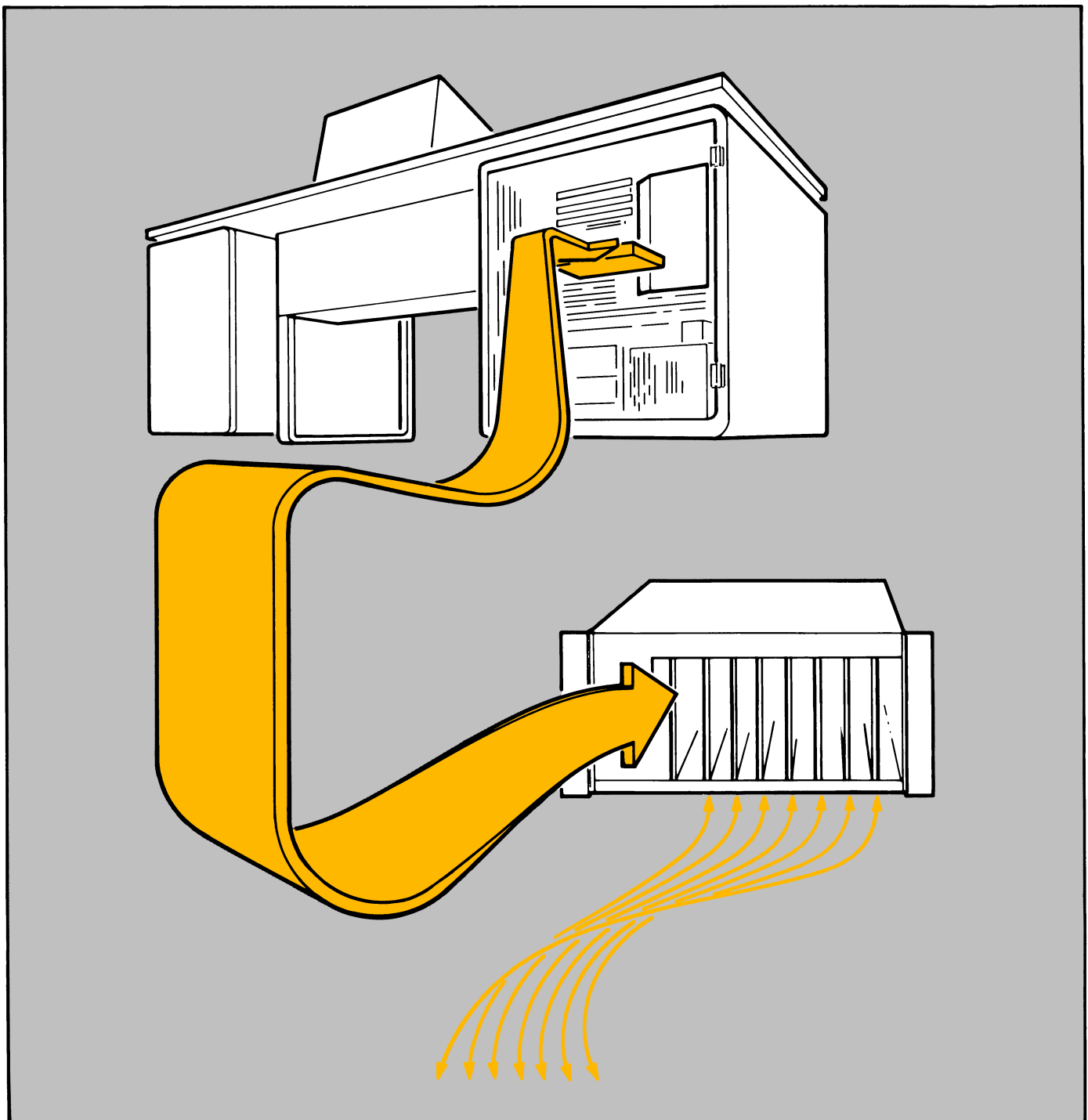


HP 12792B 8-Channel Asynchronous Multiplexer Subsystem User's Manual

For HP 1000 M/E/F-Series Computers



HP 12792B

8-Channel Asynchronous Multiplexer Subsystem

User's Manual



PRINTING HISTORY

The Printing History below identifies the Edition of this Manual and any Updates that are included. Periodically, Update packages are distributed which 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 what software manual edition and update is compatible with your current software revision code, refer to the appropriate Software Numbering Catalog, Software Product Catalog, or Diagnostic Configurator Manual.

