the interface driver. A carriage return without data is a zero-length record.
2. Function code 30B configures the multiplexer card to conduct I/O transfers in a specified character format. The terminal must be configured accordingly for successful I/O processing to occur.
3. Read or write function codes of 35B bypass modem connection checks (refer to the section on modems).

Standard I/O EXEC Calling Sequences

The following sections show the general formats used for making EXEC calls from Macro, FORTRAN, and Pascal programs. In the following examples, the only names that must be used as given are EXEC and ABREG. Other parameters used such as ICODE, ICNWD, and IPARM are simply mnemonics used in this manual.

EXEC Calls from Macro

The Macro calling sequence for EXEC calls is as follows:

```

      .
      .
      .
      EXT EXEC          Declare EXEC as an external
      .
      .
      .
      JSB EXEC          Transfer control to RTE
      DEF RTN           Return address
      DEF ICODE         Request code
      DEF ICNWD         Control word
      DEF IPR1          Parameter 1, optional
      DEF IPR2          Parameter 2, optional
RTN      Return Point
*          A-Register contains I/O status
*          B-Register contains the length of the
*          transmission log
      .
      .
      .
      ICODE DEC 1       Request code word (READ)
      ICNWD OCT CNWD   Control word. Control Function plus
*          LU number assigned to the port.
      .
      .
      .
      IPR1 OCT pr1     Use depends on
      IPR2 OCT pr2     type of call

```

The return point, labeled RTN, must follow the DEF of the last parameter used. EXEC uses this address to calculate the number of parameters passed for those calls that have optional parameters.

EXEC Calls from FORTRAN

To call EXEC as a subroutine from FORTRAN, use the following calling sequence:

```
.  
. .  
. .  
ICODE = 3  
ICNWD = 600B + LU  
. .  
. .  
CALL EXEC ( ICODE, ICNWD, IPARM1, IPARM2 )  
CALL ABREG ( IA, IB )  
. .  
. .
```

EXEC can also be called as a function from FORTRAN, using the following calling sequence:

```
.  
. .  
. .  
DIMENSION IREG ( 2 )  
EQUIVALENCE ( REG, IREG ) , ( IA, IREG ) , ( IB, IREG ( 2 ) )  
. .  
. .  
REG = EXEC ( ICODE, ICNWD, IPARM1, IPARM2 )  
. .  
. .
```

The two different methods of calling EXEC from FORTRAN illustrate the two ways of obtaining the A- and B-Register values from the EXEC call.

In the following sections, the examples used to illustrate the calls are written using the CALL EXEC(...) method, with an example showing how to make the control request from FMGR using the CN command.

EXEC Calls from Pascal

An EXEC call may be coded in Pascal either as a procedure or as a function. If it is coded as a function, the return value type must be a two-word type to return the values of both the A- and B-Registers.

The Pascal compiler does not treat an EXEC call in a special manner. Therefore, it is possible to call EXEC directly if an external declaration has been made with a set of formal parameters.

If the \$HEAP 2\$ compiler option is used, then the HEAPPARMS option must be OFF for EXEC external declarations with VAR parameters.

An example of EXEC call in Pascal is as follows:

```
program muxex;

const
    lu_control_request_code = 3 ; { EXEC 3 , a control request }
    shift_left_six_bits     = 64 ; { is placed on LU 19. The 16 }
    lu_number                = 19 ; { bit control word is stripped }
    function_code            = 6 ; { of bits 15-11, so that the }
                                { function code, bits 10-6, }
                                { can be examined. In this }
                                { case the function code 6 }
                                { is placing a status request }
                                { to LU 19 }

type
    int = -32768..32767;          { single-word integer type }
    bit = 0..1;                  { single-bit type }
    bit_def = packed record      { bit data type }
        bit_15 : 0..1;          { This allows the user to }
        bit_14 : 0..1;          { access each bit field }
        bit_13 : 0..1;          { individually. }
        bit_12 : 0..1;
        bit_11 : 0..1;
        bit_10 : 0..1;
        bit_9  : 0..1;
        bit_8  : 0..1;
        bit_7  : 0..1;
        bit_6  : 0..1;
        bit_5  : 0..1;
        bit_4  : 0..1;
        bit_3  : 0..1;
        bit_2  : 0..1;
        bit_1  : 0..1;
        bit_0  : 0..1;

end;

word_def = record               { word data type }
    CASE int of
        1 : ( bits : bit_def); { this double definition }
        2 : ( word : int );    { allows the user to access }
                                { the information bit by bit }
```

```

                end;                                { or as a word }
var
    control_word    : int;
    sub_function    : word_def;
    a_reg           : word_def;
    b_reg           : word_def;
    S1              : text;

procedure rte_exec_call $alias 'EXEC'$
    (request_code : int;
     var control_request : int;
     var subfunction : word_def); external;

procedure get_the_a_b_registers $alias 'ABREG'$
    (var a:word_def; var b : word_def); external;

procedure initialize_sub_function;

begin    { initialize optional parameters }

    sub_function.bits.bit_15 := 0;
    sub_function.bits.bit_14 := 0;
    sub_function.bits.bit_13 := 0;
    sub_function.bits.bit_12 := 0;
    sub_function.bits.bit_11 := 0;
    sub_function.bits.bit_10 := 0;
    sub_function.bits.bit_9  := 0;
    sub_function.bits.bit_8  := 0;
    sub_function.bits.bit_7  := 0;
    sub_function.bits.bit_6  := 0;
    sub_function.bits.bit_5  := 0;
    sub_function.bits.bit_4  := 0;
    sub_function.bits.bit_3  := 0;
    sub_function.bits.bit_2  := 0;
    sub_function.bits.bit_1  := 0;
    sub_function.bits.bit_0  := 0;

end;

begin    { beginning of main program }

    initialize_sub_function;
    sub_function.bits.bit_1 := 1;
    sub_function.bits.bit_3 := 1;    { set the appropriate bits }
    sub_function.bits.bit_5 := 1;    { in the optional parm }
    sub_function.bits.bit_7 := 1;
    sub_function.bits.bit_9 := 1;

```

```

{
  .
  .
  .
}
{ construct the control word }

  control_word := lu_number+(function_code*shift_left_six_bits);

{ place the RTE EXEC call }

  rte_exec_call (lu_control_request_code,control_word,sub_function);

  get_the_a_b_registers (a_reg,b_reg);

begin    { examine the A-Register for the status of this channel }
  reset (S1,'1');
  {
    .
    .
    .
  }
  if a_reg.bits.bit_15 = 0
  then
    if a_reg.bits.bit_14 = 0
    then
      writeln (S1, 'unit available for use')
    else
      writeln (S1,'unit disabled')
    else
      if a_reg.bits.bit_14 = 0
      then
        writeln (S1,'unit currently in operation')
      else
        writeln (S1, 'unit waiting for DMA channel');
        {
          .
          .
          .
        }
      }
  end;
end.    { end of PASCAL example }

```

It may be necessary or desirable to use aliases for each EXEC service used in a program for the following reasons:

- The name EXEC represents an entire class of services. A program using EXEC calls is more readable if a descriptive Pascal name is given to each service.
- Each EXEC service requires a different set of parameters. Some services (for example, EXEC 11) have optional parameters. Each Pascal routine must have a specific set of parameters.

EXEC Call Parameters

Request code ICODE and control word ICNWD, in that order, are the first two parameters of an EXEC call. Other parameters, when needed, are described for each request in the following sections.

Control Requests to the MUX

Control requests have the following general format:

```
CALL EXEC (ICODE, ICNWD, IPARM)
```

Request code ICODE has a value of 3 for all control requests. Each control request has a different function code specified in ICNWD, and the value of the IPARM parameter depends on the function code. Table 2-1 contains a summary of the function codes and their meanings.

Equipment Table word five (EQT 5) contains the status word. If a control request is made to an unbuffered EQT (Equipment Table), the A-Register will contain the device's status. If the EQT is buffered, the A-Register is meaningless. In either case the B-Register is meaningless, except for function code 6B. This status request will return the length of the type-ahead data in the B-Register.

When issuing a function code command from FMGR, the following format is used:

```
:CN, lu, fn [, pr]
```

where: *lu* = LU number
 fn = function code
 pr = optional control parameter

For example, to place LU 19 in type-ahead mode with cancel on break, the following control command is issued.

```
:CN, 19, 33B, 23000B
```

Table 2-1. Control Request Function Codes

Code	Description	Parameters Required
6B	Dynamic Status of Port	No
10B	Initiate Modem Loop Test	Yes
12B	Terminate Receive Buffer	No
20B	Enable Scheduling	No
21B	Disable Scheduling	No
22B	Set Timeout	Yes
23B	Type-Ahead Schedule Retry Count	Yes
24B	Set ID Segment Address of Modem Alarm Program	Yes
25B	Get Terminal Configuration	No
26B	Flush Input Buffer	Yes
27B	Set Program Address	Yes
30B	Set Port ID	Yes
31B	Connect Modem Line	Yes
32B	Disconnect Modem Line	Yes
33B	Configure Driver Response	Yes
34B	Set Port Configuration	Yes
36B	Set Read Binary Length	Yes
37B	Set Read Type	Yes

Device Initialization

Device initialization is accomplished by executing the following three control requests. Typically this is done for each terminal from your WELCOM file, but can be executed interactively.

- set port ID (required) function code 30B
- configure driver responses (optional) function code 33B
- enable scheduling (optional) function code 20B

Interface Driver Control Requests

Function Code 6B: Dynamic Status

Dynamic Status can be used to find out the status of the previous request and to determine the length of the type-ahead data in the input buffers.

An example of a dynamic status request to LU 42 is coded as follows:

```
ICODE = 3
ICNWD = 600B+42
CALL EXEC ( ICODE, ICNWD, IPARM1 )
CALL ABREG ( IA, IB )
.
.
.
```

If IPARM1 is set to zero, the B-Register will contain the character count of any type-ahead data. If IPARM1 is not set to zero, modem related port status will be returned in the B-Register (providing that a modem is being used through the system's modem panel).

The status bits returned in the A-Register are defined as follows:

- Bits 15-7: Undefined
- Bit 6: Break key hit
- Bit 5: EOT (Cntl-D) entered on last request
- Bit 4: Device failure (for example, modem line down)
- Bit 3: Parity error or overflow detected on last request
- Bit 2: Type-ahead data available (length in B-Register)
- Bit 1: Program schedule enabled
- Bit 0: Last request timed out

The modem related status returned in the B-Register (if IPARM1 is not zero) is defined as follows:

- Bits 15-8: Undefined.
- Bit 7: 0 = connected to systems modem panel.
1 = hardwired (no systems modem panel).
- Bit 6: 1 = no response from systems modem.
- Bit 5: 1 = modem not present.
- Bit 4: 1 = being called.

- Bit 3: 0 = analogue loopback.
1 = remote digital loopback.
- Bit 2: 0 = not in loopback mode.
1 = loopback completed.
- Bit 1: 0 = low speed.
1 = high speed.
- Bit 0: 0 = line disconnected.
1 = line connected.

Note that on power-up, the B-Register status equals 200B and it will remain so if an HP 37214A modem panel is not connected to the MUX.

The dynamic status request is a call to the driver; therefore, it waits until outstanding requests to that LU have completed.

Function Code 10B: Loop Test

Function Code 10B performs a local analog or a remote digital loop test when using the HP 37213 Modem Card and only applies to this card in the HP 37214A Systems Modem Card Cage. For loopback tests using other modems, refer to the instructions in the appropriate manuals. For these tests, the ENQ/ACK handshake and ECHO must be off.

After initiating a loop test, wait for approximately three seconds and then confirm that the modem being tested has looped the data lines by reading the port status (refer to Dynamic Status, Function Code 6B). After confirming the loopback, the user can put the port in type-ahead mode and then perform the integrity check of the modem line by comparing the received data against the transmitted data. After the test, the user can disable the loopback by making another control request with function code 10B and with IPARM1 set to 0.

Note that if a port's modem line status is "down", the driver DVM00 will pass only the write request with function code 35B to the card. Therefore, if the loopback port is "down", the user should use the write request with function code 35B to send the loopback data to the card. The port's configuration should be set to "do not down the EQT on line failure" to prevent the EQT from going down.

An example from FMGR is:

```
:CN,LU,10B,IPARM1
```

where, IPARM1 is

- Bit 2: 0 = low speed (300 baud).
1 = high speed (1200 baud).
- Bit 1: 0 = analog.
1 = remote digital.
- Bit 0: 0 = disable loop test.
1 = enable loop test.

The following is an example of a loopback test:

```
:**  ENABLE TYPE-AHEAD; DO NOT CHANGE READ CONFIG. EVERY TIME
:CN,LU,33B,20200B
:**  SPECIFY ECHO/EDIT OFF, END TRANSFER ON CARRIAGE RETURN
:CN,LU,37B,100000B
:**  INITIATE LOCAL ANALOG LOOPBACK MODE AT HIGH SPEED
:CN,LU,10B,5
.
.
C**  WRITE DATA TO THE LU; USE 35B AS THE WRITE FUNCTION CODE
CALL EXEC(2,3500B+LU,TBUFF,BUFLEN)
C**  READ BACK THE DATA
CALL EXEC(1,3500B+LU,RBUFF,BUFLEN)
.
.
    NOW COMPARE TBUFF WITH RBUFF (THEY SHOULD BE IDENTICAL)
.
.
:**  DISABLE THE MODEM LOOPBACK TEST
:CN,LU,10B,0
:**  CONFIGURE THE PORT BACK TO ITS NORMAL MODE OF OPERATION
:CN,LU,33B,10100B
```

Function Code 12B: Terminate Receive Buffer

Function code 12B instructs the interface card to immediately terminate its active receive buffer. A subsequent read request will read the terminated buffer with the length of the received data returned in the B-Register (that is, the transmission log).

If the active receive buffer on the interface card is empty when function code 12B is issued, the buffer is terminated and the driver is informed as soon as the first character is received. The subsequent read request issued is completed with a transmission log of one byte.

This control request is useful to read incoming data that is not in a format known to the multiplexer, for example, ending on <CR>, <DC2>, <RS>, Cntl-D, or count. In other words, if a user does not know how many characters to expect and if the data does not have a record terminator that is recognized by the MUX, function code 12B can be used to read the data.

The following example shows how to read data from a device connected to the multiplexer. (The length of the incoming data is not known ahead of time and/or the record terminator is not recognized by the multiplexer. Also, the port must be configured to type-ahead mode, and the character count is set to 254.)

```

      :
      :
C
C   PROGRAM THE MUX PORT IN TYPE-AHEAD MODE & SPECIFY NOT TO
C   RECONFIGURE THE READ OPERATION ON A READ REQUEST.
C
      CALL EXEC(3,3300B+LU,22200B)
C
C   SET THE READ CONFIGURATION TO END ON A COUNT OF 254, ECHO &
C   EDIT OFF
C
      CALL EXEC(3,3600B+LU,254)
      CALL EXEC(3,3700B+LU,4000B)
C
C   THE FOLLOWING LOOP WILL TERMINATE & READ THE INCOMING DATA
C   BUFFER
C
10   CALL EXEC(3,1200B+LU,0)
      CALL EXEC(1,LU,BUFF,-254)
      CALL ABREG(ISTAT,LEN)
C
C   LEN HAS THE LENGTH OF THE DATA RECEIVED
C
      :
      :
C
C   PROCESS THE RECEIVED DATA
C
      :
      :
C
C   READ MORE DATA
C
      GO TO 10

```

Instead of performing a read after the terminate request, a user may choose to schedule a program when type-ahead data is available. This can be done by setting bits 11 and 10 to “10” in a control request with function code 33B. The program to be scheduled is specified by function code 27B. After the terminate request is issued, the program is scheduled as soon as the type-ahead data is sent to the driver by the interface card. The scheduled program then reads the data, and if desired, issues another terminate request to read more data.

Function Code 20B: Enable Scheduling

Function code 20B enables the driver to schedule a program on interrupt. The program to be scheduled is specified at generation or the driver can interactively be informed of the address of the program's ID segment through function code 27B. Scheduling will commence if the following conditions are met:

1. Scheduling is enabled.
2. The program to be scheduled is dormant (state 0).
3. The program is a permanently loaded program.
4. A read operation is not in progress.
5. The port is not in type-ahead mode and any key is hit.

—or—

The port is in type-ahead mode and the break key is hit (see control 33B regarding type-ahead and the break key).

—or—

The port is in type-ahead mode with “scheduling on data available” and a valid terminator, or count, is received.

To enable scheduling and schedule a program on an unsolicited interrupt at LU 41, the following request is issued:

```
ICODE = 3
ICNWD = 2000B+41
CALL EXEC(ICODE, ICNWD)
```

or

```
:CN, 41, 20B
```

Function Code 21B: Disable Scheduling

Function code 21B resets the flag set by function code 20B (enable scheduling). When a terminal is disabled, striking a key on the keyboard will not schedule the program specified at generation or by Control Request 27B. Once a port is disabled, programs will not be scheduled. At boot, the default value of the schedule enable flag is disabled.

For example, to disable LU 41:

```
ICODE = 3
ICNWD = 2100B + 41
CALL EXEC(ICODE, ICNWD)
:
```

or

```
:CN, 41, 21B
```

To re-enable the terminal, an “Enable Schedule” request must be issued:

```
:CN, 41, 20B
```

Function Code 22B: Set Timeout

To alter the RTE device timeout value that was established at system generation, use function code 22B. The timeout value can be set to 10-millisecond intervals by the integer provided as an additional parameter.

Timeout values can also be set by using the system TO command. The User's Manual for your operating system describes how to use the TO command. When using a control request or the CN command, be sure to specify the channel or device by LU number; when you use the TO command, specify the channel by the EQT number. The TO command checks for a lower limit of 500 milliseconds, but function code 22B does not.

The timer specifies the number of tens of milliseconds to wait for keyboard input. If this time is exceeded before a user keyboard input completes, the driver sets bit 0 in the terminal's status byte and returns to the caller with a zero-length transmission log.

For example, to set the timeout of LU 41 to 25 seconds:

```
ICODE = 3
ICNWD = 2200B + 41
ITO = 100 * 25
REG = EXEC(ICODE, ICNWD, ITO)
      :
```

or

```
CN, 41, 22B, 2500
```

Function Code 26B: Flush Input Buffer

Function code 26B instructs the interface card to clear data from the channel's input buffer that might have accumulated in type-ahead mode. The value of IPARM indicates whether only the active buffer (IPARM=0) or all of that port's receiving buffers (IPARM=1) should be cleared. Function code 26B ensures that the information requested is what is obtained, eliminating the possibility of processing outstanding data previously entered. To flush only this channel's active buffer use IPARM=0. Setting IPARM=1 flushes the two 254-byte input buffers on this port.

For example, to flush the two input buffers on LU 41:

```
ICODE = 3
ICNWD = 2600B+41
IPARM = 1
CALL EXEC(ICODE, ICNWD, IPARM)
      :
```

or

```
CN, 41, 26B, 1
```

Function Code 27B: Set Program Address

Function code 27B saves the value of IPARM as the address of the ID segment of a program to be scheduled on an unsolicited interrupt. If the value of IPARM is zero or negative, program scheduling is disabled regardless of function code 20B. This call overrides, for this particular port, the value set at system generation time. This function code is intended for programmatic rather than interactive use.