First Edition Jan 1983

NOTICE

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

HEWLETT-PACKARD MAKES NO WARRANTY OF ANY KIND WITH REGARD TO THIS 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 program language without the prior written consent of Hewlett-Packard Company.

Preface

This manual is designed as a technical reference for the Hewlett-Packard 12792B Eight 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.

The Overview provides general information concerning the multiplexer subsystem and its interrelationships with HP 1000 products.

The User Interface 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.

Using the features of the multiplexer and error handling/recovery is covered in Chapter 3, Using The Multiplexer.

The Device Driver chapter is directed at the advanced programmer who is experienced with Assembly language. It provides the user with a tutorial on device driver writing.

The Device Specific Considerations chapter 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	2-1
Function Code	2-2
Logical Unit Number	2-2
I/O Requests	2-3
Standard I/O EXEC Calling Sequences	2-6
EXEC Calls From Assembly Language	2-7
EXEC Calls From FORTRAN	2-8
EXEC Calls From PASCAL	2-9
EXEC Call Parameters	2-12
Control Requests To The MUX	2-12
Device Initialization	2-14
Interface Driver Control Requests	2-14
Function Code 6B: Dynamic Status	2-14
Function Code 10B: Loop Test	2-16
Function Code 12B: Terminate Receive Buffer	2-17
Function Code 20B: Enable Scheduling	2-18
Function Code 21B: Disable Schedule	2-19
Function Code 22B: Set Timeout	2-20
Function Code 26B: Flush Input Buffer	2-21
Function Code 27B: Set Program Address	2-21
Function Code 30B: Set Port ID	2-22
Function Code 31B: Connect Line	2-24
Function Code 32B: Disconnect Line	2-26
Function Code 33B: Configure Driver Responses	2-26
Function Code 34B: Set Port Configuration	2-29
Function Code 36B: Set Binary Length	2-30
Function Code 37B: Set Read Type	2-30

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	3-5
Full Type-Ahead Mode	3-5
Type-Ahead With Scheduling Mode	3-6
Type-Ahead With Flush On Break Mode	3-6
Error Recovery	3-7
I/O Status	3-7
Failure Analysis	3-8
Read Errors	3-8

Chapter 4 Device Driver Writing

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	4-3
Device Driver Tasks	4-3
HP Implementations Of Device Drivers	4-3
Lineprinter Device Driver DDV12	4-3
Block Mode Terminal Device Driver DDV05	4-4
Device Driver Interface	4-4
Device Drivers For HP 12792B Multiplexer	4-4
Restrictions And Requirements	4-5
System Abort Requests	4-5
Interface Definitions	4-6
Return To The Interface Driver	4-6
Return To Interface Driver -- Device Driver EQT Extent.	4-7
Return To Interface Driver -- A-Register	4-7
Exit Command	4-7
Function Modifier	4-8
Return To Interface Driver -- B Register	4-10
Return To Interface Driver -- EQT Entries	4-10
Selected EQT Definitions And Uses	4-10
Device Driver Address Table	4-13
Location And Size Of Device Drivers	4-14
Case Study: A Device Driver Writing Example	4-15
Task Definition	4-15
Margin Set Up	4-15
Cursor Position	4-15
Cursor Tracking	4-16
Minor Tasks	4-16
Device Driver Operation	4-16
Operation Flow	4-17
Set Up Device Driver EQT Extent Pointers	4-19
EQT Setup On First Entry	4-19
Subchannel Determination	4-20
Output a Setup String to the Terminal	4-20
Perform The Original User Request	4-22
Read Cursor Position	4-22
Final Completion Return to the Interface Driver.	4-23
Device Driver Address Table	4-23
Sample Device Driver Listing	4-24

Chapter 5 Device-Specific Considerations

Device-Specific Considerations

Handshaking	5-1
DDV12 Lineprinter Driver	5-2
DDV05 Terminal Driver	5-2
Black Box Considerations	5-3
Dumb Devices	5-3
Modems	5-4

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
HP 7310 Line Printer Device Driver	B-4

Appendix C Glossary

Index

Chapter 1

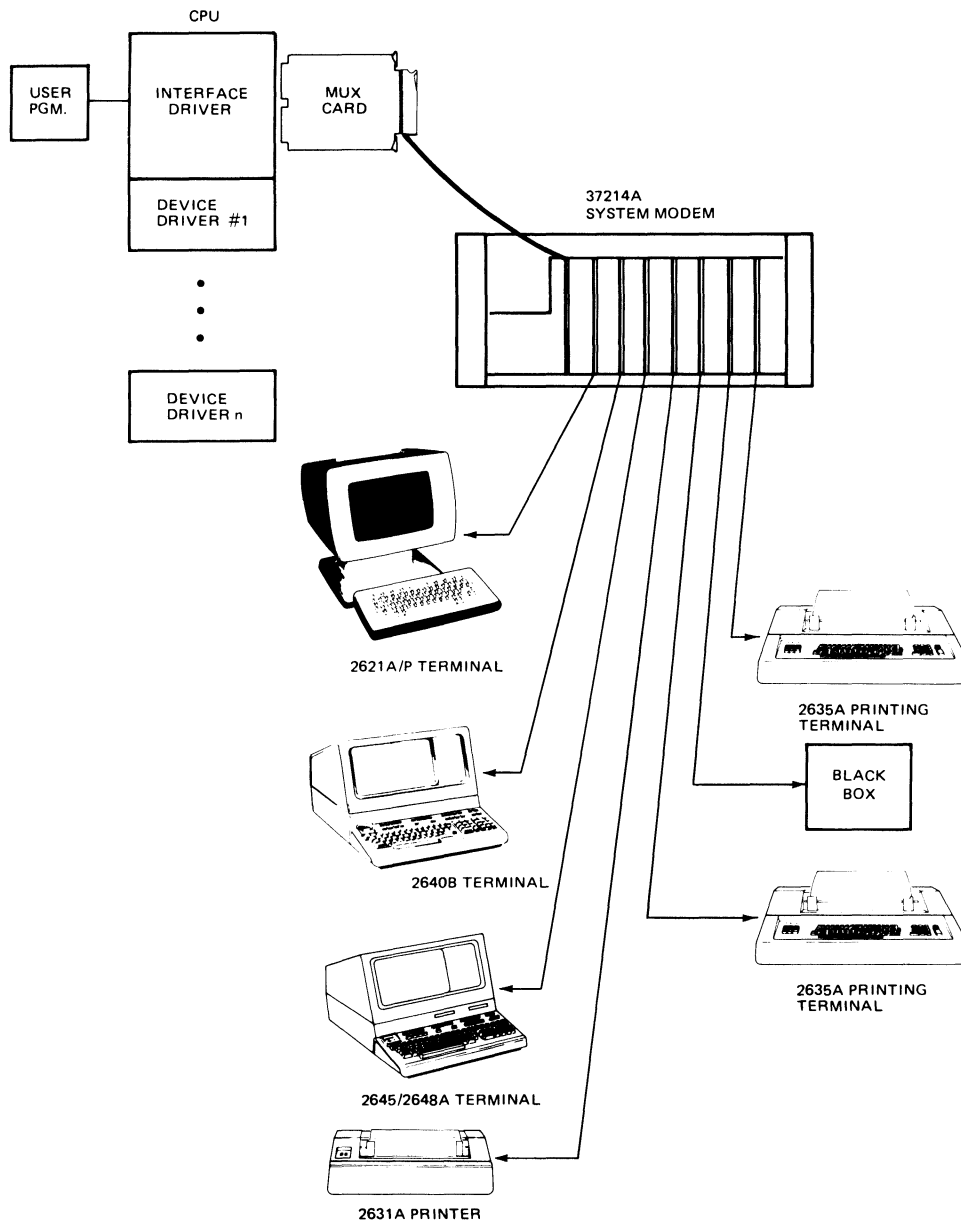
Overview

The Hewlett-Packard 12792B Eight-Channel Multiplexer Subsystem for HP 1000 M-, E-, and 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 is referred to as the multiplexer, or MUX, in this manual unless its complete name is more appropriate.