A program's ID segment address can be found using the system utility subroutine IDGET. Care should be exercised that the address supplied is correct and points to an ID segment of a permanently loaded program. On return, the B-Register is set to the address of the old ID segment. For example, if IADDR contains the address of a program's ID segment, this program will be scheduled on an unsolicited interrupt. IADDX will be set to the previous program ID segment address if the EQT is unbuffered.

```
ICODE = 3
ICNWD = 2700B+LU
CALL EXEC(ICODE, ICNWD, IADDR)
CALL ABREG(IA, IADDX)
:
```

or

```
CN, LU, 27B, IADDR
```

Function Code 30B: Set Port ID

Function code 30B establishes a logical connection between the LU and the physical terminal connected to the interface. This function is normally executed from the WELCOM file to initialize and configure ports 0 through 7, but can be done interactively. Function code 30B must be given before any other request is given to that port. If other commands are sent prior to this function call, they may be ignored.

The value of IPARM for function code 30B is defined as follows:

Bits 15-14: Number of bits per character for transmission and reception. This does not include parity.

0 = 5 bits/char 2 = 6 bits/char
1 = 7 bits/char 3 = 8 bits/char

Bit 13: 1 = Enable this port as a modem LU.
 0 = Do not enable this port as a modem LU.

CAUTION: Do not set bit 13 if you are not using a modem in the port because setting this bit causes port 7 to be assigned to the HP 37214A Systems Modem Card Cage prohibiting its (port 7) use as a hardwired port. Conversely, if you want to use a modem with the Systems Modem, do not configure port 7 with a function code 30B.

Bit 12: Baud rate generator for this port:

0 = baud rate generator 0
1 = baud rate generator 1

Bits 11-10: Number of stop bits:
All data transfers to and from the interface card require a delay between each character. For all asynchronous transfers, there is always at least one stop bit.

0 = reserved	2 = 1-1/2 bits
1 = 1 bit	3 = 2 bits

Bits 9-8: Parity select:

0 = none	2 = none
1 = odd	3 = even

Bit 7: 1 = ENQ/ACK handshaking enabled
0 = ENQ/ACK handshaking disabled

Bits 6-3: Baud rate:

0 = no change	8 = 1800
1 = 50	9 = 2400
2 = 75	10 = 4800
3 = 110	11 = 9600
4 = 134.5	12 = 19200
5 = 150	13 = reserved
6 = 300	14 = reserved
7 = 1200	15 = reserved

Notes for Bits 6-3:

1. The 19200 baud rate is not supported on eight channels simultaneously because it would exceed the maximum throughput of the card (76800 baud). A baud rate parameter of zero will not change any of the port's parameters (baud rate, parity, stop bits, and so on).
2. The MUX card has two on-board baud rate generators providing baud rates to the eight ports. These eight ports can be divided into two groups and connected to either of the two generators. However, all ports on a given baud rate generator must be initialized to the same baud rate with the exception that (75 and 150) or (300 and 1200) or 2400, or (4800, 9600, and 19200) can be simultaneously selected.

For example, assume that ports 0 through 3 are connected to baud rate generator 0 and ports 4 through 6 are connected to baud rate generator 1; and that a modem card is plugged into port 5. If port 0 is set to 9600 baud, then ports 1 through 3 must be set to either 4800, 9600, or 19200 because they are on the same baud rate generator. Also, if the modem is initialized to auto-answer, the modem must be set to 1200 baud, and if the modem port is set to 1200 baud, then the other ports on baud rate generator 1 (ports 4 and 6) must be set to either 300 or 1200 baud.

When the MUX is connected to the HP 37214A Systems Modem, the firmware uses port 7 to communicate to the systems modem controller at 1200 baud. Hence, port 7 should be grouped with the modem ports that will be run at 300 or 1200 baud.

3. The baud rate should be set to 300 or 1200 baud as required while originating a call. If you are in auto-answer mode, the baud rate should be initially set to 1200 baud. The firmware automatically changes it to 300 baud if the systems modem detects that the remote modem is calling in at low speed (300). This is referred to as speed sensing.

Bits 2-0: Port number of this terminal (0-7).

For example, to set the port ID of an HP 2621 terminal on channel 0, as LU 41, with a baud rate of 9600, ENQ/ACK handshaking enabled, and no parity, the following control request is issued:

```
CN, 41, 30B, 142330B
```

Function Code 23B: Type-Ahead Schedule Retry Count

This control function applies only to ports that have been configured to schedule a program when type-ahead data is available. Function code 23B specifies the number of attempted scheduling retries to make if the program is busy before giving up. Retries are attempted every 100 milliseconds. For example, normally when type-ahead data becomes available, the program to be scheduled is not busy and is scheduled successfully. However, on occasion it is possible for the program to be busy and the schedule fails. If a CN 23B had been previously done, such as when the ports were initially configured, then after 100 milliseconds another schedule request is attempted.

CN, LU, 23B, 0	Retry 0 times (attempt to schedule only once).
CN, LU, 23B, 500	Retry 500 times.
CN, LU, 23B, 100000B	Bit 15 set, retry indefinitely.

The default is 0, that is, try to schedule the program once and if it is busy, do not try to schedule it again.

Function Code 24B: Set ID Segment Address of Modem Alarm Program

This control function is used to tell the driver the ID Segment address of a modem alarm program, that is, the program to be scheduled if a modem line is disconnected on the HP 37213A System Modem Panel. Program MODEM is available (part no. 92077-16391) for use as a disconnect program and should suffice in most situations. MODEM can be configured to terminate active programs and log off a session upon disconnect.

The program's ID segment address (whether it be MODEM or some other program) can be found using the system utility subroutine, IDGET. As in function code 27B, care should be exercised that the address supplied is correct and points to an ID segment of a permanently loaded program. If the EQT is unbuffered, the B-Register will return the address of the old ID segment.

For example:

```
DIMENSION NAME(3)

DATA NAME/'MODEM' /
.
.
.
IDADDR=IDGET(NAME)
CALL EXEC(3,2400B+LU,IDADDR)
CALL ABREG(IA,IADDX)           ! If EQT of LU is unbuffered,
.                               ! IADDX = previous ID segment addr
.
.
```

Function Code 25B: Get Terminal Configuration

Control function 25B causes the driver to read the strap settings on an HP terminal. This information is used by the driver to ensure correct terminal handshake when doing, for example, a block read on an HP terminal.

A control function 25B is automatically performed when the driver receives its first read request. If the terminal straps are subsequently changed manually or by escape sequences, the user must issue another control function 25B to keep the driver posted of any changes. Failure to do so may result in the terminal getting “hung up”.

```
Example 1: INTEGER PAGE(3)
DATA PAGE/15446B,71461B,42000B/    ! ESC&s1D
.
.
.
CALL EXEC(2,LU,PAGE,-5)           ! Put terminal in page mode
CALL EXEC(3,2500B+LU)            ! Inform driver of strap change
.
.
.
```

```
Example 2: INTEGER BLOCK(3)
DATA BLOCK/15446B,65461B,41000B/   ! ESC&k1B
.
.
.
CALL EXEC(2,LU,BLOCK,-5)         ! Put terminal into block mode
CALL EXEC(3,2500B+LU)           ! Inform driver of strap change
.
.
.
```


Function Code 31B: Connect Modem Line

If the HP 37214A Systems Modem Panel is being used, issuing function code 31B establishes a modem connection. This function code can also specify the name of a program to schedule when a modem line disconnect takes place. Program MODEM is available (part no. 92077-16391) for use as a disconnect program and should suffice in most situations. MODEM can be configured to terminate active programs and reinitialize the modem port for auto-answer. Also, if the application requires it, MODEM can terminate and log off a session upon disconnect.

Once the connect line has been performed on a given port, the user need not do it again unless a powerfail occurs or a disconnect request is executed. In the event that the modem gets disconnected accidentally, the user will be able to call back and establish the connection. However, in the case of an auto-dialed call, the user must make a connect line request again to perform the auto dialing. When the line gets disconnected, the action taken by the driver is selected according to the user specification of bits 15 and 14 in function code 33B (that is, down or do not down the device if the line gets disconnected). Connect modem line can be done interactively or programmatically by an EXEC request. For example:

```
:CN,LU,31B,IPARM1
```

where IPARM1 is as follows:

Bit 15: No Wait bit

0 = driver completes the request (that is, return) only after line has been connected.

1 = driver does not wait for the line to be connected before completing the request.

Bits 14 through 6 apply only to program MODEM.

Bit 14: If the modem line goes down,

0 = abort active programs and log off the session.

1 = do not abort active programs or log off the session.

Bits 13 - 6: The log LU for messages from program MODEM.

Bits 5-3: Configuration straps for the HP 37213A modem card. These straps do not affect the configuration of the external modem connected to the HP 37215A modem interface card. (The modem cards are contained in the HP 37214A modem card cage.)

Bit 5 0 = guard tone off
1 = guard tone on

Bit 4 0 = 212 mode
1 = V.22 mode

Bit 3 0 = 10 bits
1 = 9 bits

Bit 2: 0 = originate
 1 = answer

Bit 1: 0 = manual
 1 = auto-dial

Bit 0: 0 = low speed (300 baud)
 1 = high speed (1200 baud)

If the user wants to auto-dial, the number to be dialed is specified before the Connect Modem Line request by making a write request with function code 35B as follows:

```
CALL EXEC (2, 3500B+lu, bufr, bufln)
```

where: *lu* is the LU of the modem.
 bufr is the buffer that contains the phone number (AUTO-DIAL BUFR).
 bufln is the length of the buffer.

Function code 35B tells the driver that this is a special write buffer. The AUTO-DIAL BUFR should start with a <T> or <P> for DTMF tone or pulse dialing followed by a string of numbers. The format of the BUFR is:

```
T+n+n+n+... n+n+n        or        P+n+n+n+... n+n+n
```

where + is a delimiter. Other valid delimiters are:

```
SP ( ) , - /
```

A delimiter need not be sent. Consistency of the choice of delimiters is not needed, and any number of delimiters may be sent.

n is a digit from 0 to 9, or *

An * causes an access pause of two seconds during dialing. Up to two access pauses may be included. The total number of digits including pauses cannot exceed 125.

Examples:

1. P /031/331 - 1000 (Pulse dial the number 031 331 1000).
2. T 9 * 0101 (916) 786 2001 (Tone dial 9 0101 916 786 2001 with an access pause after the first digit).

Function Code 32B: Disconnect Modem Line

Function code 32B disconnects a line from being used as a modem line. Once a Disconnect Modem Line request is done, an incoming call cannot establish a connection until a Connect Modem Line request is executed unless the local modem is programmed to auto-answer a call.

This request can be done from file manager as well as an EXEC call. For example, from file manager:

```
:CN,LU,32B,IPARM1
```

where IPARM1 is as follows:

Bit 15: No Wait bit.

0 = driver completes the request (that is, return) only after line has been disconnected.

1 = driver does not wait for the line to be disconnected before completing the request.

Bit 14: Applies only when program MODEM is used.

0 = abort active programs and log off the session upon disconnect.

1 = do not abort active programs or log off the session upon disconnect.

Bits 13-1: Reserved; set to 0.

Bit 0: 1 = disable auto-answer.

Program MODEM consists of the following:

1. Main program %MODEM (92077-16391)
2. Library %MDMLB (92084-16958)

Permanently load MODEM using the loader.

```
RU,LOADR:IH
OP,PE
LI,%MDMLB
RE,%MODEM
EN
```

A typical output message from MODEM is as follows:

```
MDM: LINE DISCONNECT DETECTED 5:45 PM TUE., 20 SEPT, 1983
MDM: 12792B ST= 3410 LU 71
```

The following is an example of a program to get the ID segment address of program MODEM and issue a CN 24B.

```

FTN7X,L
PROGRAM IDADD
C
C :RU,IDADD,P1 program to get MODEM's ID segment addr
C and issue CN 24. (P1= LU.)
C
C DIMENSION IPARM(5),NAME(3),IFCN(2)
C DATA NAME/'MODEM '/
C
C --- GET LU
C
C CALL RMPAR(IPARM)
C
C --- GET ID SEGMENT ADDRESS OF PROGRAM 'MODEM'
C
C IDADDR=IDGET(NAME)
C WRITE(1,5) IDADDR,NAME ! Display the ID segment address.
5 FORMAT("IDADDR= ",07," of ",3A2)
C IF(IDADDR.EQ.0) STOP
C
C --- ISSUE CN 24B
C
C 8 IFCN(2)=2400B
C IFCN(1)=IPARM(1)
C CALL XLUEX(3,IFCN,IDADDR)
C CALL ABREG(IA,IB)
C WRITE(1,10) IA,IB,IPARM(1)
10 FORMAT("ISSUED CN 24B; IA=",07," ; IB=",07," ; TO LU=",I3)
C
C --- DONE.
C
C 14 WRITE(1,15)
15 FORMAT("IDADD : DONE")
C END
C END$

```

The following is a typical transfer file to initialize an HP 37213A modem port, specifying the use of program MODEM.

```

:CN,21,30B,172271B,,,MUX MODEM PORT 1; 1200 BAUD
:CN,21,33B,040003B,,,DOWN THE DEVICE IF LINE GOES DOWN; ATTACH DDV05
:CN,21,31B,100105B,,,ENABLE FOR AUTO-ANSWER; ABORT SESSION; LOG TO LU 1
:CN,21,16,,,ENABLE SCHEDULING OF PRMPT
:SYTO,15,0,,,SET T.O. = 0
:RU,IDADD,21,,,ISSUE CN 24B TO SET ID SEGMENT ADDRS OF "MODEM"
:**
:** MODEM PORT UP AND ENABLED FOR AUTO-ANSWER
:**

```



```

C
C --- Tell the card to dial (high speed is the default).
C
      xluexparms(2) = 3100b
      call xluex(3,xluexparms,100103b)
C
C --- WAIT FOR LINE CONNECT
C
      ITRYS=1
      XLUEXPARDS(2) = 100600B
700  CALL XLUEX(3,XLUEXPARDS,1)           ! GET DYNAMIC STATUS.
      CALL ABREG(IA,IB)                   ! GET A & B REG.
      IF(IAND(IB,1).EQ.1) GO TO 900       ! CONNECTION COMPLETED YET?
      CALL EXEC(12,0,2,0,-4)              ! NO, PAUSE ANOTHER 4 SECS.
      ITRYS=ITRYS+1                       !
      IF(ITRYS.LT.10) GO TO 700          ! GET THE STATUS AGAIN.
C
      SCBADDR=LUSES(XLUEXPARDS(1))       ! RTE-6 LOGOFF
      CALL LOGOF(XLUEXPARDS(1),SCBADDR)  ! RTE-6 LOGOFF
      XLUEXPARDS(2)=3100B
      CALL XLUEX(3,XLUEXPARDS,105B)      ! RE-INIT PORT FOR AUTO ANS.
      STOP
C
900  WRITE(1,*) ' '
      WRITE(1,*) ' '
      WRITE(1,*) ' * * * * * '
      WRITE(1,*) ' * * W E L C O M E * * '
      WRITE(1,*) ' * * * B A C K * * * * '
      WRITE(1,*) ' * * * * * '
      WRITE(1,*) ' '
      CALL FTIME(IDATE)
      WRITE(1,15) IDATE
      WRITE(1,*) ' '
      END

```

Function Code 33B: Configure Driver Response

Function code 33B uses the IPARM parameter to specify port parameters. The value of IPARM configures the driver without sending the parameters to the card. The bit fields are defined as follows (all fields default to the 01 state at system boot time):

- Bits 15-14 control responses to device or line failures, such as the modem line going down.
- 00 = no change.
 - 01 = if the device or line goes down, set the device down (for example, IO NR).
 - 10 = if the device or line goes down, do not down the device but abort the request, then return EOT and go into hard flush mode (that is, ignore all subsequent I/O requests). Function code 6B will return additional information regarding the failure.
- Bits 13-12 define the type-ahead feature of the MUX card.
- 00 = no change.
 - 01 = (default value) no type-ahead. Striking any key when there is not a read request pending will gain the system's attention, if enabled.
 - 10 = Type-ahead data can be received without a pending read request. The information on the card is saved until a read request is made. At this point the data is retrieved. Only the break key will gain the system's attention unless type-ahead with scheduling is enabled.
- Bits 11-10 define the action to be taken when type-ahead data becomes available. Type-ahead data is defined as "available" when an End-of-Record is read by the card. Valid terminators are defined by the previous read or through control request 37.
- 00 = no change.
 - 01 = (default value) bit 2 is set in the EQT status word.
 - 10 = Bit 2 is set and scheduling is attempted.
- Bits 9-8 define the action to be taken when the BREAK key is struck.
- 00 = no change.
 - 01 = (default value) if scheduling has been enabled via control 20, scheduling is attempted.
 - 10 = cancels any type-ahead data and then attempts to schedule the designated program.
- Bits 7-6 control the sending of read configuration information to the card. See also, control function 37B.
- 00 = no change.
 - 01 = This is a normal read operation. The driver examines bits 10 through 6 of the control word in the user's EXEC request which specifies a unique read request type to the MUX card.
 - 10 = This will not reconfigure the read operation. When bit 7 is set, the driver overlooks bits 10 through 6, and only the device driver or a control 37 can modify the read configuration type.

- Bits 5-4 Reserved; set to zero.
- Bits 3-0 These bits define the device driver attached to this port. Device driver number one is the default device driver that is included as part of the interface driver. Driver number one passes the user's requests directly to the interface driver. Device driver numbers two through n (n < 16) are defined at system generation time. The device driver address table \$DVTB is established at generation time and defines the association (relation) between a device driver number two through n and its device driver (refer to "Device Driver Address Table" in Chapter 4). For the HP 12792B/C Multiplexer Subsystem, device driver number two defaults to the HP-supplied driver DDV12 and device driver number three defaults to HP-supplied driver DDV05. These drivers can be overridden by the user. Exactly one device driver is attached to each port at any time. If zero is entered, no change is made.

For example, to configure the driver response for a full type-ahead mode on LU 41:

```

ICODE = 3
ICNWD = 3300B+41
IPARM = 022400B
CALL EXEC (ICODE, ICNWD, IPARM)
      :
```

or

```
CN, 41, 33B, 022400B
```

Note that if any port is configured for type-ahead mode, the break key must be struck to schedule the LOGON prompt.

Function Code 34B: Set Port Configuration

Function code 34B uses the IPARM parameter to specify port configuration additional to function code 30B. The bit fields in IPARM are defined as follows:

Bits 15-2: Reserved; set to zero.

Bit 1: Force an Xon condition.*

0 = do not force Xon condition.

1 = force Xon condition.

* If the Xon/Xoff handshake is enabled and the printer is powered off, issuing "CN, LU, 34B, IPARM" where IPARM=3 forces an Xon condition.

Bit 0: Transmit pacing with Xon/Xoff.

0 = Disable Xon/Xoff handshake

1 = Enable Xon/Xoff handshake

Transmit pacing is a mechanism by which the remote device can control (stop and resume) the transmission of data from the multiplexer. If enabled, transmit pacing is performed using Xon and

Xoff control codes. When the multiplexer receives an Xoff code (ASCII DC3), it stops transmitting data. When the multiplexer subsequently receives an Xon code (ASCII DC1), it resumes transmitting data.