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 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.



8200-174

Figure 1-1. Example Multiplexer Configuration.

The HP 12792B 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 which 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 two device drivers with the 12792B product -- DDV05 (26XX terminal screen mode device driver) and DDV12 (2631/2635/7310 line printer device driver).

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 which 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.

The maximum number of physical devices which will be supported in the multiplexer subsystem is 61. There are 63 available EQT's in the system but one EQT should be reserved for the system console and one for the disc. 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 is 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. This standard accessory panel is hardwired connecting port 0 to one baud rate generator, and ports one through seven to the other baud rate generator.

The multiplexer panel is connected to the MUX card and can be at the CPU (with the standard cable) or up to 91 metres (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 metres (50 feet) in length.

The MUX will support asynchronous, full-duplex modems through the systems modem (HP 37214A Card Cage and modem cards).

Chapter 2

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 file manager 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

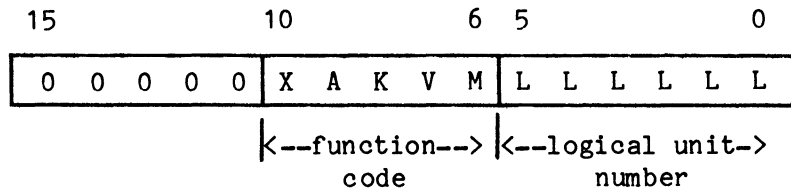
ICODE = 1	READ REQUEST
ICODE = 2	WRITE REQUEST
ICODE = 3	CONTROL REQUEST
ICODE = 13	I/O STATUS REQUEST

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:



Function Code

The octal value of the required function code is provided for each of the request descriptions in the following sections. The user 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.

Logical Unit 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.

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 - DISABLE 1 - ENABLE
BIT 7	(V BIT)	Honesty Bit;
		0 - DISABLE 1 - ENABLE
BIT 6	(M BIT)	Binary Mode Bit;
		0 - DISABLE 1 - ENABLE

Figure 2-1. ICNWD Function Code Bits.

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

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 BITS					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 in 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 BITS					ACTION TAKEN FOR WRITE REQUESTS
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:

- a. Zero-length keyboard entries will not be ignored by the interface driver. A carriage return without data is a zero length record.
- b. 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.
- c. Read or write function codes of 35B bypass any 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 RTE Assembly, RTE FORTRAN IV and PASCAL/1000 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 Assembly Language

The Assembly language 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 RTE FORTRAN IV, 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 RTE FORTRAN IV, 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 the File Manager using the CN command.

EXEC Calls From PASCAL

An EXEC call may be coded in PASCAL/1000 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/1000 compiler does not treat an EXEC call in any 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;
    end;

```

```

        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 will be more readable if a descriptive PASCAL/1000 name is given to each service.
- Each EXEC service requires a different set of parameters. Some services (e.g., EXEC 11) have optional parameters. Each PASCAL/1000 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 (EQT5) 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 the File Manager the following format is used:

:CN,lu,fn[,pr]

lu = LU number
fn = function code
pr = optional control parameter

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	ENABLING SCHEDULING	NO
21B	DISABLE SCHEDULING	NO
22B	SET TIMEOUT	YES
26B	FLUSH INPUT BUFFER	YES
27B	SET PROGRAM ADDRESS	YES
30B	SET PORT'S ID	YES
31B	CONNECT MODEM LINE	YES
32B	DISCONNECT MODEM LINE	YES
33B	CONFIGURE DRIVER RESPONSES	YES
34B	SET PORT CONFIGURATION	YES
36B	SET READ BINARY LENGTH	YES
37B	SET READ TYPE	YES

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

:CN,19,33B,23000B

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 15-8	Undefined
Bit 7	Last request timed out
Bit 6	Break key hit
Bit 5	EOT (control-D) entered on last request
Bit 4	Device failure (e.g., 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	Undefined

The modem related status returned in the B-register (if IPARM1 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: 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 will wait until any 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. Refer to the manuals for the external modems for loopback test instructions on them. 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 a 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 "don't down the EQT on line failure" to prevent the EQT from going down.

An example from file manager 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 CONFIGURATION EVERY
    TIME MODE

:CN,LU,33B,20200B

*** SPECIFY ECHO/EDIT OFF, END TRANSFER ON CARRAGE RETURN

:CN,LU,37B,100000B

*** INITIATE THE 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 (i.e., transmission log).

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

This control request is useful to read incoming data which is not in a format known to the multiplexer; e.g., 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
C       CALL EXEC(3,3300B+LU,22200B)
C
C   SET THE READ CONFIGURATION TO END ON A COUNT OF 254, ECHO & EDIT OFF
C
C       CALL EXEC(3,3600B+LU,254)
C       CALL EXEC(3,3700B+LU,4000B)
C
C   THE FOLLOWING LOOP WILL TERMINATE & READ THE INCOMING DATA BUFFER
C
C   10   CALL EXEC(3,1200B+LU,0)
C       CALL EXEC(1,LU,BUFF,-254)
C       CALL ABREG(ISTAT,LEN)
C
C   LEN HAS THE LENGTH OF THE DATA RECEIVED
C
C       :
C       :
C   PROCESS THE RECEIVED DATA
C
C       :
C       :
C   READ SOME MORE DATA
C
C       GO TO 10

```

Instead of doing 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 11-10 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 will be scheduled as soon as the type-ahead data is sent to the driver by the interface card. The scheduled program will then read the data, and if desired, issue 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. A read operation is not in progress.
4. 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 the 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 the following request is issued:

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

or to enable scheduling on an unsolicited interrupt at LU 41:

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

Function Code 21B: Disable Schedule

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-up time 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 time-out value that was established at system generation, use function code 22B. The time-out value can be set in 10 millisecond intervals by the integer provided as an additional parameter.

Time-out values can also be set by using the system TO command. The RTE Programmer's Reference Manual describes how to use the TO command. When using a control request or the File Manager 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 7 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 any data from the channel's input buffer which might have accumulated in the 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 the user that the information requested is what is obtained, eliminating the possibility of processing any outstanding data previously entered. To flush only this channel's active buffer use IPARM=0. Setting IPARM=1 will flush 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 will override 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 logical unit 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: # 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 since setting this bit causes port 7 to be assigned to the 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: # 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 handshake 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 since 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, etc.).

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, 4800, and 9600) can be simultaneously selected.

For example, assume that ports 0-3 are connected to baud-rate generator 0 and ports 4-6 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 1-3 must be set to either 2400 or 4800 or 9600 since 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 which 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 will automatically change 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 31B: Connect Line

Function code 31B connects a modem line when the systems modem panel is being used. Once a Connect Line request has been executed on a given port, the user need not do it again unless a power fail occurs or a Disconnect Line request is executed. Even if 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 will have to 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. Connect Line requests can be done from file manager or by EXEC request. For example:

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

where IPARM1 is as follows:

Bit 15: No Wait bit

0 = driver will complete the request (i.e., return) only after line has been connected.

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

Bits 5-3: Configuration straps for the HP 37213A modem card. These straps will 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 0 = 10 bits
1 = 9 bits

Bit 0 = 212 mode
1 = V.22 mode

Bit 0 = guard tone off
1 = guard tone on

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 Line request by making a write request with function code 35B as follows:

```
CALL EXEC (2,3500B+LU,BUFR,BUFLN)
```

Where: LU = LU of the modem
BUFR = buffer that contains the phone number (AUTO-DIAL BUFR)
BUFLN = length of BUFR

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 0 to 9, or *

An * will cause 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:

- a. P /031/331 - 1000 (Pulse dial the number 031 331 1000).
- b. 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 Line

Function code 32B disconnects a line from being used as a modem line. Once a Disconnect Line request is done, an incoming call cannot establish a connection until a Connect 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 will complete the request (i.e., return) only after line has been disconnected.

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

Bit 0: 1 = disable auto-answer.

Function Code 33B: Configure Driver Responses

Function code 33B uses the IPARM parameter to specify port parameters. The value of IPARM will configure 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 These bits are used to 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 (e.g., IO NR).

10 = if the device or line goes down, don't down the device, but abort the request, then return EOT and go into a hard flush mode (i.e., ignore all subsequent I/O requests. Function code 6B will return additional information regarding the failure.

Bits 13-12 These bits 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 These bits 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 These bits 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 These bits control the sending of read configuration information to the card. Also see control 37B.

00 = no change

01 = This is a normal read operation. The driver examines bits 10-6 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 10-6, and only the device driver or a control 37 can modify the read configuration type.

Bits 5-4 Reserved for future use, should be 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 all of the user's request directly to interface driver. Device drivers number 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 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: If any port is configured for a 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 IPARAM parameter to specify port configuration additional to function code 30B. The bit fields in IPARAM are defined as follows:

Bits 15-1 : Reserved for future use and should be set to zero.

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          (Causes a long output to the terminal)
CTRL-S          (XOFF will cause the output to stop; e.g., if
.               the user wants to stop to look at something)
.
CTRL-Q          (XON resumes the output to the terminal)
```

Note: XON and XOFF codes can be issued through the keyboards to pace the data transmitted to the terminal. The CNTRL and Q keys (when pressed simultaneously) generate an XON code and the CNTRL and S keys generate XOFF.

CAUTION

If XON/XOFF transmit pacing is enabled, all Cntrl-S characters received by the MUX are treated as handshake characters and therefore can't be used as data characters. Similarly, each Cntrl-Q preceded by a Cntrl-S is treated as a handshake character. A Cntrl-Q received without a Cntrl-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 Cntrl-Q can be used for editing as long as it is not preceded by a Cntrl-S. Similarly, it is recommended that the XON/XOFF transmit handshake is disabled while sending binary data (For example, from a data cartridge) 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 10-6 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:

```
ICCODE = 3
ICNWD = 3700B+41
ITYPE = 100000B
CALL EXEC(ICCODE,ICNWD,ITYPE)
.
.
.
OR
CN,41,37B,100000B
```

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

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

Chapter 3

Using the MUX

This chapter describes the features of the HP 12792B 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 will appear identical to other non-multiplexed RTE terminal drivers. When a port is inactive, the driver will set 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, etc.) 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.

An advantage of type-ahead is that applications 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, telling it 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.

Since 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.

Since 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 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 any 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 doesn't 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 will 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 which 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 which will schedule the program for the MUX port as described below (refer to function code 33B, bits 13, 12):

- a. 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.
- b. 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.
- c. 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 will also recognize the BREAK key.

A program scheduled by one of the above events is run with the CPU's 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 which gets 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 on-line by a control request.

Common Type-Ahead Modes

Function code 33B allows the user to provide control requests for the driver responses by manipulating four fields to specify sixteen different type-ahead combinations. However, the four following combinations are sufficient for most user applications. If a specific application is desired, the user can design a mode by manipulating the control-request word bit fields using function code 33B.

The common operating modes are:

Normal Non-Type-Ahead Mode

Full Type-Ahead Mode

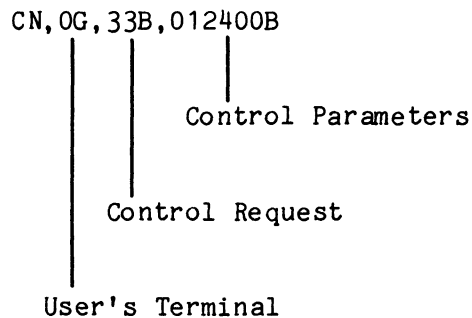
Type-Ahead with Flush on Break Mode

Type-Ahead with Scheduling Mode

Each mode is summarized below along with the run string necessary to configure the user's terminal. Control requests and bit manipulation are covered in the Interface Driver section.