For example:

:CN, LU, 34B, 1	(Enable Xon/Xoff)
:DL, CRN	(Cause a long output to the terminal)
Cntl-S	(Xoff will cause the output to stop; for example, if
:	the user wants to stop to look at something)
Cntl-Q	(Xon resumes the output to the terminal)

Note that Xon and Xoff codes can be issued through the keyboards to pace the data transmitted to the terminal. The CNTL and Q keys (when pressed simultaneously) generate an Xon code, and the CNTL and S keys generate Xoff.

Caution If Xon/Xoff transmit pacing is enabled, all Cntl-S characters received by the MUX are treated as handshake characters and, therefore, cannot be used as data characters. Similarly, each Cntl-Q preceded by a Cntl-S is treated as a handshake character. A Cntl-Q received without a Cntl-S is treated as a data character. Some of the HP Software Programs (screen mode EDIT and BASIC) use Xon and/or Xoff characters to perform line and/or page editing. It is advised that these characters are not used for editing and handshaking at the same time. A Cntl-Q can be used for editing as long as it is not preceded by a Cntl-S. Similarly, it is recommended that the Xon/Xoff transmit handshake be disabled while sending binary data (for example, from a CTU) to the MUX.

Function Code 36B: Set Binary Length

Function 36B sets the physical buffer length for binary type read requests. This information is normally provided by the driver from a user read (EXEC 1) request, but it may be overridden.

Function Code 37B: Set Read Type

Function code 37B sends configuration information to the interface card for use in read (EXEC 1) operations. Under normal operation, this information is provided by the interface driver as directed by the function field bits 10 through 6 of the EXEC request.

This call provides the user with a mechanism to override the interface driver defined values or to configure a read operation on the card without executing a read request. This is useful in type-ahead initialization. If bit 7 in the driver configuration word (control 33B) is not set, the next read operation will reset the read type. See Table 2-2 for a description of the Set Read Type parameter.

For example, to establish a read type with a buffer transfer on a carriage return for LU 41:

```
ICODE = 3
ICNWD = 3700B+41
ITYPE = 100000B
CALL EXEC (ICODE, ICNWD, ITYPE)
:
```

or

```
CN, 41, 37B, 100000B
```

Table 2-2. Set Read Type (Function 37B) Parameter Description

Bit Number	Read Type
15	End transfer on a carriage return <CR>.
14	End transfer on a record separator <RS>.
13	End transfer on Cntl-D.
12	End transfer on DC2.
11-10	00 – End transfer based on bits 15 through 12. 01 – End transfer based on bits 15 through 12. 10 – End transfer on count using control function 36B. 11 – Reserved. *
9	Enable input data editing (backspace and delete).
8	Enable input data echoing.
7-0	Reserved; set to zero.
* If Bit 11 is set, a control 36B should also be issued to set the length.	

Using the MUX

This chapter describes the features of the HP 12792B/C Multiplexer. Type-ahead is explained, and the most commonly used type-ahead modes are covered. Error handling and failure analysis in user-written programs are also addressed.

Normal Mode

In the normal, non-type-ahead mode of operation, the subsystem appears identical to other non-multiplexed RTE terminal drivers. When a port is inactive, the driver sets up a “read pending” on the terminal so that it will be informed when any key is struck. The appropriate action (system attention, program schedule, and so on) will then be taken.

Type-Ahead

Type-ahead is the ability of a system to accept data from the user’s terminal or device before it is requested by the CPU. The MUX card is a buffered device, and for each channel it is capable of holding up to two 254-byte buffers of text in on-board memory. Note, however, that a type-ahead buffer is terminated when the termination character is detected, regardless of how full the buffer is, up to the 254-byte limit. For example, if the termination character is a carriage return, the type-ahead buffers can be “filled” by two successive carriage returns.

An advantage of type-ahead is that application programs can make the system appear more responsive to the user, increasing total (system plus human) throughput. This is done by having the application program prompt the user to respond while processing the previous input. By the time the user has finished typing, the system will have processed the last request and can begin on the next. As long as the processing takes less time than the typing, the user perceives instant response time.

While in type-ahead mode, the driver leaves a read request pending on the card (not the EQT) at all times. This read allows the user to enter data into the card even though the system does not have a read pending. Upon receiving a record, the card will interrupt the CPU, indicating that a buffer of data is available. If no request has been posted to that port, a flag is set in the status word and the driver returns to the system and waits. When a request is issued, the driver reads the data from the card and completes the user request.

Because keyboard characters are buffered on the card, system attention in type-ahead mode cannot be gained by striking a terminal key. The BREAK key, however, is not buffered and can be used to obtain system attention.

Because multi-line type-ahead is possible, two different type-ahead modes are available. Full type-ahead, as described above, would cause successive read requests to fetch successive lines of text from the multiplexer card. This mode is useful for such tasks as text editing and using DBUGR. Typing can be done as far ahead of the data processing as allowed by available multiplexer buffer memory, up to and not exceeding two records.

In situations where system response could radically alter a user's next command (FMGR error messages, for example), a full multi-line type-ahead may cause problems. The following will illustrate this problem:

User types... ST, FILE, 8

while tape is moving, the user types:

PU, FILE

the tape runs out; the system downs the device

The user hits the BREAK key, the system issues a prompt and a read, the system rather than FMGR reads the PU command from the card buffer and tries to execute the FMGR command.

In the above example, the user merely gets back an "OP CODE ERR" from the system the first time the request for system attention is made. It is possible, however, for the commands stored on the card to have a disastrous effect on the system.

The solution to the above problem is to configure the driver to cancel all card data upon receiving a BREAK interrupt (refer to control function 33B). This preserves the multi-line type-ahead feature and reduces the chance of data being read by the wrong process.

If an analogous situation could occur for user-written programs, another possible solution is for the user to issue a "Flush Card Buffer" request (control request 26B,1) prior to a sensitive read request. This will clear the extra commands before they can be misread.

Note that type-ahead is also useful in non-terminal device communication. The buffering on the card eliminates the need for stacking two or three class read requests on an LU to prevent data loss, thus reducing program size and complexity and the need for a large SAM (System Available Memory). Type-ahead scheduling can be used to invoke a data processing program.

When data is available on the multiplexer card and there is no pending request to accept it, a bit is set in the status word and program scheduling will be attempted. Should the user program decide it does not want the data, it can issue an input flush (control 26B) to remove the data.

Program Scheduling

Program scheduling is a mechanism whereby certain external events cause the interface driver to schedule a program in the system. This program is given the address of EQT (Equipment Table) word 4 which provides adequate information to determine at which port the event occurred.

Program scheduling is an optional feature that must be enabled to operate via a control request. Function code 20B enables the driver to schedule a program on interrupt, and function code 21B disables it. The program to be scheduled can be specified at generation or through function code 27B. Function code 27B allows programmatic scheduling of MUX port programs where the address of the program's ID segment is stored as a parameter value in the call statement. This program will override any program for the port that was designated when the system was generated.

There are several events that can cause an interrupt that will schedule the program for the MUX port as described below (refer to function code 33B, bits 13 and 12):

1. When the port has been set to "normal" mode, it requires that either any character key or the BREAK key on a terminal keyboard is struck (the character struck will be ignored) or a character or BREAK is received from a device.
2. When the port has been set to "type-ahead" mode, it requires the receipt of a BREAK to schedule the program because any characters received will be saved in the port's data buffers.
3. The port can also be configured to schedule the program on receipt of a buffer of data from the device. This type-ahead with scheduling mode also recognizes the BREAK key.

A program scheduled by one of the above events is run with the B-Register pointing to word 4 of the EQT entry that corresponds to the port upon which the event took place. Library functions EQLU or TRMLU can be used by the program to recover the Logical Unit (LU) of that port. This LU can be used later to make I/O, function code, and status calls to that port. The library subroutine RMPAR can be used to recover EQT words 4 through 8. Note that both these routines require that the B-Register set by the driver remain intact.

The programs PRMPT and R\$PN\$ are used for terminal break-mode command processing and are supplied with most RTE systems. These programs are an example of the use of program scheduling.

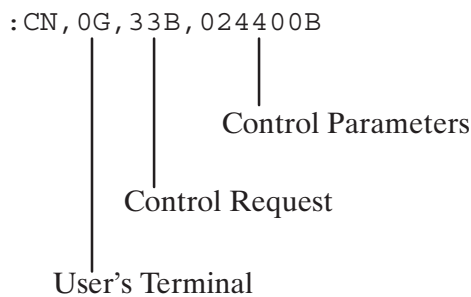
In operation, PRMPT is the program that is scheduled on interrupt from the terminal. When invoked, it finds the LU of the interrupting port and writes the break-mode prompt to that LU. It then posts a class read against that port and schedules the program R\$PN\$. R\$PN\$, waiting on a class GET, receives a command from the user and executes it, returning to suspend on the GET call for the next command.

User-supplied programs may be written to process other schedule-driven applications. These programs may either be included as the program to be scheduled when the system is generated or assigned online by a control request.

Type-ahead is a mode of operation enabling the interface to accept strings of data from terminal devices even though the system did not request information. This information is stored in one of the two 254-byte receiving buffers for that port and remains buffered until a program reads the contents of the buffer. While in type-ahead mode, the driver leaves a read pending on the interface, looking for a valid terminator. The terminator merely signals the interface driver that a complete record has been encountered, and the interface card will interrupt the CPU.

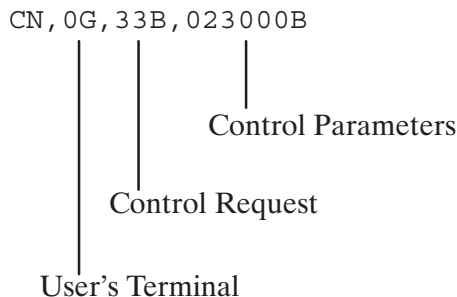
In this mode, the only way to schedule the designated program is to strike the BREAK key. Data resident on the card, if any, is not disturbed.

Type-Ahead with Scheduling Mode



This mode configures the interface driver responses to utilize type-ahead mode. Scheduling occurs when an end-of-record is encountered. Depressing the BREAK key always schedules the designated program. Program specification is accomplished with control function 27 or, more commonly, it is specified at generation time.

Type-Ahead with Flush on Break Mode



In this mode, when the BREAK key is struck, the interface driver flushes the contents of the input buffers and the program designated by control function 27 is scheduled. This mode of operation is the preferred type-ahead mode because it reduces the possibility of having data misread. The user has the option of “erasing” the contents of the buffers just entered by hitting the BREAK key or leaving the buffers alone, allowing them to execute when the next read request reads them.

NOTE: Flush on break may be used in conjunction with either full type-ahead or type-ahead with scheduling.

Error Recovery

Dynamic status checking and I/O status checking allow the user to check the status of a multiplexer port for normal processing and error checking. I/O status can provide the user with two of the device status words (EQT 5 and EQT 4) and an LU status word. Dynamic status checking provides the user with the port's status and the length of any type-ahead data, if present. Function code 6B is described in Chapter 2, User Interface.

All errors associated with the MUX will appear as:

- timeouts
- parity error or overflow

Parity and overflow errors are indistinguishable. As soon as an error is encountered, the user's buffer is flushed. However, if a pending read or a timeout occurs, the status returned indicates a parity/overflow error.

I/O Status

The I/O status request, using a request code (ICODE) of 13, calls the RTE operating system to provide information contained in system tables. This EXEC call is not a call to the interface driver and, therefore, may not return the current status of the port. The LU number of the port must be specified in the control word (ICNWD). One additional parameter is required, and two more are optional. One, two, or three words are returned to the user's program in the parameters passed. Table 3-1 lists the I/O status request returns.

A sample calling sequence for LU 41 is shown below:

```
.  
. .  
. .  
ICODE = 13  
ICNWD = 41  
CALL EXEC ( ICODE , ICNWD , ISTA1 , ISTA2 , ISTA3 )  
. .  
. .  
. .
```

When the call completes, the variables ISTA1, ISTA2, and ISTA3 contain the I/O status as shown in Table 3-1. ISTA1 is the status word (EQT 5) and ISTA2 is also a status word (EQT 4).

Table 3-1. I/O Status Request Returns

Word	Bits	Description
ISTA1	15-14	I/O controller availability indicator: 00 = Available for use 01 = EQT disabled (down) 10 = Device busy
	13-8	Equipment Type code
	7-0	Status: 1 =
	7	Reserved; always zero
	6	Break key hit
	5	Cntl-D entered on the last request (EOT)
	4	Modem line down
	3	Parity error or overflow detected on the last request
	2	Type-ahead data available, control function 6B will return the length of type-ahead data in the B-Register
	1	Program schedule enabled
	0	Last request timed out
ISTA2	15	Reserved; always zero
	14	1 = Automatic output buffering enabled
	13	1 = Driver to process powerfail (always 1)
	12	1 = Driver to process timeout (always 1)
	11	System communication flag
	10-6	Last subchannel addressed
	5-0	Select code of the multiplexer card
ISTA3	15	Logical Unit Status: 1 = LU down, 0 = LU up
	14-5	Reserved; always zero
	4-0	EQT subchannel associated with the LU number

Failure Analysis

For failure analysis it is important to note that all errors appear as timeouts, parity, or overflow errors. Current HP-supplied device drivers do not produce the following error message. User-written device drivers may use the EXIT command described in Chapter 4 to have the following error message displayed at the system console:

```
I/O xx L _#x E _#y S _#z
```

where:

```
xx = NR  
    TO  
    PE
```

and so on, as specified by the device driver

In the above example, x, y, and z are the LU number, EQT number, and subchannel number, respectively. If a device is down, any I/O control request waits for the operator to “UP” the EQT number.

For timeouts, it may be that a simple timeout has occurred, indicating the operator was too slow in responding to a read request. In this case, retry the request.

If the device is not downed, control will return to the user program on error and the user program should be structured to check for errors and process accordingly. The “I/O Status” request can be used to obtain the status to test for various conditions.

Read Errors

If the last command issued was a read, a parity error or data overrun may have occurred. Data overrun indicates the multiplexer maximum throughput rate has been exceeded and data on the LU with the overflow bit set was lost. These errors are only detectable on a read operation.

Device Driver Writing

This chapter explains the writing and use of device drivers that can be called by the HP 12792B/C Multiplexer Interface Driver, DVM00. The basic philosophy of using device drivers is explained to give you a better understanding of the steps involved.

Device Driver/Interface Driver Concept

An interface driver is a standard RTE driver that converts user EXEC requests for input, output, and control into a sequence of assembly level instructions that control and pass data to an interface card through the I/O backplane of an HP 1000 computer. The interface driver need know nothing about the device that is the eventual source or destination for the data; the interface driver only communicates with the interface. The device driver modifies user requests to make them compatible with the device. The device driver is a subroutine that is called by the interface driver to examine and modify user requests.

Reasons for Device Driver/Interface Driver Use

The device driver/interface driver concept offers several advantages over the conventional monolithic driver. The use of device drivers allows flexibility for system designers and users. Many different types of equipment may be controlled by a single type of interface as long as they are electrically compatible and use the same basic line protocol. For example, any RS-232-C (electrical specification), asynchronous (basic line protocol) device may be controlled by the HP 12792B/C MUX interface. Individual device drivers for each of these devices may be easily written without knowledge of the I/O card/backplane interface. New devices may be added to a system without undertaking the monumental task of writing an entirely new driver. The system programmer need only write a subroutine to add the required character sequences to the user data to control the new device.

Differences between devices may be made transparent to user programs. Application programmers need only concern themselves with reading or writing data to a “standard” device while the device driver takes care of the control needed for the “exotic” device the program is actually communicating with.

Some devices may be customized by using different device drivers for different tasks. Printing terminals may be made to look like line printers to the user program by writing a device driver to translate column one carriage control into the proper escape sequences for the terminal. A different device driver may then be used when an interactive terminal is desired. These various

device drivers may be dynamically switched in and out by the user program or by the system manager when required.

A single driver written to control a large number of different devices through a common type of interface would be very large. Requiring the use of this driver would penalize users who only need a few of these devices. By using device drivers, a system manager need only include the driver code needed for the devices on the system, thus saving space for other uses.

Interface Tasks

To write efficient device drivers it helps to have an understanding of the responsibilities of the other components in the I/O interfacing subsystem. In the HP 12792B/C Multiplexer Subsystem, the MUX interface card is primarily responsible for sending and receiving characters on the RS-232-C line and for handling line protocol. When enabled to do so, it handles the ENQ/ACK line protocol to prevent terminal buffer overruns, it transmits and receives the characters to and from the terminal at the baud rate for which it has been set by the driver, and it automatically packs the 8-bit characters into 16-bit data words for efficient DMA transfer to the computer or unpacks the 16-bit words into 8-bit bytes for the terminal. The card treats the parity bit as described in the Interface Support Definition section in the *HP 12792B/C 8-Channel Multiplexer Configuration Guide*, part number 5955-8868, and notifies the driver when incorrect parity has been received.

Interface Driver Tasks

Interface Control

The interface driver DVM00 for the HP 12792B/C multiplexer subsystem is responsible for controlling the MUX interface card via assembly level I/O instructions to the computer I/O backplane. The driver interprets user requests to properly initialize the card for baud rate, parity, character length, number of stop bits, and so on. Also, it initializes and starts DMA transfers between the computer memory and the card.

Operating System Interface

The interface driver receives EXEC level user requests from the RTE operating system and passes them to the device driver for further processing. The interface driver processes requests from the device driver, returning to the device driver on each request completion. The interface driver requests a DMA channel from the RTE operating system when a data transfer is required either to send data to the card or receive data from the card. When the device driver informs the interface driver that the user request is complete, the interface driver returns to RTE with the correct device status and transmission log or error code in the A- and B-Registers.

Device Driver Tasks

The device driver is entered on each new user request and on completion of each device driver request. The device driver may do further checking on request legality. If the device requires a special sequence of characters prior to receiving or sending the user data, the device driver should format the characters into a buffer and send them to the device via a device driver request to the interface driver. When the user request is to be processed, the device driver instructs the interface driver to start the request currently in the EQT. When the entire request has completed, the device driver places the correct status in the EQT and the transmission log in the B-Register and then informs the interface driver that the request is complete.

HP Implementations of Device Drivers

There are two examples of device driver applications that Hewlett-Packard has implemented as part of the HP 12792B/C Multiplexer subsystem.

Line Printer Device Driver DDV12

Device driver DDV12 causes HP 2631/2635/7310 printers to look like typical line printers to user programs. These devices use escape sequences and control characters for carriage control while standard line printers interpret the first character of each line as a carriage control character. The DDV12 device driver examines the user's first character and sends the proper control character sequence to the printer. The first character is then stripped from the data, and the data is sent to the printer. The device driver also changes the driver type in the EQT to type 12 for line printers.

Block Mode Terminal Device Driver DDV05

The device driver DDV05 allows utilization of the block mode read capabilities of an HP 264x or HP 262x terminal. The first time a read request is made to the terminal its status is read to determine whether it is in block or character mode. When a user read request is made, the device driver first issues a write to the interface driver to send a DC1 to the terminal. If the terminal is in block mode, the device driver issues a read to the interface driver and examines the first returned character. If the character is a DC2, the device driver knows that the terminal is in block mode and tries to send data to the interface. A read is then issued for the user buffer length with echo and character editing turned off. If the returned character is not a DC2, the user program probably issued a program enabled block read (esc 'd') and the program's data is in the buffer just read.

If the terminal is in character mode, the user's request is executed "as is" after the DC1 is sent (to enable the softkeys).

Device Driver Interface

An uncomplicated device-driver/interface-driver interface is provided making it easy for systems programmers to write their own device drivers. All that is required beyond the information given in this chapter is a basic familiarity with the flow of I/O requests in RTE and a thorough knowledge of the particular device that is being communicated with.

Device Drivers for the HP 12792B/C Multiplexer

Keep in mind the following points when writing device drivers for the HP 12792B/C Multiplexer subsystem. First, all read, write, and control requests are passed to the device driver by the interface driver for modification before they are sent to the interface card. The device driver must only make read, write, or control requests to the interface driver; the device driver does not issue I/O instructions to the interface card. The device driver requests are at the EXEC level, that is, a request word (control word as defined for EQT word 6) buffer address and length, or optional control request parameters are passed to the interface driver. A device driver will typically make several of these requests for each user EXEC request. After each device driver request completes, the interface driver will return to the device driver for the next request. It is up to the device driver to instruct the interface driver when the original user request is complete. The device driver and interface driver pass parameters back and forth between each other using the A- and B-Registers and the portion of the EQT extent defined as the Device Driver EQT Extent.

Restrictions and Requirements

When a device driver issues read or write requests, the data buffer must be either within the device driver or in the same map as the user request buffer. If the user request is unbuffered, the user request buffer is in the user map. If the user request is buffered, Class I/O, REIO (re-entrant I/O), or \$XSIO (system I/O), the user request buffer is in the system map.

All requests are passed to the device driver prior to checking by the interface driver. Device drivers should check only for control requests that are defined for the device driver. Unrecognized control requests should be passed to the interface driver with a command to execute the request.

System Abort Requests

A system abort request may be issued to the interface driver at any time if the user program currently doing I/O is aborted for any reason. The device driver may be entered with the system abort either as a new user request or as a continuation request. If the device driver is entered as a new user request with the system abort request, the device driver should treat it as any unknown control request and pass it back to the interface driver.

However, if the device driver is entered as a continuation with the system abort, two problems may occur. If the device driver does not check for the system abort on a continuation entry and subsequently issues a read or write request to the user buffer, the buffer area may have been re-allocated for other uses. Program corruption and system or subsystem crashes may occur. It is also possible to leave the device in an unknown state if an expected user buffer is not written to the

device. If this is a problem with a device, the device driver should check for system abort requests and reset the device to a known state.

In all cases, the device driver should check for a system abort request prior to issuing an I/O request to the user buffer area.

To test for a device driver system abort request, check the contents of EQT word 6 or word 2 of the extent for a 100003 octal (\$XSIO control zero request). The above tests are necessary if the device driver issues its own read or write to or from the user buffer area on a continuation entry. If the device driver is simply trying to execute the user's original request by leaving it in the device driver EQT extent word 2, the test for system abort request is not necessary. In this case, the contents of device driver EQT extent word 2 are changed to a control zero at the same time as EQT word 6.

Interface Definitions

On entry to the device driver, the following parameter locations are defined:

A-Register, Bit 15: 1 = initial entry on a new user request
 0 = continuation entry, signifying a previous device driver request is complete

Bits 14-0: address of device driver EQT extent (defined below)

B-Register: Previous device driver request transmission log, if any.

The device driver EQT extent words 2 through 4 are set to the current user request definition. These three words are copied from EQT words 6 through 8 on each (new or continuation) entry to the device driver. See the expanded definitions of the EQT words below.

Base page locations 1660 through 1672 are the addresses of the current EQT words 1 through 11, and base page locations 1771 through 1774 are the addresses of EQT words 12 through 15.

On each entry, EQT words 4 through 10 and 14 are defined per the RTE definitions (expanded below). EQT words 9 and 10 (Read/Write optional parameters) are defined per RTE on new request entries only (A-Register bit 15 = 1). However, they are not defined on subsequent continuation entries. If their contents are required by the device driver on subsequent entries, they should be saved in the device driver EQT extent on the new request entry.

Return to the Interface Driver

On return to the interface driver, the device driver must ensure that the proper parameters are passed back to the interface driver. The device driver must differentiate between new user request entries and continuation entries as the parameters returned to the interface driver are different for each case. Also, the device driver must tell the interface driver when the original user request is complete and set up the correct transmission log and status indications for the calling program.

On return to the interface driver, the following parameter locations are defined:

A-Register, Bits 15-3: Function modifier.

Bits 2-0: Exit command.

B-Register: Request timer, or user transmission log.

EQT 5, Bits 7-0: Status for user.

Device driver EQT extent,

- word 1: Physical record length, in characters, for read requests if different from user buffer length.
- word 2: Request word as defined for EQT word 6 except that bits 15 through 11 are not defined and should be zero.
- word 3: Request buffer address.
- word 4: Request buffer length (positive number of words or negative number of characters).

Device Driver EQT Extent

The physical record length (device driver EQT extent word 1) is used to prepare the HP 12792B/C interface card for binary data read requests where the device does not terminate the record with a special character such as carriage return. The physical record length must be a positive number of characters. If this parameter is not set, it defaults to the user buffer length.

Words 2 through 4 of the device driver EQT extent may be changed by the device driver to cause the interface driver to execute a different request, or they may remain unmodified causing the interface driver to perform the initial user request. Remember that on each entry, words 2 through 4 of the device driver EQT extent are restored to the original user request, copied from EQT words 6 through 8.

A-Register

Exit Command

On return to the interface driver from the device driver, the A-Register bits 2 through 0 must be set up with the exit command. The exit command definition is similar to the RTE definition for the A-Register for a standard driver on return to RTE. The exit command definition is as follows:

Exit command if entered with a new user request (A-Register bit 15 = 1 on entry)

- 0 = start request in device driver extent words 2-4; B-Register = timeout value (-10s ms)
- 1 = user I/O request is illegal; give IO07 error
- 2 = user control request is illegal; ignore it
- 3 = I/O device not ready; down it and print IONR message
- 4 = user request completed (immediate completion); B-Register = transmission log
- 5 = start request (same as 0)

Exit command if entered after completion of a device driver (A-Register bit 15 = 0 on entry)

- 0 = user request is complete; B-Register = transmission log
- 1 = I/O device not ready; down it and issue IONR message

- 2 = end of transmission (EOT) reached; down device and issue IOET message
- 3 = parity error; down device and issue IOPE message
- 4 = device timeout; down device and issue IOTO message
- 5 = new request in device driver EQT extent words 2-4;
B-Register = timeout value (-10s ms)

Function Modifier

Error type exit commands (new request 1, 2, and 3 or continuation entry 1, 2, 3, and 4) are simply passed to RTE in the A-Register by the interface driver. Action taken (program abort, print error message, and so on) is determined by RTE the same as for any standard driver.

For exit commands that initiate another device driver request (new request exit command equals 0 or 5, continuation entry exit command equals 5), a function modifier may be placed in A-Register bits 15 through 3 to override and expand the normal request function code contained in the device driver EQT extent word 2, bits 10 through 6. Function modifiers are defined for read and write operations. Write function modifiers contain read modification fields and can be used to define the function modification for the next read or series of read operations. The write function modifier bit fields are defined as follows:

A-Register bits 15-3

- Bit 15: end transfer on carriage return (CR)
- 14: end transfer on record separator (RS)
- 13: end transfer on end of tape (EOT, Cntl-D)
- 12: end transfer on (DC2)
- 11: end transfer on specified character count
- 10: enable end on character specified in bits 15-12
- 9: enable character editing (backspace, delete, etc)
- 8: echo received characters
- 7: not defined, should be 0
- 6: not defined, should be 0
- 5: disable ENQ/ACK handshake this transfer only
- 4: add CR/LF to buffer if last character is not an underline (137 octal)
- 3: use write overrides in bits 7-4, if bit 3 is 0, bits 7-4 should be 0

If bits 7 through 3 are zero (do not override), the write is configured by bits 10 through 6 in the device driver EQT extent word 2. These bits are defined as bits 10 through 6 in EQT word 6 and the ICNWD description in the EXEC write section of this manual.

The read related fields in the write function modifier (bits 15 through 8) will configure the card for subsequent read operations. This eliminates the “window” between writing and reading so that if the write triggers a response from the device, no data is lost.

If enable end on character (bit 10) is set, one or more of bits 15 through 12 must be set. Reads will complete on reception of any one of the specified characters. If bit 10 is clear, bits 15 through 12 should be zero. If end on count (bit 11) is set, the physical record length in device driver EQT extent word 1 should be set to a positive number of characters. If bit 11 is set, the end on character bits 15 through 12 and 10 are ignored. Only one of bits 10 and 11 should be set.

For read functions, the modifier bit fields are defined as follows:

A Register bits 15-8, 3

- Bit 15: end transfer on carriage return (CR)
- 14: end transfer on record separator (RS)
- 13: end transfer on end of tape (EOT, Cntl-D)
- 12: end transfer on (DC2)
- 11: end transfer on specified character count
- 10: enable end on character specified in bits 15-12
- 9: enable character editing (backspace, delete, etc)
- 8: echo received characters
- 7-4: reserved; set to zero
- 3: use current card configuration

If enable end on character (bit 10) is set, one or more of bits 15 through 12 must be set. Reads will complete on reception of any one of the specified characters. If bit 10 is clear, bits 15 through 12 should be zero. If end on count (bit 11) is set, the physical record length in device driver EQT extent word 1 should be set to a positive number of characters.

If bits 15 through 3 are all zero, the read configuration is determined from the control word bits (10-6) in the device driver EQT extent word 2. These bits are defined as in EQT word 6 and the ICNWD described in the EXEC read section of this manual. Bit 9 of the EXEC request (EQT extent word 2) is always used and must be valid. If bit 3 is set, bits 15 through 4 should be zero.

B-Register

On return to the interface driver, the device driver should set the B-Register to be either the transmission log or the device timeout value. If the initial user request is complete, the B-Register should contain the transmission log to be returned to the user program. Transmission logs for each device driver operation are returned to the device driver in the B-Register by the interface driver on each continuation entry. The device driver may save one or more of these to return, or the device driver may return any meaningful number. Convention requires that the transmission log be a positive number, either a number of words, if the initial user request specified words (EQT word 8 is positive), or a number of characters, if characters were initially specified (EQT word 8 is negative).

If a new device driver request is to be initiated (exit command equals 5 on continuation, or 5 or 0 on initial entry), the B-Register should contain the request timeout value. This value will be a negative number of time base ticks (tens of milliseconds). If the device driver needs to use the system defined timeout for the device, EQT word 14 should be copied into the B-Register.

EQT Entries

As a general rule, it is not advisable for the device driver to modify the EQT, except for the area defined as the device driver EQT extent. However some EQT areas are routinely modified by device drivers. In EQT word 5, the equipment type (bits 13 through 8) should be modified on the first entry to a device driver to reflect the device type the device driver is emulating. On each completion exit (new request exit command equals 4 or continuation entry exit command equals 0), the status field in EQT word 5, bits 7 through 0 should be updated to return status to the user. This field should be the same as is defined for the device type the device driver is emulating.

After the user's request has been processed, if further interaction with the interface driver is required, EQT words 7 and 8 are available as convenient temporary storage areas. It is common to store the transmission log in EQT word 8 in these cases. Words 9 and 10 are used by the interface driver for temporary storage and should not be modified by the device driver.

Selected EQT Definitions and Uses

EQT Word 4 Subchannel EQT word 4 bits 10 through 6 contain the currently addressed subchannel. This information is required by device drivers that perform different tasks for different subchannels.

EQT Word 5 Equipment Type Code and Status

EQT word 5 bits 13-8 contain the equipment type code as specified by the driver name at generation. The HP 12792B/C Multiplexer interface driver is DVM00 so the type code is 00. Device drivers that emulate devices should use a type code that corresponds to the device they are emulating. On first entry, the device driver should change the type code in the EQT table. The following is a list of type codes and devices they represent:

- 00 to 07 = terminals or paper tape devices
 - 00 = teleprinter or keyboard control device
 - 01 = photoreader
 - 02 = paper tape punch
 - 05 = intelligent terminal devices generally having block mode capability (HP 264x and 262x terminals)
 - 07 = multipoint devices
- 10 to 17 = other unit record devices
 - 10 = plotters (Calcomp or HP 7210)
 - 11 = card readers
 - 12 = line printers
 - 13 = TV monitor
 - 15 = mark sense card readers
- 20 to 35 = magnetic tape or mass storage devices
 - 23 = 9 track magnetic tape
 - 24 = 7 track magnetic tape
 - 30 = fixed-head disk
 - 31 = HP 7900 moving-head disk
 - 32 = HP 7905/06/20/25 moving-head disk
 - 33 = flexible disk drives
 - 36 = writable control store (microcode execution space)
 - 37 = HP-IB Interface
 - 47 = Multidrop FDL interface

EQT word 5 bits 7-0 contain the device status of the HP 12792B/C Multiplexer on each entry into the device driver. This status is defined as follows:

Bit 7 Timeout, if the driver was entered on a timeout, this bit will be set on entry to the device driver.

- Bit 6 Break, if the HP 12792B/C Multiplexer card received a break character from the terminal during the last operation, this bit will be set.
- Bit 5 EOT, the end-of-tape bit will be set if an EOT (004 octal) was received during the last read.
- Bit 4 Modem line is down.
- Bit 3 PE/OV, the Parity Error/Overflow bit will be set if either one of these conditions occurred on the last read.
- Bit 2 Type-ahead data, this bit will be set if type-ahead data is available on the card.
- Bit 1 Schedule, this bit indicates that program scheduling on unsolicited interrupt has been enabled (interface driver control function 20B).
- Bit 0 Bit 0 is not used.

The above definitions apply whenever the device driver is entered from the interface driver. The device driver is free to change any of the status bits if emulation of other driver types is desired. On a user request, complete exit from the device driver; the status bits (EQT word 5) will be passed to the user program in the A-Register.

EQT word 6 and device driver EQT extent word 2 contain the current request word which is defined as follows:

- Bits 15-14 Request type:
 - 00 = standard user request
 - 01 = automatic buffered user request (request buffer is in system available memory)
 - 10 = a system request (\$XSIO)
 - 11 = user Class I/O request (request buffer is in system available memory).

Bits 15-14 are only defined in EQT word 6. They are undefined in the device driver EQT extent word 2 and should be set to zero if the device driver modifies this word.

- Bit 12 Z-bit indicates a second buffer is available on a read or write. If set, EQT word 9 contains the address of the buffer and EQT word 10 contains the length. If the Z-bit is clear, EQT words 9 and 10 contain one-word optional parameters.

In the HP 12792B/C Multiplexer subsystem, the interface driver does not use the double buffering feature, it is therefore available to the device driver for use.

- Bits 10-6 Subfunction, as defined in the EXEC request section of this manual for the EXEC control word.

- Bits 1-0 Function:
 - 01 = read request
 - 10 = write request
 - 11 = control request.

Bits 13, 11 These bits are undefined and should be set to zero if the device driver and 5-2 modifies the request in the device driver EQT extent word 2.

EQT word 7 and device driver EQT extent word 3 is the user buffer address. The interface/device driver is always entered in the same map as the user buffer, so the user buffer address is in the current map.

EQT word 8 and device driver EQT extent word 4 is the user buffer length. The length is either a positive number of words or a negative number of characters.

EQT word 9 is an optional parameter. If the Z-bit (EQT word 6 bit 12) is set, EQT word 9 is the address of a secondary user buffer which is in the same map as the primary user buffer. If the Z-bit is clear, EQT word 9 contains the optional parameter, or zero if no parameter was passed.

EQT word 10 is an optional parameter. If the Z-bit is set, EQT word 10 is the length of the secondary user buffer. It is a positive number of words or a negative number of characters. If the Z-bit is clear, EQT word 10 contains the second optional parameter, or zero if a second optional parameter was not passed.

Both EQT words 9 and 10 are only available to the device driver on a new request entry. These words must be saved in the device driver EQT extent if they are required later by the device driver.

EQT word 14 contains the system defined timeout reset value for the device (a negative number of time base ticks at multiples of 10 milliseconds). This value is set by the system at generation or by the system TO command or by the interface driver by a control request of 22B. This word may also be set directly by the device driver, if desired.

EQT word 15 contains the timeout clock count down counter. This word is set by the interface driver prior to returning to the system. This word should not be modified by the device driver. On any device driver request to the interface driver, the timeout count for EQT 15 should be passed in the B-Register. The value should be a negative number in multiples of 10 milliseconds. If the system defined timeout is to be used, the device driver must pass the contents of EQT word 14 to the interface driver in the B-Register.

Device Driver Address Table

The interface driver uses a device driver address table to find the correct device driver when the device driver is selected with a control request of 33B. The device drivers are selected by numbers that are determined by their positions in the device driver address table. Each device driver to be used with the interface driver must have an entry in the device driver address table. To add device drivers to the device driver address table, the user must create his or her own table.

The device driver address table should have the following format:

```

        NAM $DVTB, 8    DEVICE DRIVER ADDRESS TABLE
        ENT $DVTB
        EXT DVNM1, . . . , DVNMn
*
*   DEVICE DRIVER ADDRESS TABLE
*
$DVTB  DEC  n           NUMBER OF ENTRIES IN TABLE
        DEF  DVNM1+0    ADDRESS OF DEVICE DRIVER      2
        DEF  . . . . . +0    . . . . . . . . . . . . . . 3
        .
        .
        DEF  DVNMn+0    ADDRESS OF DEVICE DRIVER      n+1
        END

```

The names of the device drivers may be any valid label, as long as they do not conflict with any other symbol in the system. Note that the first device driver in the table is selected by a control request 33B to use device driver number two. This is because the value zero is reserved for “no change” and one is used for the default device driver. Because the device driver number field is four bits wide, the user is able to include the default and up to 14 other device drivers in the system.

Location and Size of Device Drivers

Because the device driver address table and device drivers themselves are called directly by the interface driver, they must be resident within the same map. This poses a few restrictions on the number and location of these modules.

The interface driver requires approximately 1400 words of memory, so up to 600 words are left in a standard two-page driver partition for the device driver address table and the device drivers. If this is not enough room, either the driver partition can be changed to three or more pages, or one or more device drivers and the table may be relocated into Table Area I. If \$DVTB is relocated into Table Area I, all device drivers will be forced to Table Area I. The disadvantages are that the user available space in the system is reduced. If the driver partition size is increased, the size of the largest available user partition is reduced by an equal amount, and the size change must be an incremental number of pages. If the modules are relocated in Table Area I, the actual space used may not take away from user space unless a page boundary is crossed, in which case a page will be taken away from the largest available user partition. Device drivers relocated in Table Area I will take space otherwise used as System Available Memory (SAM). In RTE-IVB, only these two methods of gaining space for device drivers will guarantee that the device driver and interface driver will be in the same map and be mapped properly to handle all user requests. The interface driver and device drivers and table could be all relocated into the system driver area (SDA). More space is available to users, but large background programs will not be able to make unbuffered requests to the driver.

Case Study: A Device Driver Writing Example

The following is an example of device driver writing that illustrates some of the problems, solutions, and steps involved in writing a typical device driver. The device driver in this example is written to make a terminal look like two separate terminals, sharing the keyboard, and splitting the screen into two separate areas.

Task Definition

The tasks involved in interfacing with a device using a device driver should be clearly defined and broken down into a sequence of logical steps. In this example, the object is to make an HP 26xx terminal appear as two terminals for read and write requests. Requests made to an LU defined as EQT subchannel 0 will go to the left half of the terminal display, and requests to subchannel 1 will go to the right half of the display.