No Type-Ahead Mode

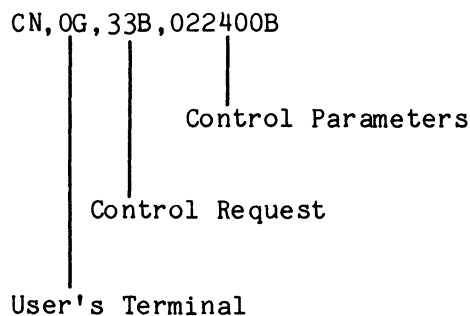
No Type-Ahead Mode



This will return the port to a standard RTE mode. This mode is commonly used in the WELCOM file so that the individual may later configure the port to a specific application. If a key is struck while executing in this mode and no request is pending on the terminal, the designated program will be scheduled.

3.3.2 Full Type-Ahead Mode

Full Type-Ahead Mode

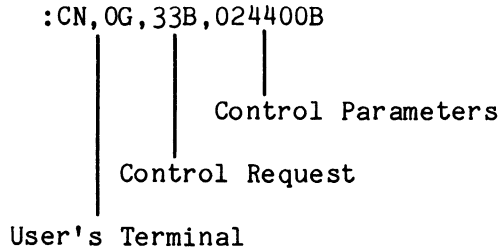


The type-ahead is a mode of operation enabling the interface to accept strings of data from terminal devices even though the system did not request any information. This information is stored in one of the two 254-byte receiving buffers for that port and remains buffered until a program reads the contents of the buffer. While in type-ahead 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

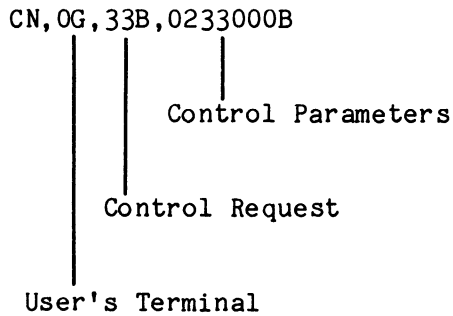
Type-Ahead with Scheduling Mode



This mode configures the interface driver responses to utilize the type-ahead mode. Scheduling will occur when an end-of-record is encountered. Depressing the Break Key will always schedule 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

Type-Ahead with Flush on Break Mode



In this mode when the break key is struck, the interface driver will flush the contents of the input buffers and then 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 on 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 (EQT5 and EQT4) 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:

- time outs
- 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 time-out occurs, the status returned will indicate a parity/overflow error.

I/O Status

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 (EQT5) and ISTA2 is also a status word (EQT4).

Failure Analysis

For failure analysis it is important to note that all errors appear as time outs, parity or overflow errors. Current HP supplied device drivers will 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
```