Three major tasks are defined for the device driver while the interface driver handles the user's actual read or write request. The three tasks all involve sending specific character sequences to the terminal for initialization in a classic device driver application.

Margin Setup

The first task is to set the left and right margins on the terminal to keep the following text on the respective side of the screen. Upon determination of the subchannel for each new user request, the device driver sends the escape sequence to set the left and right margin at predetermined columns on the terminal screen. Due to terminal idiosyncrasies, the left margin must be set first for subchannel 0 (left side) and the right margin must be set first for subchannel 1 (right side).

Cursor Position

The second major task is to position the cursor so that the subsequent read or write operations will appear at the correct place on the screen. The escape sequence to position the cursor is formatted with the correct cursor position for the left or right side of the screen. The device driver keeps track of the current cursor position for each side in the device driver EQT extent. Once the request buffer is formatted with the correct cursor position, the device driver passes it to the interface driver as a device driver request.

Cursor Tracking

The third major task for the device driver is to find out where the user's request has left the cursor for the side of the screen that was just addressed. To do this, the device driver writes a request for a cursor position sense to the terminal and then reads back the result. The resulting cursor position is separated from the escape sequence that precedes it and stored away in the device driver EQT extent for the subchannel that is addressed.

Minor Tasks

Additionally, in an effort to reduce overhead, the device driver is written to not set the margins or position the cursor when the subchannel addressed is the same as the previous subchannel. It is assumed that the cursor and margins will remain in position between sequential requests to the subchannel. In order to implement this step, the device driver saves the last addressed subchannel in the device driver EQT extent.

Finally the device driver patches the equipment type code into EQT word 5. This patch will take place only the first time the device driver is accessed for any particular EQT. Because either subchannel most closely resembles type 00 devices to the user, the equipment type used is 00. This step is included for illustration only. When any “Select New Device Driver” request is made (CN,LU,33B,XXXXXn, where bits 3 through 0 equal zero), the driver is reset to 00.

Device Driver Operation

Functionally, the device driver makes a series of tests on each entry to determine the action required. Processing a user request is a sequence of actions that generally fall in the following order:

1. Position left or right margin
2. Set margin
3. Position other margin
4. Set margin
5. Position cursor
6. Perform user request
7. Request cursor position
8. Read cursor position
9. Save cursor position

Each action is handled by a separate routine that saves the address of the next routine in the device driver EQT extent so that execution moves in a step-by-step fashion on each continuation entry to the device driver.

Operation Flow

Figure 4-1 shows the complete device driver flowchart.

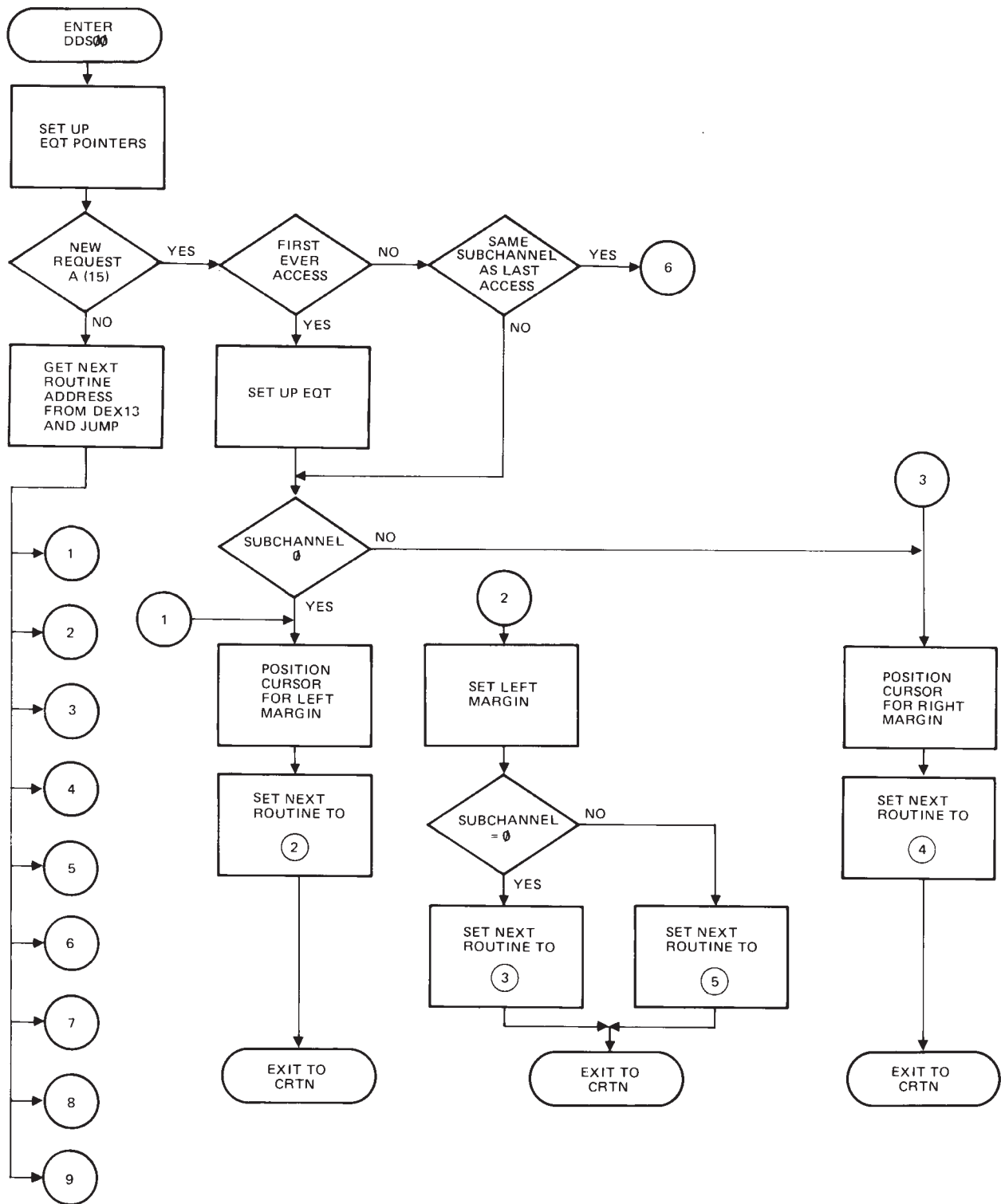


Figure 4-1. Device Driver Flowchart

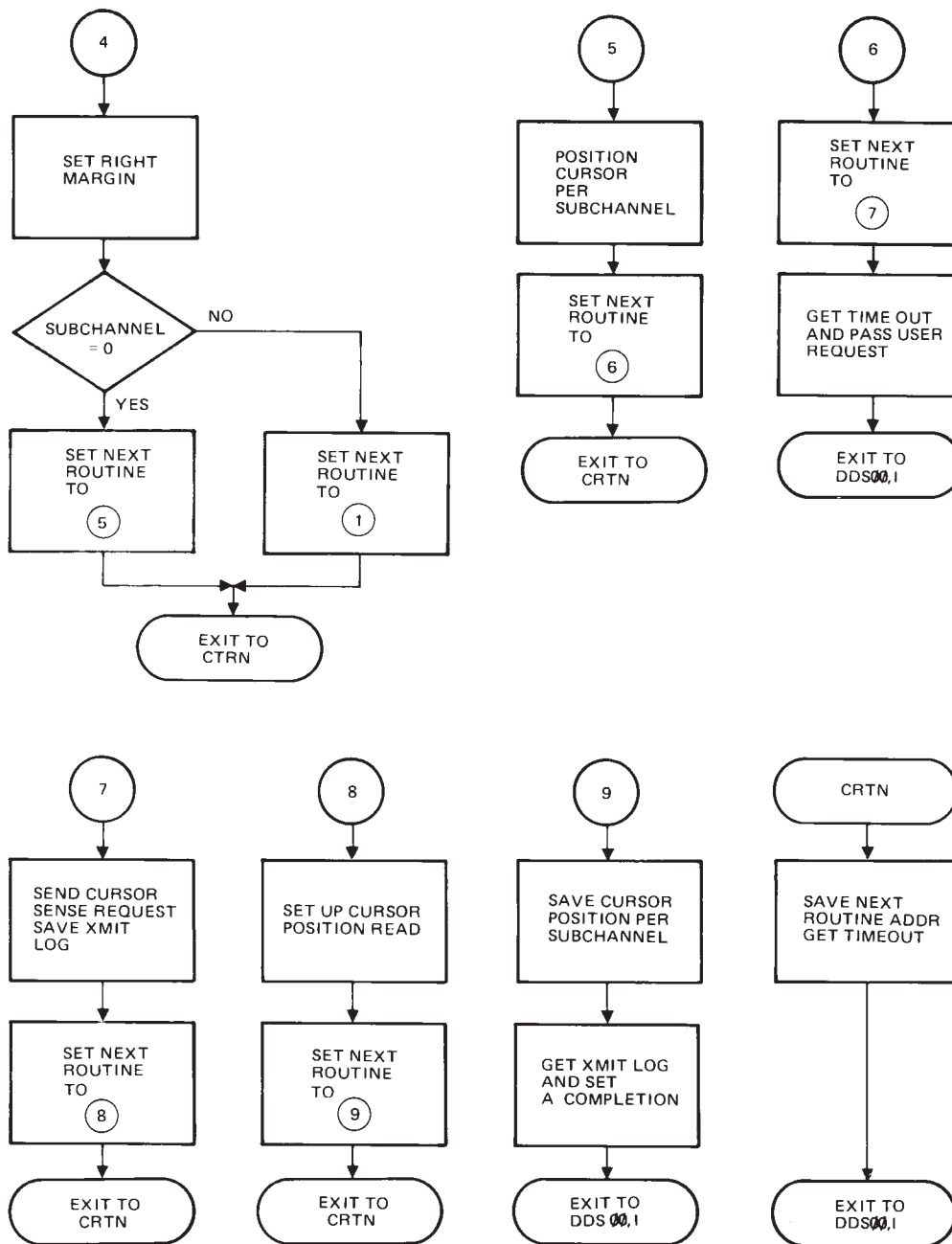


Figure 4-1. Device Driver Flowchart (continued)

Set Up Device Driver EQT Extent Pointers

On each entry to the device driver, the device driver EQT extent addresses are stored in a table in the device driver. On each entry, the A-Register contains the first device driver EQT extent address and bit 15 indicates new or continuation entry. Bit 15 is saved for later testing and stripped from the address before the addresses of the device driver extent are saved.

```

        DDS00  NOP                DEVICE DRIVER ENTRY POINT
            STB TEMP              SAVE B TEMPORARILY
            CLE                   SAVE A[15]
            ELA, RAR              AND CLEAR IT
            LDB DEXAD             ADDRESS OF TABLE
            LDX DM15             DECIMAL MINUS 15
*
* CREATE TABLE OF DD EXTENT ADDRESSES
*
        DEXLP  STA B, I           A CONTAINS ADDRESS OF DD EXTENT WORD
            INA                   B CONTAINS ADDRESS IN TABLE
            INB                   X CONTAINS COUNT DOWN
            ISX
            JMP DEXLP
            .
            .
            .
        DEXAD  DEF DEX01          ADDRESS OF TABLE
        DEX01  NOP                ADDRESS OF FIRST DD EXTENT WORD
        DEX02  NOP
            .
            .
        DEX15  NOP                ADDRESS OF DD EXTENT WORD 15
```

After the initial setup is done on each entry, the device driver then tests the bit that indicates a new request entry that was saved in the E-Register. Continuation entries go to the next routine to be executed whose address is always saved in the device driver EQT extent word 13. If it is not a continuation entry, the device driver tests to see if it is the first ever entry for the EQT. Device driver EQT extension word 15 contains an ASCII "S0" if this is not the first ever entry.

EQT Setup on First Entry

On the first entry for any EQT, the starting cursor positions for the left and right sides of the screen are established. The cursor positions are stored in ASCII format in the device driver EQT extent words 5 through 12. The starting positions, upper left corner of each screen, are hard coded in ASCII in the driver:

```

      .
      .
      LDA AS0          GET THE ASCII "S0"
      STA DEX15,I      SAVE IT TO INDICATE NOT FIRST ACCESS
*
      JSB .CFER        MOVE FOUR WORDS OF CURSOR POSITION
      DEF DEX05,I      TO THE DD EXTENT
      DEF S0RC         FROM THE DEFINITION LOCATION
      JSB .CFER        MOVE FOUR WORDS FOR THE OTHER CURSOR
      DEF DEX09,I      TO THE DD EXTENT
      DEF S1RC         FROM THE DEFINITION LOCATION
*
      LDA EQT5,I       GET THE EQT ENTRY WITH EQUIP TYPE
      AND TMASK        (14037B) MAKE THE TYPE 00
      STA EQT5,I       SAVE IT
      .
      .
EQT5  EQU 1644B
S0RC  ASC 4,000r000C  STARTING ROW & COLUMN SUBCHANNEL 0
S1RC  ASC 4,000r042C  STARTING ROW & COLUMN SUBCHANNEL 1
```

Subchannel Determination

On a new request entry, the device driver determines to which subchannel the request is addressed. The subchannel is in EQT word 4 bits 10 through 6. The subroutine GTSCH gets the subchannel and returns it in the A-Register.

```

GTSCH  NOP
      LDA EQT4,I       GET FROM EQT WORD 4
      AND B3.7K        (3700B) ONLY LOOK AT THE SUBCHANNEL BITS
      ALF,ALF
      RAL,RAL          POSITION TO RIGHT
      JMP GTSCH,I      RETURN
      .
      .
EQT4  EQU 1663B
```

Once the subchannel has been determined, the device driver must save it in the device driver EQT extent and then set the left or right margin. Note that although the driver specifies subchannel 0 or 1, it will use any even subchannel as the left side or any odd subchannel as the right side.

```

      JSB GTSCH        GET THE SUBCHANNEL FROM THE EQT
      STA DEX14,I      SAVE IT IN DD EXTENT WORD 14
      SLA              ODD OR EVEN?
      JMP RMPOS,I      ODD -- DO RIGHT FIRST
      JMP LMPOS,I      EVEN -- DO LEFT FIRST
```

Output a Setup String to the Terminal

The device driver routines to output various strings of characters to set up the terminal are all basically the same. They all set up the request in device driver EQT extent words 2 through 4 and exit through a common return routine. Device driver extent word 2 is set with a read or write request code, word 3 with a buffer address inside the device driver, and word 4 is set up with the buffer length.

```
*
* POSITION CURSOR FOR LEFT MARGIN SET
*
LMPOS  DEF  *+1          ADDRESS OF ROUTINE
        LDA  BNWT          GET THE CONTROL WORD FOR WRITE W/O CRLF
        STA  DEX02,I       PUT INTO DD EXTENT
        LDB  DEX14,I       GET THE SUBCHANNEL NUMBER
        LDA  LMPA          GET THE LEFT MARGIN POSITION ADDRESS POINTER
        SLB                    TEST ON SUBCHANNEL
        INA                    ODD -- USE THE OTHER ONE
        LDA  A,I           GET THE ADDRESS OF THE CHARACTER STRING
        STA  DEX03,I       PUT INTO DD EXTENT
        LDA  CMLNG         GET THE CURSOR MOVE LENGTH WORD
        STA  DEX04,I       PUT INTO DD EXTENT
        LDB  LMSET         GET THE ADDRESS OF THE NEXT ROUTINE
        LDA  MODX1         GET THE WRITE MODIFIER/EXIT COMMAND
        JMP  CRTN          GO TO THE COMMON RETURN ROUTINE
        .
        .
BNWT    OCT  000102       CONTROL WORD FOR WRITE W/O CRLF
LMPA    DEF  LMPAD        ADDRESS OF LEFT MARGIN POSITION TABLE
LMPAD   DEF  LMPA0        EVEN SUBCHANNEL POSITION ADDRESS
        DEF  LMPA1        ODD SUBCHANNEL POSITION ADDRESS
LMPA0   OCT  15446        ASCII "ESC &"
        ASC  3,  000C     COLUMN POSITION FOR LEFT SIDE LEFT MARGIN
LMPA1   OCT  15446        ASCII "ESC &"
        ASC  3,  042C     COLUMN POSITION FOR RIGHT SIDE LEFT MARGIN
CMLNG   DEC  4
MODX1   OCT  102005       WRITE MODIFIER/EXIT COMMAND:
*                               DO REQUEST IN DEX02-4, END NEXT READ ON CR
*                               DO NOT MODIFY WRITE IN DEX02
```

The common return routine is used by all the device driver routines that initiate their own requests to the interface driver. The return routine expects the address of the next routine to be in the B-Register and the modifier/exit command to already be in the A-Register. The return routine saves the next address in the device driver EQT extent word 13 and picks up the timeout value used for all setup requests.

```
CRTN    STB  DEX13,I      SAVE NEXT ROUTINE ADDRESS IN DD EXT WORD 13
        LDB  TO           GET TIMEOUT FOR SETUP REQUESTS
        JMP  DDS00,I      RETURN TO INTERFACE DRIVER
```

Stepping from one routine to the next is made simple by always saving the next routine address in device driver EQT extent word 13. On any continuation entry, the device driver must only jump through the contents of extent word 13 indirect:

```

DDS00  NOP                DEVICE DRIVER ENTRY POINT
        STB TEMP          SAVE B TEMPORARILY
        CLE
        ELA,RAR          SAVE A[15] FOR CONTINUATION TEST
        .
        .                SET UP DD EXTENT ADDRESSES
        .
        LDB TEMP          RESTORE B
        SEZ,RSS          TEST FOR CONTINUATION
        JMP CS00         IF E (WAS A[15]) IS SET, GO TO CONTINUATION
        .
        .
CS00   LDA DEX13,I       GET NEXT ROUTINE ADDRESS
        JMP A,I          GO DO IT

```

Perform the Original User Request

Because the original user request is restored to the device driver EQT extent words 2 through 4 on each entry to the device driver, processing the original request is quite simple. Before returning to the interface driver, the device driver puts only the system-defined timeout value in the B-Register and an exit command equals 5 in the A-Register. In this device driver, the next routine address is also saved in the device driver EQT extent word 13 to keep the flow of requests going.

```

DORQ   DEF *+1          ADDRESS OF ROUTINE
        LDB EQT14,I     GET THE SYSTEM TIME OUT WORD
        LDA SENCU       GET THE NEXT ROUTINE ADDRESS
        STA DEX13,I     SAVE IT FOR RETURN
        LDA MODX2       GET THE MODIFIER/EXIT COMMAND
        JMP DDS00,I     RETURN DIRECTLY TO THE INTERFACE DRIVER
        .
        .
MODX2  OCT 000005       UNIVERSAL DO NOT MODIFY ANYTHING/DO REQUEST
*      IN THE DD EXT MODIFIER/EXIT COMMAND
EQT14  EQU 1773B

```

Because further requests to the interface driver are required after completion of the original user request, the device driver must save the transmission log from the user request. This is accomplished by storing the contents of the B-Register in EQT word 8, which was the original user request length (in characters).

Read Cursor Position

SENCU senses where the cursor was left at the end of the user request. An escape - lowercase a - DC1 (binary write) is sent to the terminal, requesting the terminal to send back the cursor position. The card is pre-configured for the next read by setting the high-order bits in MODX1. This demonstrates the read modifier on a write request:

```
SENCU DEF *+1      ADDRESS OF THE ROUTINE
      STB EQT8,I    SAVE TRANSMISSION LOG IN EQT 8
      LDA BNWT      SET UP BINARY WRITE
      STA DEX02,I   IN DEVICE DRIVER EQT EXT
      LDA SENCA     GET ADDRESS OF CURSOR SENSE
      STA DEX03,I   FOR DD EQT EXT
      LDA SENSL     GET LENGTH FOR SENSE COMMAND
      STA DEX04,I   PUT IT IN THE DD EQT EXT
      LDA MODX1     WRITE MODIFIER/EXIT COMMAND
      LDB RDCUS     GET THE ADDRESS OF NEXT
      JMP CRTN      RETURN TO INTERFACE DRIVER
```

Final Completion Return to Interface Driver

Completion is signified on return to the interface driver by a zero in the A-Register and the user request transmission log in the B-Register.

```
      .
      .
      LDB EQT8,I    RETRIEVE TRANSMISSION LOG
      CLA           SET COMPLETION EXIT COMMAND
      JMP DDS00,I   RETURN TO INTERFACE DRIVER
      .
EQT8  EQU 1667B
```

Device Driver Address Table

The following device driver address table is required to include the device driver with the interface driver at generation time:

```
ASMB,Q
      NAM $DVTB,8   DEVICE DRIVER ADDRESS TABLE
      ENT $DVTB
      EXT DDS00
*
* DEVICE DRIVER ADDRESS TABLE
*
$DVTB DEC 1        NUMBER OF ENTRIES IN TABLE
      DEF DDS00+0  ADDRESS OF DEVICE DRIVER 2
      END
```

The device driver is then selected via a control function 33B, 000002 request to the interface on either the subchannel 0 or 1 LU.

Sample Device Driver Listing

The following sample device driver is given to illustrate the various procedures involved in interfacing to the HP 12792B/C Multiplexer Interface Driver (DVM00). It is intended as an example only and is not a supported functioning product.

```
0001             ASMB,Q
0002*
0003* MULTIPLEXER DEVICE DRIVER FOR SPLIT SCREEN OPERATION OF
0004* A 264X TERMINAL. LEFT HALF OF SCREEN IS SUBCHANNEL 0,
0005* RIGHT HALF IS SUBCHANNEL 1. FUNCTION IS OTHERWISE DVM00.
0006* THIS DEVICE DRIVER WILL SET THE MARGINS FOR LEFT OR RIGHT
0007* HALF OPERATION AND POSITION THE CURSOR TO IT'S LAST KNOWN
0008* POSITION IN THE APPROPRIATE HALF OF THE SCREEN ACCORDING
0009* TO THE SUBCHANNEL ADDRESSED ON EACH OPERATION.
0010*
0011 00000          NAM DDS00,8 SPLIT SCREEN DEVICE DRIVER
0012             ENT DDS00
0013             EXT .CFER
0014*
0015 00000          A      EQU 0
0016 00001          B      EQU 1
0017 01663          EQT4   EQU 1663B
0018 01664          EQT5   EQU 1664B
0019 01667          EQT8   EQU 1667B
0020 01773          EQT14  EQU 1773B
0021*
0022 00000 000001R DEXAD DEF DEX01
0023 00001 000000 DEX01 NOP          PHYSICAL RECORD LENGTH
0024 00002 000000 DEX02 NOP          EQT6 COPY
0025 00003 000000 DEX03 NOP          EQT7 COPY
0026 00004 000000 DEX04 NOP          EQT8 COPY
0027 00005 000000 DEX05 NOP          CURRENT SUB CH 0 ROW WORD 1
0028 00006 000000 DEX06 NOP          "                WORD 2
0029 00007 000000 DEX07 NOP          CURRENT SUB CH 0 COL WORD 1
0030 00010 000000 DEX08 NOP          "                WORD 2
0031 00011 000000 DEX09 NOP          CURRENT SUB CH 1 ROW WORD 1
0032 00012 000000 DEX10 NOP          "                WORD 2
0033 00013 000000 DEX11 NOP          CURRENT SUB CH 1 COL WORD 1
0034 00014 000000 DEX12 NOP          "                WORD 2
0035 00015 000000 DEX13 NOP          NEXT ROUTINE ADDRESS
0036 00016 000000 DEX14 NOP          CURRENT (LAST) SUBCHANNEL
0037 00017 000000 DEX15 NOP          FIRST ACCESS FLAG = ASCII S0
0038*
0039* SETUP ON EACH ENTRY
0040*
0041 00020 000000 DDS00 NOP
0042 00021 000313R      STB TEMP          SAVE B TEMPORARILY
0043 00022 000040          CLE
0044 00023 001623          ELA,RAR          SAVE A[15] FOR CONTINUE TEST
0045 00024 000000R      LDB DEXAD          SAVE EXTENT ADDRESSES
0046 00025 105745          LDX DM15
          00026 000267R
```

0047	00027	000001	DEXLP	STA B,I	A = ADDRESS OF DD EQT EXT 1
0048	00030	002004		INA	B = ADDRESS OF DEX01
0049	00031	006004		INB	DO FOR DEX01-15, ADDRESSES
0050	00032	105760		ISX	OF DEVICE DD EXT WORDS 1-15
0051	00033	000027R		JMP DEXLP	
0052*					
0053	00034	000313R		LDB TEMP	RESTORE B
0054	00035	002041		SEZ,RSS	TEST FOR CONTINUATION
0055	00036	000254R		JMP CS00	GO DO CONTINUATION
0056*					
0057*	SPECIAL PROCESSING TO SETUP EQT ON FIRST ACCESS				
0058*					
0059	00037	000017R		LDA DEX15,I	GET FIRST ACCESS FLAG
0060	00040	000277R		CPA AS0	CONTAINS ASCII "S0"
0061	00041	000250R		JMP SUBCK	NOT FIRST ACCESS, CHECK SUBCH
0062*					
0063	00042	000277R		LDA AS0	FIRST ACCESS, SET UP FLAG
0064	00043	000017R		STA DEX15,I	
0065*					
0066	00044	000001X		JSB .CFER	SET UP SUB CH 0 ROW AND COL
0067	00045	100005R		DEF DEX05,I	
0068	00046	000300R		DEF S0RC	
0069	00047	000001X		JSB .CFER	SET UP SUB CH 1 ROW AND COL
0070	00050	100011R		DEF DEX09,I	
0071	00051	000304R		DEF S1RC	
0072*					
0073	00052	001664		LDA EQT5,I	SET UP DRIVER TYPE
0074	00053	000276R		AND TMASK	
0075	00054	001664		STA EQT5,I	
0076*					
0077*	GET THE SUBCH AND DECIDE THE PATH (SUB 0 SET LEFT MARGIN FIRST,				
0078*	SUB 1 SET RIGHT MARGIN FIRST)				
0079*					
0080	00055	000261R		JSB GTSCH	GO GET SUBCHANNEL
0081	00056	000016R	SVSCH	STA DEX14,I	AND SAVE
0082	00057	000010		SLA	ODD SUBCHANNEL?
0083	00060	000117R		JMP RMPOS,I	YES, DO RIGHT MARGIN FIRST
0084	00061	000062R		JMP LMPOS,I	NO, DO LEFT MARGIN FIRST
0085*					
0086*	POSITION FOR LEFT MARGIN SET				
0087*					
0088	00062	000063R	LMPOS	DEF *+1	ADDRESS OF ROUTINE
0089	00063	000310R		LDA BNWT	SET UP BINARY WRITE
0090	00064	000002R		STA DEX02,I	TO POSITION THE CURSOR
0091	00065	000016R		LDB DEX14,I	GET SUBCHANNEL
0092	00066	000330R		LDA LMPA	GET LEFT MARGIN POINTER
0093	00067	004010		SLB	ODD SUBCH USE THE OTHER ONE
0094	00070	002004		INA	
0095	00071	000000		LDA A,I	GET THE ADDRESS
0096	00072	000003R		STA DEX03,I	PUT IT IN THE DD EXTENT
0097	00073	000272R		LDA CMLNG	GET CURSOR MOVE LENGTH WORD
0098	00074	000004R		STA DEX04,I	PUT IT IN THE DD EXTENT

```

0099 00075 000100R      LDB LMSET      GET L. MARGIN SET ADDRESS
0100 00076 000314R      LDA MODX1      WRITE MODIFIER/EXIT COMMAND
0101 00077 000256R      JMP CRTN       RETURN TO INTERFACE DRIVER
0102*
0103* SET THE LEFT MARGIN
0104*
0105 00100 000101R LMSET DEF *+1      ADDRESS OF ROUTINE
0106 00101 000310R      LDA BNWT       SET UP BINARY WRITE
0107 00102 000002R      STA DEX02,I   IN DEVICE DRIVER EQT EXT
0108 00103 000332R      LDA LMSTA     GET ADDRESS OF L. MARGIN SET
0109 00104 000003R      STA DEX03,I   FOR DD EQT EXT
0110 00105 000271R      LDA MSLNG     GET LENGTH FOR MARGIN SET
0111 00106 000004R      STA DEX04,I   PUT IT IN THE DD EQT EXT
0112 00107 000016R      LDA DEX14,I   GET SUBCHANNEL
0113 00110 000010      SLA           ODD?
0114 00111 000114R      JMP *+3       YES, GO POSITION CURSOR
0115 00112 000117R      LDB RMPOS     NO, GET RIGHT MARGIN ADDRESS
0116 00113 002001      RSS
0117 00114 000154R      LDB CUPOS     GET CURSOR POSITION ADDRESS
0118 00115 000314R      LDA MODX1     WRITE MODIFIER/EXIT COMMAND
0119 00116 000256R      JMP CRTN      RETURN TO INTERFACE DRIVER
0120*
0121* POSITION CURSOR FOR RIGHT MARGIN SET
0122*
0123 00117 000120R RMPOS DEF *+1      ADDRESS OF ROUTINE
0124 00120 000310R      LDA BNWT       SET UP BINARY WRITE
0125 00121 000002R      STA DEX02,I   TO POSITION THE CURSOR
0126 00122 000016R      LDB DEX14,I   GET SUBCHANNEL
0127 00123 000345R      LDA RMPA      GET R. MARGIN ADDRESS POINTER
0128 00124 004010      SLB           ODD SUBCH USE THE OTHER ONE
0129 00125 002004      INA
0130 00126 000000      LDA A,I       GET THE ADDRESS
0131 00127 000003R      STA DEX03,I   PUT IT IN THE DD EXTENT
0132 00130 000272R      LDA CMLNG     GET CURSOR MOVE LENGTH WORD
0133 00131 000004R      STA DEX04,I   PUT IT IN THE DD EXTENT
0134 00132 000135R      LDB RMSET     GET R. MARGIN SET ADDR
0135 00133 000314R      LDA MODX1     GET WRITE MODIFIER/EXIT
0136 00134 000256R      JMP CRTN      RETURN TO INTERFACE DRIVER
0137*
0138* SET THE RIGHT MARGIN
0139*
0140 00135 000136R RMSET DEF *+1      ADDRESS OF ROUTINE
0141 00136 000310R      LDA BNWT       SET UP BINARY WRITE
0142 00137 000002R      STA DEX02,I   IN DEVICE DRIVER EQT EXT
0143 00140 000347R      LDA RMSTA     GET ADDRESS OF R. MARGIN SET
0144 00141 000003R      STA DEX03,I   FOR DD EQT EXT
0145 00142 000271R      LDA MSLNG     GET LENGTH FOR MARGIN SET
0146 00143 000004R      STA DEX04,I   PUT IT IN THE DD EQT EXT
0147 00144 000016R      LDA DEX14,I   GET THE SUBCHANNEL
0148 00145 000010      SLA           ODD?
0149 00146 000151R      JMP *+3       YES, GO SET LEFT MARGIN
0150 00147 000154R      LDB CUPOS     NO, GET CURSOR POS. ADDRESS

```

```

0151 00150 002001          RSS
0152 00151 000062R        LDB LMPOS          GET L. MARGIN POS. ADDRESS
0153 00152 000314R        LDA MODX1          WRITE MODIFIER/EXIT COMMAND
0154 00153 000256R        JMP CRTN           RETURN TO INTERFACE DRIVER
0155*
0156* POSITION CURSOR FOR OPERATION ON A SUBCHANNEL
0157*
0158 00154 000155R CUPOS DEF *+1          ADDRESS OF ROUTINE
0159 00155 000310R        LDA BNWT           SET UP BINARY WRITE
0160 00156 000002R        STA DEX02,I        TO POSITION THE CURSOR
0161 00157 000016R        LDB DEX14,I        GET SUBCHANNEL
0162 00160 000360R        LDA CPAD           GET CURSOR ADDRESS POINTER
0163 00161 004010          SLB              ODD SUBCH USE THE OTHER ONE
0164 00162 002004          INA
0165 00163 000000          LDA A,I           GET THE ADDRESS OF LAST
0166 00164 000361R        LDB CPVAD          AND THE BUFFER FILL ADDRESS
0167 00165 105777         MVW D4            MOVE THE LAST POSITION
          00166 000272R
          00167 000000
0168 00170 000362R        LDA CPBFA          GET THE WHOLE BUFFER ADDRESS
0169 00171 000003R        STA DEX03,I        PUT IT IN THE DD EXTENT
0170 00172 000273R        LDA CPLNG          GET CURSOR MOVE LENGTH WORD
0171 00173 000004R        STA DEX04,I        PUT IT IN THE DD EXTENT
0172 00174 000177R        LDB DORQ          GET DORQ ROUTINE ADDRESS
0173 00175 000314R        LDA MODX1          WRITE MODIFIER/EXIT COMMAND
0174 00176 000256R        JMP CRTN           RETRURN TO INTERFACE DRIVER
0175*
0176* DO THE ORIGINAL USER REQUEST
0177*
0178 00177 000200R DORQ  DEF *+1          ADDRESS OF THE ROUTINE
0179 00200 001773          LDB EQT14,I        GET THE TIME OUTWORD
0180 00201 000205R        LDA SENCU          GET THE SENCU ROUTINE ADDRESS
0181 00202 000015R        STA DEX13,I        SAVE IT FOR RETURN
0182 00203 000315R        LDA MODX2          GET THE EXIT COMMAND
0183 00204 000020R        JMP DDS00,I        RETURN DIRECTLY
0184*
0185* USER REQUEST DONE, SENSE WHERE THE CURSOR WAS LEFT
0186*
0187 00205 000206R SENCU DEF *+1          ADDRESS OF THE ROUTINE
0188 00206 001667          STB EQT8,I         SAVE TRANSMISSION LOG IN EQT8
0189 00207 000310R        LDA BNWT           SET UP BINARY WRITE
0190 00210 000002R        STA DEX02,I        IN DEVICE DRIVER EQT EXT
0191 00211 000363R        LDA SENCA          GET ADDRESS OF CURSOR SENSE
0192 00212 000003R        STA DEX03,I        FOR DD EQT EXT
0193 00213 000270R        LDA SENSL          GET LENGTH FOR SENSE COMMAND
0194 00214 000004R        STA DEX04,I        PUT IT IN THE DD EQT EXT
0195 00215 000314R        LDA MODX1          WRITE MODIFIER/EXIT COMMAND
0196 00216 000220R        LDB RDCUS          GET THE ADDRESS OF NEXT
0197 00217 000256R        JMP CRTN           RETURN TO INTERFACE DRIVER
0198*
0199* READ THE SENSED CURSOR POSITION
0200*

```

```

0201 00220 000221R RDCUS DEF *+1 ADDRESS OF ROUTINE
0202 00221 000311R LDA RDWCR CONTROL WORD FOR READ W/CR
0203 00222 000002R STA DEX02,I PASS TO I/F DRIVER
0204 00223 000366R LDA CRDBA ADDRESS OF BUFFER
0205 00224 000003R STA DEX03,I
0206 00225 000273R LDA CPLNG LENGTH
0207 00226 000004R STA DEX04,I
0208 00227 000232R LDB COMPL ADDRESS OF NEXT ROUTINE
0209 00230 000315R LDA MODX2 GET THE EXIT COMMAND
0210 00231 000256R JMP CRTN RETURN TO INTERFACE DRIVER
0211*
0212* COMPLETION ROUTINE, SAVES RETURNED CURSOR POSITION AND EXITS
0213*
0214 00232 000233R COMPL DEF *+1 ROUTINE ADDRESS
0215 00233 000016R LDA DEX14,I GET CURRENT SUBCHANNEL
0216 00234 000360R LDB CPAD GET CURSOR STORAGE POINTER
0217 00235 000010 SLA ODD SUBCHANNEL...
0218 00236 006004 INB YES, USE THE OTHER ONE
0219 00237 000001 LDB B,I GET THE ADDRESS
0220 00240 005200 RBL MAKE IT A BYTE ADDRESS
0221 00241 000375R LDA CUBYT GET BYTE ADDRESS
0222 00242 105765 MBT D8 MOVE BYTES
00243 000274R
00244 000000
0223 00245 001667 LDB EQT8,I RETRIEVE THE TRANSMISSION LOG
0224 00246 002400 CLA SET EXIT COMPLETION COMMAND
0225 00247 000020R JMP DDS00,I
0226*
0227* TEST FOR SUBCHANNEL ALREADY EQUAL, SKIP MOST OF SETUP
0228*
0229 00250 000261R SUBCK JSB GTSCH GET REQUEST SUBCHANNEL
0230 00251 000016R CPA DEX14,I COMPARE TO LAST ONE ADDRESSED
0231 00252 000177R JMP DORQ,I SAME, GO DO USER REQUEST
0232 00253 000056R JMP SVSCH DIFFERENT, GO SET UP TERMINAL
0233*
0234* CONTINUATION PROCESS SELECTION
0235*
0236 00254 000015R CS00 LDA DEX13,I GET ADDRESS OF NEXT ROUTINE
0237 00255 000000 JMP A,I GO DO IT
0238*
0239* RETURN TO INTERFACE DRIVER ROUTINE A=MODIFIER/EXIT CMD,
0240* B=NEXT ROUTINE ADDRESS
0241*
0242 00256 000015R CRTN STB DEX13,I SAVE NEXT ROUTINE ADDRESS
0243 00257 000312R LDB TO GET THE SETUP TIME OUT
0244 00260 000020R JMP DDS00,I
0245*
0246* SUBROUTINE TO RETURN THE SUBCH IN THE A REGISTER
0247*
0248 00261 000000 GTSCH NOP
0249 00262 001663 LDA EQT4,I GET SUBCHANNEL WORD
0250 00263 000275R AND B3.7K ONLY LOOK AT SUBCHANNEL BITS

```

```

0251 00264 001727          ALF,ALF
0252 00265 001222          RAL,RAL          POSITION TO RIGHT
0253 00266 000261R        JMP GTSCH,I
0254*
0255*  CONSTANTS AND VARIABLES
0256*
0257 00267 177761  DM15  DEC -15
0258 00270 177775  DM3   DEC -3
0259 00271 000001  D1    DEC 1
0260 00272 000004  D4    DEC 4
0261 00273 000006  D6    DEC 6
0262 00274 000010  D8    DEC 8
0263 00275 003700  B3.7K OCT 3700
0264 00276 014037  TMASK OCT 14037
0265 00277 051460  AS0   ASC 1,S0
0266 00300 030060  S0RC  ASC 4,000r000C
      00301 030162
      00302 030060
      00303 030103
0267 00304 030060  S1RC  ASC 4,000r042C
      00305 030162
      00306 030064
      00307 031103
0268 00310 000102  BNWT  OCT 000102  CNWD FOR BINARY WRITE
0269 00311 000001  RDWCR OCT 000001  CNWD FOR READ TO CR, NO ECHO
0270 00312 177160  TO    DEC -400   4 SEC TIME OUT ON SETUP
0271 00313 000000  TEMP  BSS 1
0272 00314 102005  MODX1 OCT 102005  WRITE MODIFIER/EXIT COMMAND
0273*                                     DO REQ. IN DEX02, END READS
0274*                                     ON CR, DO NOT MODIFY WRITE.
0275 00315 000005  MODX2 OCT 000005  UNIV. MODIFIER/EXIT COMMAND
0276*                                     DO NOT MODIFY ANYTHING,
0277*                                     JUST START REQUEST IN EXTENT
0278*
0279*  TERMINAL COMMAND STRINGS
0280*
0281 00273          CPLNG EQU D6          LENGTH OF CURSOR POSITION RQ
0282 00272          CMLNG EQU D4          LENGTH OF MARGIN REQUESTS
0283 00271          MSLNG EQU D1          LENGTH OF MARGIN SET REQUESTS
0284*
0285 00316 015446  LMPA0 OCT 15446          (ESC&) POS. CURSOR FOR LEFT
0286 00317 060440          ASC 3,a 000C  MARGIN SET, SUB 0
      00320 030060
      00321 030103
0287 00322 015446  LMPA1 OCT 15446          (ESC&) POS. CURSOR FOR LEFT
0288 00323 060440          ASC 3,a 042C  MARGIN SET, SUB 1
      00324 030064
      00325 031103
0289 00326 000316R LMPAD DEF LMPA0          ADDRESS OF LEFT MARGIN, SUB 0
0290 00327 000322R          DEF LMPA1          ADDRESS OF LEFT MARGIN, SUB 1
0291 00330 000326R LMPA  DEF LMPAD          ADDRESS OF ADDRESSES
0292*

```

```

0293 00331 015464 LMST OCT 15464 SET L. MARGIN COMMAND (ESC4)
0294 00332 000331R LMSTA DEF LMST AND ADDRESS
0295*
0296 00333 015446 RMPA0 OCT 15446 (ESC&) POSITION CURSOR FOR R.
0297 00334 060440 ASC 3,a 037C MARGIN SET, SUB 0
00335 030063
00336 033503
0298 00337 015446 RMPA1 OCT 15446 (ESC&) POSITION CURSOR FOR R.
0299 00340 060440 ASC 3,a 079C MARGIN SET, SUB 1
00341 030067
00342 034503
0300 00343 000333R RMPAD DEF RMPA0 ADDRESS OF R. MARGIN, SUB 0
0301 00344 000337R DEF RMPA1 ADDRESS OF R. MARGIN, SUB 1
0302 00345 000343R RMPA DEF RMPAD ADDRESS OF ADDRESSES 0303*
0304 00346 015465 RMST OCT 15465 SET R. MARGIN COMMAND (ESC5)
0305 00347 000346R RMSTA DEF RMST AND ADDRESS
0306*
0307 00350 015446 CPBUF OCT 15446 (ESC&) POSITION CURSOR FOR A
0308 00351 060440 ASC 1,a SUB CHANNEL FOR OPERATION
0309 00352 000000 CPVAL BSS 4 AREA TO PUT CURSOR COORD.
0310 00356 000005R CPADD DEF DEX05 ADDR OF CURSOR COORD. SUB 0
0311 00357 000011R DEF DEX09 ADDR OF CURSOR COORD. SUB 1
0312 00360 100356R CPAD DEF CPADD,I ADDRESS OF ADDRESSES
0313 00361 000352R CPVAD DEF CPVAL ADDRESS OF COORDINATE STORAGE
0314 00362 000350R CPBFA DEF CPBUF ADDRESS OF BUFFER
0315*
0316 00363 000364R SENCA DEF SENCC ADDR OF SENSE CURSOR COMMAND
0317 00364 015541 SENCC OCT 15541 (ESCa) SENSE CURSOR COMMAND
0318 00365 010400 OCT 10400 DC1 SEND DATA
0319 00270 SENSL EQU DM3 CHAR COUNT FOR SENSE COMMAND
0320*
0321* RETURN AREA FOR CURSOR SENSE
0322*
0323 00366 000367R CRDBA DEF CRDBF CURSOR READ BUFFER ADDRESS
0324 00367 000000 CRDBF NOP SPACE FOR ESC &
0325 00370 000000 NOP SPACE FOR aY
0326 00371 000000 NOP SPACE FOR YY
0327 00372 000000 NOP SPACE FOR rX
0328 00373 000000 NOP SPACE FOR XX
0329 00374 000000 NOP SPACE FOR C
0330 00375 000761R CUBYT DBR CRDBF+1 BYTE ADDRESS OF RIGHT BYTE
0331 END
** NO ERRORS *TOTAL **RTE ASMB 92067-16011**

```


Device-Specific Considerations

The Multiplexer subsystem supports the following HP terminals as well as printer support for the HP 263x and the HP 7310A:

HP 2621A/B/P	HP 2640A/B	HP 2622A	HP 2628A
HP 2645A	HP 2647A	HP 2623A	HP 2635B
HP 2648A	HP 2649B/C/G	HP 2624B	HP 2382A
HP 2626A		HP 2625A	HP 45610A
		HP 2627A	

Other HP or non-HP devices may be used in conjunction with the HP 12792B/C Multiplexer subsystem. A prerequisite for HP support is the device must be either point-to-point hardwired (or modem linked using the HP 37214A Systems Modem subsystem), in an asynchronous, bit-serial environment. However, for these devices it may be necessary for the user to write simple device drivers to supplement line protocol and specific control characters.

Handshaking

Transmission and reception of data or instructions are coordinated by firmware controlled handshaking. Handshaking can be approached from one of two aspects, either from the multiplexer firmware or from the device acting as the transmitter. Some line printers and other devices use hardware handshaking between the computer and the terminal/device; these devices are not supported.

The HP 12792B/C interface card uses firmware on the interface card rather than a software driver to accomplish ENQ/ACK handshaking and other line protocol necessary to communicate between the MUX card and a terminal/device. If the card configuration has ENQ/ACK handshaking enabled, data is transferred to the terminal/device in the following manner:

The card sends data to the terminal/device in blocks of 80 characters. Between blocks, an ENQ is sent and the firmware waits up to five seconds for an ACK. If one block is acknowledged, the next block is sent. If no response is given, another ENQ is sent.

If the handshaking is disabled, information is transmitted serially (character by character) to the terminal/device.

The other type of handshaking is from the terminal/device to the multiplexer card, and this is accomplished using DC1 and DC2 handshaking. DC1 and DC2 are used for CPU reception in block mode. This type of handshaking is controlled by the terminal driver DDV05.

The Xon/Xoff handshake for pacing the data sent to a terminal is also supported on the multiplexer. Control function 34B is used to enable and disable Xon/Xoff handshaking (refer to Chapter 2 under function 34B for details).

The device control signals Xon and Xoff that allow the user to control or pace transmission from the terminal are treated by the multiplexer as handshake characters. Xon starts transmission when Cntl-Q is received by the multiplexer, and transmission stops when Cntl-S is received. Use of Xon and Xoff are enabled in the Port Configuration control request (refer to function 34B in Chapter 2).

DDV12 Line Printer Driver

HP supplies a line printer driver (DDV12) similar to DVR12, although some limitations are:

- no vertical form feed except top of form
- no over print carriage control (asterisk (*) in col 1)
- no status requests

DDV05 Terminal Driver

When using the HP 264x terminal in the Multiplexer subsystem, the device expects to see 8 bits per character data transfers. Users wanting to communicate with an HP 264x or 262x terminal with parity checking should configure the interface card for a 7 bits per character data transfer or without parity use 8 bits per character. The HP 264x terminals require handshaking with the ENQ/ACK protocol in order to preserve data integrity. These terminals use a block mode handshaking scheme with the CPU receiving DC1/DC2 protocol. A DC1 must be detected before the information can be sent across the line.

Black Box Considerations

In order to connect a “black box” RS-232-C or RS-423-A device to the HP 12792B/C Multiplexer Interface, the following three criteria must be examined:

- RS-232-C and RS-423-A Capability
- Handshaking
- Driver Considerations

HP offers support to most RS-232-C and RS-423-A compatible devices. HP support is limited to correct passage of user’s data to and from the user’s buffer and from and to the specified multiplexer channel data links with insertion and deletion of specifying characters and parity information.

The user should be aware of the line protocol, control sequences, and handshaking used by the device. The line protocol must match in order for two-way communication to exist. The user must

understand how requests are mapped in as control requests. The user must specify whether the terminal/device uses character or block mode handshaking.

The last consideration requires the user to determine if the terminal/device can function using the HP supplied drivers or if it will require a user-written device driver. Any specialized control required by the device not included in the user buffer indicates the need for a user-written device driver. When functioning with user-written device drivers, support is also limited to correct passage of EQT extent information to and from the user's device driver and the correct execution of the device driver requests.

NOTE: The use of short records can cause the CPU to become I/O bound.

Dumb Devices

If the device requires no additional information beyond what is contained in the user's buffer and does not use DC1 handshaking, the device can be considered a "dumb" device and will be able to operate using DVM00 and the default device driver (device driver number one). Some devices that are normally considered dumb devices actually require CR/LF delays and will require a user-written device driver for proper operation. One example of these devices is the common Teletype.

Modems

The HP 12792B/C Multiplexer has no modem control lines, but it may be connected to an HP 37214A Systems Modem subsystem and modem control and I/O cards for full-duplex asynchronous modem operation. The active control functions of the modem are contained in the modem panel, and the multiplexer and its driver need only take care of the passive functions. For example when using modems, if the modem line is disconnected, the condition is detected by the modem panel, not the multiplexer.

Be aware that if a user logs on under an RTE session and the line is disconnected before the user logs off, anyone dialing into that port will be re-connected to the session in progress at the time of the previous disconnect unless a program such as MODEM is used with the HP 37214A Systems Modem subsystem.

Cartridge Tape Units

DDV05 can access subchannels 0 (display/keyboard), 1 (left CTU), and 2 (right CTU). The CTUs can be used with FMGR stores and dumps, and so forth, the same as DVA05. Application programs can directly control access as follows:

READ/WRITE Request. This driver uses only bit 6 of the control word to determine whether this is an ASCII or BINARY READ/WRITE request.

ASCII READ is a string of characters terminated by a CR. A record is read from the CTU to the user buffer. Any data exceeding the user buffer length is lost.

NOTE: In the sequence below, the CPU is sending to a device and receiving from a device.

```
SEND:  ESC c ESC & p DEV s 0 R DC1
REC:   DATA CR
SEND:  ESC b
```

BINARY READ is a string of characters specified by the buffer length or by the byte count from the CTU, whichever is smaller. A record will be read from the CTU.

```
SEND:  ESC c ESC & p DEV s 2 R DC1
REC:   BYTECOUNT CR
SEND:  DC1
REC:   DATA
SEND:  ESC b
```

ASCII WRITE a string of characters to the CTU terminated by a CR.

```
SEND:  ESC c ESC & p DEV d W DATA CR LF DC1
REC:   S CR (for successful completion)
SEND:  ESC b
```

BINARY WRITE a string of characters specified by the buffer length. Maximum record length is 256 bytes.

```
SEND:  ESC c ESC & p DEV d BYTECOUNT W ENQ
REC:   ACK
SEND:  DATA DC1
REC:   S CR
SEND:  ESC b
```

An RS is sent by the CTU during a write operation if an EOF is encountered.

Control Request

Function	Description
00	Unlock keyboard
01	Write end-of-file mark
02	Back space 1 record
03	Forward space 1 record
04	Rewind
05	Rewind standby
06	Dynamic status (will read and return CTU status)
13	Forward space 1 file
14	Back space 1 file
26	Write end-of-data (EOD)
27	Locate file, the absolute file number is in the optional parameter.

Any error will be returned in the EQT 5 status byte.

Device Control Sequence

```
SEND:  ESC c ESC & p DEV u  
       [+ OR -] COUNT p] CMD C DC1 ,  
REC:   S CR  
SEND:  ESC b
```

Device Status Sequence

```
SEND:  ESC & p DEV ^ DC1  
REC:   ESC \ p DEV STATUS CR
```

DEV = 1 for left CTU, 2 for right CTU
ESC c = Lock keyboard
ESC b = Unlock keyboard
CMD = Control request command to CTU

Device Equipment Table

The HP 12792B/C Multiplexer Subsystem requires a device Equipment Table (EQT) entry for each port on the multiplexer. The entry consists of 15 words plus an extension of 31 words, or a total of 46 words. The EQT entry is configured into the RTE Operating System at system generation time.

During system operation, the device and interface drivers receive channel configuration instructions and pass information to each other through the EQT entry for that channel. Table A-1 provides the function of each word in the Equipment Table Entry in RTE-IVB and RTE-6/VM.

Table A-1. Equipment Table Entry

EQT Words 1–8:	Standard in the RTE operating environment.
Word 5:	<p>The status word, bits 7–0 describe the channel's status unless it is altered by a device driver:</p> <ul style="list-style-type: none"> Bit 7: Reserved; set to zero Bit 6: BREAK key hit Bit 5: EOT (Cntl-D entered) Bit 4: Modem line down Bit 3: Parity error or overflow Bit 2: Type-ahead data available Bit 1: Program scheduling enabled Bit 0: Last request timed out
Word 9:	On initiation entry, this is an optional user parameter to the device driver. Thereafter, it is the starting address for transfers.
Word 10:	On initiation entry, this is an optional user parameter to the device driver. Thereafter, it is the character length of the data transfer.

Word 11:	Port Status Word 1 Bit 15: Card is busy processing a command Bit 14: Deferred abort in process (system clear request) Bit 13: Waiting for or using DCPC channel Bit 12: Reserved Bit 11: Using DCPC channel 1 (select code = 6) Bit 10: I/O transfer in process Bit 9: Unsolicited interrupt in progress Bit 8: Defer abort flag Bit 7: End on CR Bit 6: End on RS Bit 5: End on Cntl-D Bit 4: End on DC2 Bit 3: End on Count Bit 2: End on Character Bit 1: Edit enable Bit 0: Echo enable
Word 12:	Bit 15: This EQT is suspended on itself Bits 14-0: The address of first EQT suspended, waiting for access to the backplane.
Word 13:	Address of EQT extension
Word 14:	Standard usage: EQT timeout value reset
Word 15:	Standard usage: EQT running timer
EQT extension words: (extension word 1 = EQT word 16)	
Word 16:	Address of the program to schedule -1 if none 0 if the driver has not been entered
Word 17:	Level 1 subroutine return address
Word 18:	Level 2 subroutine return address
Word 19:	Level 3 subroutine return address
Word 20:	Port ID from control 30B optional parameter, used in powerfail recovery
Word 21:	Driver configuration word (from control 33B)
Word 22:	Reserved
Word 23:	Length of type-ahead data, in characters
Word 24:	Temporary, usually contains the character length of the data remaining to be transferred
Word 25:	Temporary, usually the second word of the card command

Word 26:	Temporary, usually the length of the character space left in the user buffer
Word 27:	Port Status Word 2: Bit 15: Terminating character has not yet been found Bits 14,13: 00 = Cntl-D (terminating character) 01 = <CR> 10 = <DC2> 11 = <RS> Bit 12: Reserved Bit 11: Card reset in progress Bits 10,9: Reserved Bit 8: Port has key Bits 7-0: default status for word 5 bits 7-0
Word 28:	Device driver command to the interface driver (A-Register)
Word 29:	Type-ahead schedule retry counter
Word 30:	Running counter for type-ahead schedule retries
Word 31:	CN 31 parameter
Word 32:	CN 32 parameter
Word 33:	Modem alarm program ID segment address
Word 34:	Card and error code for MODEM
Word 35:	Card status for MODEM
Word 36:	EQT address of this LU for MODEM
Word 37:	Loglu for MODEM
Word 38:	Parameter 5 for MODEM (must always be 0)
Word 39:	Device driver timeout, –10's ms
Word 40:	Device driver EXEC request
Word 41:	Device driver I/O buffer address or control request optional parameter
Word 42:	Device driver buffer length (+words, –characters)

Any further storage used is defined by the device driver in use.

Device Driver Interfaces

HP 26xx Screen Mode Device Driver

This section describes the HP-supplied 26xx Screen Mode device driver DDV05 used with the Multiplexer interface driver DVM00. The driver supports HP terminals in both character and block mode. All screen mode functions (the ENTER key, soft keys, and so on) are supported. Peripheral devices (for example, CTUs) are not supported by this device driver.

The layout of the user I/O and control calls are designed to be roughly compatible with DVR05. Because this subsystem can support a far wider range of terminal capabilities, differences are inevitable.

For generation and initialization information please refer to the configuration guide.

DDV05 User Interface for HP 26xx Terminals

The device driver DDV05 utilizes the block mode read capabilities of an HP 264x or 262x terminal. At bootup, the device driver reads the terminal straps. The strappings may vary between character, block line, or block page mode. The character mode is a normal read operation, with a carriage return or Cntl-D indicating an end-of-record. A carriage return denotes an end-of-record in the block line mode, while a record separator denotes an end-of-record in the block page mode. Prior to every read request, the device driver instructs the interface driver to write a DC1, allowing the softkeys to be read.

Subchannel Assignment

The MUX terminal may or may not use the EQT subchannels, depending on which driver is used. If the system has DVM00 and DDV05 generated in, then EQT subchannels can be used. However, if DVT00 and DDT05 are used, EQT subchannels are ignored.

Control Request Definition

The control requests accepted by this driver perform various functions. Some requests require additional data that is passed to the driver through the optional EXEC parameter IPARM. Any control request not listed here is passed on to the interface driver for execution. The various requests are described as follows:

Control Function 11B: Line Spacing

Control function 11B sends a number of CR/LFs to the terminal's display as determined by the value of the optional parameter. A maximum of 63 lines can be spaced in one request. Any value greater than 63 will be truncated modulo 64. A zero or negative line count results in one CR/LF sent.

Control Function 25B: Update Terminal Configuration

Control function 25B causes the driver to read the strap settings on HP terminals. This information is used by the driver to ensure correct terminal handshaking when doing, for example, block reads on HP terminals.

A control function 25B is automatically performed when the driver receives its first read request. If the terminal straps are subsequently changed manually or by escape sequences, the user must issue another control function 25B to keep the driver posted of any changes. Failure to do so may result in the terminal getting "hung up".

Input/Output Requests

The action taken by the driver in the processing of I/O requests depends on the function code specified in the EXEC call from the user. Bits 10 through 6 of the EXEC ICNWD define the function code for the request as follows:

10	9	8	7	6	Action Taken for READ Request
0	x	0	x	0	Input editing enabled, echo off, end transfer on <CR> or Ctrl-D
0	x	1	x	0	Input editing enabled, echo on, end transfer on <CR> or Ctrl-D
0	x	0	x	1	Input editing off, echo off, end transfer on buffer full
0	x	1	x	1	Editing off, echo on, end transfer on buffer full
1	x	0	x	0	Editing off, echo off, end transfer on <CR>
1	x	1	x	0	Editing off, echo on, end transfer on <CR>

10	9	8	7	6	Action Taken for WRITE Request
0	x	x	x	0	End transfer on end of buffer, add CR/LF if last character in buffer is NOT “_”. “_” is not printed if present as the last character in buffer
	x	x	x	1	End transfer on end of buffer, nothing is added to the user’s buffer
1	x	x	x		End transfer on end of buffer, nothing is added to the user’s buffer

For all I/O requests note the following:

- Zero-length keyboard entries are not ignored by the interface driver.
- I/O transfers use a character format set up by control function 30B, and the terminal must be strapped accordingly.
- Escape and Unit Separator characters are NOT stripped from the user’s buffer as is done under DVR05.
- Binary type transfers from the display may not be used when the terminal is in block mode.
- Read function code 3000B “program enabled block read” is not required when doing ESC-d screen reads. However, the driver is not as “forgiving” as DVR05 when terminal straps are changed without informing the driver. Control function 25B must be issued in order to prevent the terminal from being “hung up”.

HP 7310 Line Printer Device Driver

This section describes the HP 2631/2635/7310 Line Printer device driver DDV12 for use under the Multiplexer driver DVM00. The driver supports both normal (column 1 as carriage control) and transparent (column 1 printed) print modes. Carriage control includes top-of-form, single, double, and triple spacing.

For generation and initialization information consult the *HP 12792B/C Multiplexer Subsystem Configuration Guide*, part number 5955-8868.

Write Request Processing

Write requests to the driver can be made either in a normal or transparent mode. The device driver DDV12 is used to make HP 2631/2635/7310 printers look like typical line printers to user programs. These devices use escape sequences for carriage control while standard line printers interpret the first character of each line as a carriage control character. The DDV12 device driver examines the user’s first character and sends the proper escape sequence to the printer. In normal mode, the first character of the line is used to direct the driver to perform carriage control. The remainder of the line is transferred to the printer. Carriage control characters recognized by the driver are:

- 1 go to top-of-form
- 0 space one extra line before printing (double space)
- space two extra lines (triple space)
- all others single space

Caution DDV12 recognizes underscores as a line continuation special character. Text and programs using underscores for other purposes will print in an undesirable format. In such cases, a point-to-point connection should be used.

Transparent mode is selected by setting bit 7 of the EXEC function code. In this mode, all data is sent to the printer regardless of the data in column 1.

Note that no processing of the user data is performed other than that described above. Because the printer always reacts to escape sequences and protocol characters (for example, ENQ), the user should be careful not to place these in the user buffer.

Control Request Processing

The only control request processed by this device driver is control function 11B. This is used to either move the paper up (line spacing) or move the paper to top-of-form, depending on the value of the optional parameter:

IPARM > 0 move the paper up IPARM lines

IPARM = 0 move the paper up one line

IPARM < 0 go to top-of-form

The maximum number of lines that can be spaced in one request is 63. If a request is made to send more than 63 lines, the value will be truncated modulo 64. For example, 66 will send 2 lines.

All other control requests are passed directly to the interface driver for processing. Refer to Chapter 2 for descriptions.

Glossary

ACK – Acknowledge

A transmission control character transmitted by a receiver as an affirmative response to the sender's block mode information.

ASCII

American Standard Code for Information Interchange.

Asynchronous transmission

Transmission in which time intervals between transmitted characters may be of unequal length. Transmission is controlled by start and stop elements at the beginning and end of each character.

BAUD

A unit of signaling speed equal to the number of discrete conditions or signal events per second. In asynchronous transmission, the unit of signaling speed corresponding to one unit interval per second; that is, if the duration of the unit interval is 20 milliseconds, the signaling speed is 50 baud. Baud is the same as "bits per second" only if each signal event represents exactly one bit.

BS

Backspace, Cntl-H.

Control character

In the ASCII code, any of the 32 characters in the first two columns of the standard code table.

CR

Carriage return, Cntl-M.

DC1 – Device control

A device control character that is primarily intended for turning on or starting a peripheral device. The host is receiving information, Cntl-Q.

DC2 – Device control

A device control character that is primarily intended for turning on or starting a peripheral device, Cntl-R.

Direct Memory Access (DMA)

A facility that permits I/O transfer directly into or out of memory independent of the processor.

Dumb device

Device that processes one unit of information at a time. It does not contain its own local processing capability. In a smart device, this is typically accomplished with a microprocessor.

Duplex

Simultaneous two-way independent transmission in both directions. Also referred to as full-duplex.

Echo

A method of checking the accuracy of transmission of data in which the received data are returned to the sending end for comparison with the original data.

ENQ – Enquiry

A transmission control character used as a request for a response, Cntl-E.

EOT

End-of-transmission, Cntl-D.

Half-duplex

A circuit designed for transmission in either direction but not both directions simultaneously.

Input editing

When enabled, the backspace and delete key are enabled and will affect the user's buffer. When disabled, the keys are not executed but are placed in the user's buffer.

Interface

The multiplexer card making possible interoperation between the terminal/device and the CPU.

Modem

A device that modulates and demodulates signals transmitted over communications circuits.

Parity check

Addition of non-information bits to data, making the number of ones in each grouping of bits either always odd for odd parity or always even for even parity. This permits single error detection in each group.

Protocol

A formal set of conventions governing the format and relative timing of message exchange between two communicating processes.

Transmission log

Length of buffer contents to or from the MUX card.

Valid terminator

End of data transfer, end of record, for example, a carriage return.

Index

Symbols

\$DVTB, 2-31, 4-12
\$XSIO (system I/O), 4-4, 4-10
 control zero request, 4-5
%MDMLB (MODEM library), 2-25

Numbers

212 versus V.22 mode, 2-23

A

address table, 4-11
 example, 4-21
aggregate throughput, 1-3
alarm program, setting ID segment address, 2-21
auto-answer mode, 2-21
auto-dial, 2-24

B

baud rate
 selection, 2-20
 support, 2-20
baud rate generator, 1-3
 setting, 2-19
binary length, setting, 2-32
binary mode bit, 2-3
bits per character, 2-19
black box considerations, 5-2
block mode, 2-22
 line mode, B-1
 page mode, B-1
 read, 4-3
 terminal device driver (DDV05), 4-3
break character, 4-10
BREAK key, 3-1, 3-3, 3-5
buffered user request, 4-4
buffers
 channel, 1-3
 input, 2-3
 flushing, 2-18
 on-board, 2-3
 phone number, 2-24
 reception, 1-3
 transmission, 1-3
 type-ahead, 3-1

C

cabling, 1-3
cartridge tape units (CTUs), 5-4
 control request, 5-5
 device control sequence, 5-5
 device status sequence, 5-5
 dynamic status, 5-5
 lock keyboard, 5-5
 read/write request, 5-4
 binary/ASCII, 5-4
 rewind, 5-5
 unlock keyboard, 5-5
channel buffers, 1-3
Class I/O, 2-1, 4-4
configuration straps, modem card, 2-23
configure
 driver response, 2-30
 port, 2-31
connect, modem line, 2-23
 no wait bit, 2-23
control request, 2-11
 configure driver response, 2-30
 connect modem line, 2-23
 no wait bit, 2-23
 disable scheduling, 2-17
 disconnect modem line, 2-25
 no wait bit, 2-25
 dynamic status, 2-13
 enable scheduling, 2-17
 flush input buffer, 2-18
 get terminal configuration, 2-22
 loop test, 2-14
 set binary length, 2-32
 set ID segment address of modem alarm program, 2-21
 set port configuration, 2-31
 set port ID, 2-19
 set program address, 2-19
 set read type, 2-33
 set timeout, 2-18
 summary, 2-12
 terminate receive buffer, 2-15
 type-ahead schedule retry count, 2-21
control word, 2-2
count down counter, 4-11
cursor position, 4-13
cursor tracking, 4-13

D

data overrun, 3-8
DC1/DC2 handshaking, 5-1
DCPC (dual channel port controller), 1-3
DDT05, 1-3

- DDV05, 1-3, 2-31, 4-3, 5-2
 - Control Function 11B (line spacing), B-2
 - Control Function 25B (terminal config.), B-2
 - control request definition, B-2
 - handshake control, 5-1
 - I/O requests, B-2
 - subchannel assignment, B-1
 - subchannel support, 5-4
 - user interface, B-1
- DDV12, 1-3, 2-31, 4-3, 5-2
 - control request, B-4
 - user interface, B-3
 - write request, B-3
- device
 - initialization, 2-12
 - maximum supported, 1-3
 - status, 2-11
 - status words (EQT 4 and 5), 3-6
 - type, 4-8
- device driver
 - address table, 4-11
 - example, 4-21
 - address table (\$DVTB), 2-31
 - assigned to port, 2-31
 - DDT05 (without CTU support), 1-3
 - DDV05 (with CTU support), 1-3, 2-31, 4-3, 5-2
 - Control Function 11B (line spacing), B-2
 - Control Function 25B (terminal config.), B-2
 - control request definition, B-2
 - handshake control, 5-1
 - I/O requests, B-2
 - subchannel assignment, B-1
 - subchannel support, 5-4
 - user interface, B-1
 - DDV12, 1-3, 2-31, 4-3, 5-2
 - control request, B-4
 - user interface, B-3
 - write request, B-3
 - description, 1-3, 4-1
 - DVA05, 5-4
 - EQT extent, 4-4
 - equipment type, 4-8
 - HP implementation, 4-3
 - interface, 4-4
 - location and size, 4-12
 - partition, 4-12
 - restrictions and requirements, 4-4
 - return to the interface driver, 4-5
 - A-Register, 4-6
 - B-Register, 4-8
 - EQT entries, 4-8
 - EQT extent, 4-6
 - Exit command, 4-6
 - function modifier, 4-7
 - sample listing, 4-22
 - system abort requests, 4-4
 - usage, 4-1
 - with CTU support, 1-3
 - writing, 4-1
 - example, 4-13

- device-specific considerations, 5-1
- dial-back program example, 2-27
- dialing
 - pulse, 2-24
 - tone, 2-24
- disable scheduling, 2-17
- disconnect, modem line, 2-21, 2-25
 - no wait bit, 2-25
- DMA (direct memory access), 1-3
- DTMF tone dialing, 2-24
- dumb devices, 5-3
- DVA05, 5-4
- DVM00, 1-3, 4-1, 5-3
- DVR05, B-1, B-3
- DVT00, 1-3
- dynamic status, 2-13, 3-6
 - bit definitions, 2-13
 - CTUs, 5-5

E

- echo bit, 2-3
- echoing, 2-2
- editing, 2-2
- enable scheduling, 2-17
- ENQ/ACK handshaking, 5-1
 - enable/disable, 2-20
- EOT (end-of-tape), 4-10
- EQLU library function, 3-3
- EQT (Equipment Table), 1-3
 - entry summary, A-1
 - extent, 4-6
 - device driver, 4-4
 - word 1, 4-6, 4-7
 - word 2, 4-5, 4-6, 4-7
 - word 3, 4-6
 - word 4, 4-6
 - word 13, 4-19, 4-20
 - words 2-4, 4-5, 4-20
 - word 4, 3-3, 3-6
 - word 5, 2-11, 3-6, 4-6, 4-8
 - word 6, 4-4, 4-5, 4-7
 - word 8, 4-5, 4-8, 4-20
 - word 14, 4-8
 - word definitions and uses, 4-9
- equipment type, 4-8
- error recovery
 - dynamic status checking, 3-6
 - EQT words 4 and 5, 3-6
 - I/O status
 - checking, 3-6
 - request returns, 3-7
 - LU status word, 3-6
 - port status, 3-6
- errors
 - data overrun, 3-8
 - IO07, 4-6
 - overflow, 3-6
 - parity, 3-6, 3-8
 - read, 3-8

- timeout, 3-6
- EXEC call, 1-3, 2-1
 - control request, 2-11
 - control word, 2-2
 - function code, 2-2
 - I/O request, 2-2
 - LU number, 2-2
 - parameters, 2-11
 - request code, 2-1
- Exit command, 4-6

F

- failure analysis, 3-8
- firmware, 5-1
- flush input buffer, 2-18
- forced Xon condition, 2-31
- full type-ahead mode, 3-4
- function code, 2-2
 - binary mode bit, 2-3
 - control request, summary, 2-12
 - echo bit, 2-3
 - honesty bit, 2-3
 - read request, 2-4
 - special buffer control bit, 2-3
 - transparent mode bit, 2-3
 - write request, 2-5
- function modifier, 4-7

G

- getting, terminal configuration, 2-22
- guard tone on/off, 2-23

H

- handshaking, 5-1
 - DC1/DC2, 5-1
 - ENQ/ACK, 2-20, 5-1
 - hardware, 5-1
 - Xon/Xoff, 2-31, 5-1
- honesty bit, 2-3
- HP 37213A Modem Card, configuration straps, 2-23
- HP 37214A Systems Modem Card Cage. *See* systems modem

I

- I/O extender, 1-3
- I/O request, 2-2
 - DDV05, B-2
 - input functions, 2-2
 - echoing, 2-2
 - editing, 2-2
 - terminators, 2-2
- I/O status, 3-6
 - request returns, 3-7
- IDGET, 2-19, 2-21

- input buffer, 2-3
 - flushing, 2-18
- interface driver
 - control requests, 2-13
 - description, 1-3, 4-1
 - DVM00 (with modem support), 1-3, 4-1, 5-3
 - DVT00 (without modem support), 1-3
 - operating system interface, 4-2
 - usage, 4-1
- IO07, 4-6

L

- line connect
 - modem panel, 2-23
 - no wait bit, 2-23
- line disconnect
 - modem panel, 2-21, 2-25
 - no wait bit, 2-25
- line printer device driver (DDV12), 1-3, 2-31, 4-3, 5-2
 - control request, B-4
 - user interface, B-3
 - write request, B-3
- line spacing, DDV05 (CN 11B), B-2
- line speed, 2-24
- lock keyboard, 5-5
- loop test, 2-14
- LU number, 2-2
- LU status word, 3-6

M

- margin setup, 4-13
- modem
 - 212 versus V.22 mode, 2-23
 - alarm program, setting ID segment address of, 2-21
 - auto-dial, 2-24
 - card cage. *See* systems modem
 - dial-back program example, 2-27
 - line speed, 2-24
 - no wait bit, 2-23, 2-25
 - panel
 - line connect, 2-23
 - line disconnect, 2-21, 2-25
 - port initialization, example, 2-26
 - support of, 5-3
 - MODEM program, 2-21, 2-23
 - modem-related port status, 2-13
- multiplexer
 - control request, 2-11
 - firmware, 5-1
 - panel, 1-3
 - cabling, 1-3
- MUX errors
 - overflow, 3-6
 - parity, 3-6
 - read, 3-8
 - timeout, 3-6

N

- no type-ahead mode, 3-4
- no wait bit
 - line connect, 2-23
 - line disconnect, 2-25
- normal mode (non-type-ahead), 3-1

O

- on-board buffer, 2-3
- operating system interface, 4-2
- overflow error, 3-6

P

- page mode, 2-22
- parameters, EXEC call, 2-11
- parity, 2-20
 - error, 3-6, 3-8
- Parity Error/Overflow bit, 4-10
- partition, driver, 4-12
- phone number buffer, 2-24
- physical record length, 4-6
- port configuration, setting, 2-31
- port ID, setting, 2-19
- port number, 2-21
- port status, 3-6
- privileged interrupt fence, 1-3
- PRMPT program, 3-3
- program
 - address, setting, 2-19
 - scheduling, 3-3
 - BREAK key, 3-3
- pulse dialing, 2-24

R

- R\$PN\$ program, 3-3
- RAM (random access memory), 1-3
- read
 - block mode, 4-3
 - error, 3-8
 - request function codes, 2-4
 - setting read type, 2-33
- reception, bits per character, 2-19
- reception buffers, 1-3
- REIO (re-entrant I/O), 4-4
- request code, 2-1
- retry count, 2-21
- RMPAR subroutine, 3-3
- RS-232-C, 1-3, 5-2
- RS-423-A EIA, 1-3, 5-2

Index-4

S

- setting
 - baud rate, 2-20
 - baud rate generator, 2-19
 - binary length, 2-32
 - ID segment address of modem alarm program, 2-21
 - port configuration, 2-31
 - port ID, 2-19
 - port number, 2-21
 - program address, 2-19
 - read type, 2-33
 - timeout, 2-18
- softkeys, B-1
- special buffer control bit, 2-3
- speed sensing, 2-21
- status
 - bit definitions from dynamic status, 2-13
 - dynamic, 3-6
 - I/O, 3-6
 - LU, 3-6
 - modem-related port, 2-13
 - port, 3-6
- status word, 2-11, 3-6
- stop bits, 2-20
- subchannel
 - assignment, B-1
 - determination, 4-18
- subchannels of CTU, 5-4
- support of
 - baud rates, 2-20
 - CTUs, 1-3
 - HP or non-HP devices, 5-1
 - I/O extender, 1-3
 - modem on multiplexer, 5-3
 - modems, 1-3
 - subchannels, B-1
 - system console, 1-3
- supported devices, maximum, 1-3
- system abort requests, 4-4
- System Available Memory (SAM), 4-12
- system console support, 1-3
- system driver area (SDA), 4-12
- systems modem, 1-1, 2-19, 5-1, 5-3
 - baud rate setting, 2-20
 - loop test, 2-14
 - panel, line connect, 2-23

T

- Table Area I, 4-12
- terminal
 - device driver DDT05 (without CTU support), 1-3
 - device driver DDV05 (with CTU support), 1-3, 2-31, 4-3, 5-2
 - Control Function 11B (line spacing), B-2
 - Control Function 25B (terminal config.), B-2
 - control request definition, B-2
 - handshake control, 5-1

- I/O requests, B-2
 - subchannel assignment, B-1
 - subchannel support, 5-4
 - user interface, B-1
- terminal configuration
 - block mode, 2-22
 - DDV05 (CN 25B), B-2
 - getting, 2-22
 - page mode, 2-22
- terminate receive buffer, 2-15
- terminator characters, 2-2, 2-4
- throughput
 - data overrun when exceeded, 3-8
 - total aggregate, 1-3
- timeout
 - count down counter, 4-11
 - error, 3-6
 - setting, 2-18
 - value in B-Register, 4-8
- transmission, bits per character, 2-19
- transmission buffers, 1-3
- transmission log, 2-15, 4-5, 4-8
- transmit pacing, 2-31
- transparent mode bit, 2-3
- TRMLU library function, 3-3
- type-ahead
 - BREAK key, 3-1
 - buffers, 3-1
 - data, 2-11
 - length, 2-11
 - description, 3-1
 - full type-ahead mode, 3-4

- no type-ahead mode, 3-4
- normal mode (non-type-ahead), 3-1
- retry count, 2-21
- with flush on break mode, 3-5
- with scheduling, 3-3, 3-5

U

- unlock keyboard, 5-5
- user interface, device drivers, B-1
- user request
 - buffered, 4-4
 - unbuffered, 4-4

W

- write request function codes, 2-5
- writing device drivers, 4-1
 - example, 4-13

X

- Xon/Xoff handshake, 2-31, 5-1
 - disable/enable, 2-31
 - force Xon condition, 2-31
 - transmit pacing, 2-31

Z

- Z-bit, 4-10
- zero-length record, 2-5