```
XX = NR
```

```
TO
```

```
PE
```

```
etc., as specified by device driver
```

In the above example x, y, and z are the Logical Unit number, EQT number, and subchannel number respectively. If a device is down, any I/O control request will wait for the operator to "UP" the EQT number.

For time-outs it may be that a simple time-out 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.

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	Last request timed out
	6	Break Key hit
	5	Control 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	Reserved for future use, always zero	
ISTA2	15	Reserved for future use, always zero
	14	1 = Automatic output buffering enabled
	13	1 = Driver to process power fail (always 1)
	12	1 = Driver to process time-out (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 for future use, should always be zero
	4-0	EQT subchannel associated with the LU number

Chapter 4

Device Driver Writing

This chapter explains the writing and use of device drivers that can be called by the 12792B Multiplexer Interface Driver, DVM00. The basic philosophy of using device drivers is explained to give the user 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 which 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 12792B 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. Applications 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 Multiplexer Subsystem the HP 12792B 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 eight-bit characters into 16-bit data words for efficient DMA transfer to the computer, or unpacks the 16-bit words into eight-bit bytes for the terminal. The card treats the parity bit as described in the Interface Support statement in the Multiplexer Configuration Guide, and notifies the driver when incorrect parity has been received.

Interface Driver Tasks

Interface Control

The interface driver DVM00 for the 12792B 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, etc. 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 tells 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 Multiplexer subsystem.

Lineprinter Device Driver DDV12

Device driver DDV12 makes HP 2631/2635/7310 printers 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 lineprinters.

Block Mode Terminal Device Driver DDV05

The device driver DDV05 allows utilization of the block mode read capabilities of an HP 264X or 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 trying 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 had probably issued a program enabled block read (escape lower case 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 HP 12792B Multiplexer

The following points should be kept in mind when writing device drivers for the HP 12792B 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 only has to 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 tell 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. Any unrecognized control requests should be passed on 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

Entry to the Device Driver

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 2-4 are set to the current user request definition. These three words are copied from EQT words 6-8 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 4-10 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 the 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 insure 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 15-11 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)

Return To Interface Driver — Device Driver EQT Extent

The physical record length (device driver EQT extent word 1) is used to prepare the 12792B 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 2-4 of the device driver EQT extent may be changed by the device driver to cause the interface driver to execute some other request, or they may remain unmodified causing the interface driver to perform the initial user request. Remember that on each entry words 2-4 of the device driver EQT extent are restored to the original user request copied from EQT words 6-8.

Return To Interface Driver — A-Register

Exit Command

On return to the interface driver from the device driver the A Register bits 2-0 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 = time out 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
request (A Register bit 15 equals 0 on entry)

- 0 = user request is complete; B Register = transmission log
- 1 = I/O device not ready, down it and give IONR message
- 2 = end of transmission (EOT) reached, down device and
 give IOET message
- 3 = parity error, down device and give IOPE message
- 4 = device time out, down device and give IOTO message
- 5 = new request in device driver EQT extent words 2-4;
 B Register = time out 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, etc.) 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 = 5) a function modifier may be placed in the A Register bits 15-3 to override and expand the normal request function code contained in the device driver EQT extent word 2, bits 10-6. 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, control 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 7-3 are zero (do not override) the write is configured by bits 10-6 in the device driver EQT extent word 2. These bits are defined as bits 10-6 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 15-8) will configure the card for any subsequent read operations. This eliminates the "window" between writing and reading so that if the write triggers a response from the device no data will be lost.

If enable end on character (bit 10) is set, one or more of bits 15-12 must be set. Reads will complete on reception of any one of the specified characters. If bit 10 is clear, bits 15-12 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 15-12 and 10 are ignored. Only one of bits 10,11 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, control 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 for future use, should be zero
- 3: use current card configuration

If enable end on character (bit 10) is set, one or more of bits 15-12 must be set. Reads will complete on reception of any one of the specified characters. If bit 10 is clear, bits 15-12 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 15-3 are all zero the read configuration will be 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 15-4 should be zero.

Return To Interface Driver — 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 time out 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 = 5 on continuation, or 5 or 0 on initial entry) the B register should contain the request time out value. This value will be a negative number of time base ticks (10s of milliseconds). If the device driver needs to use the system defined time out for the device, EQT word 14 should be copied into the B Register.

Return To Interface Driver — 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 13-8) 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 7-0 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 10-6 contain the currently addressed subchannel. This information is required by device drivers that perform different tasks for different sub-channels.

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 12792B multiplexer interface driver is DVM00, and so the type code is 00. Device drivers that emulate devices should use a type code corresponding to the device they are emulating. On first entry the device driver should change the type code in the EQT table. The type codes and devices they represent are given below:

- 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)
 - 10 = plotters (Calcomp or HP 7210)
 - 11 = card readers
 - 12 = line printers
 - 13 = TV monitor
 - 15 = mark sense card readers
- 20 to 35 = mag tape or mass storage devices
 - 23 = 9 track mag tape
 - 24 = 7 track mag tape
 - 30 = fixed head disc
 - 31 = 7900 moving head disc
 - 32 = 7905/6/20/25 moving head disc
 - 33 = flexible disc drives
 - 36 = writable control store (microcode execution space)
 - 37 = HPIB Interface
 - 47 = Multidrop FDL interface

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

- Bit 7 Time out, if the driver was entered on a time out this bit will be set on entry to the device driver.
- Bit 6 Break, if the 12792B 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 currently 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 1 word optional parameters.

In the 12792B 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 and 5-2 These bits are undefined and should be set to zero if the device driver 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 time-out 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 time out clock count down counter. This word is setup 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 time out 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 time out 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 which 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 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 of 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. Since 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

Since 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. In the RTE-IVB operating system, 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 an 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 Set Up

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. Since either subchannel most closely resembled 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 3-0 = 0) 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.

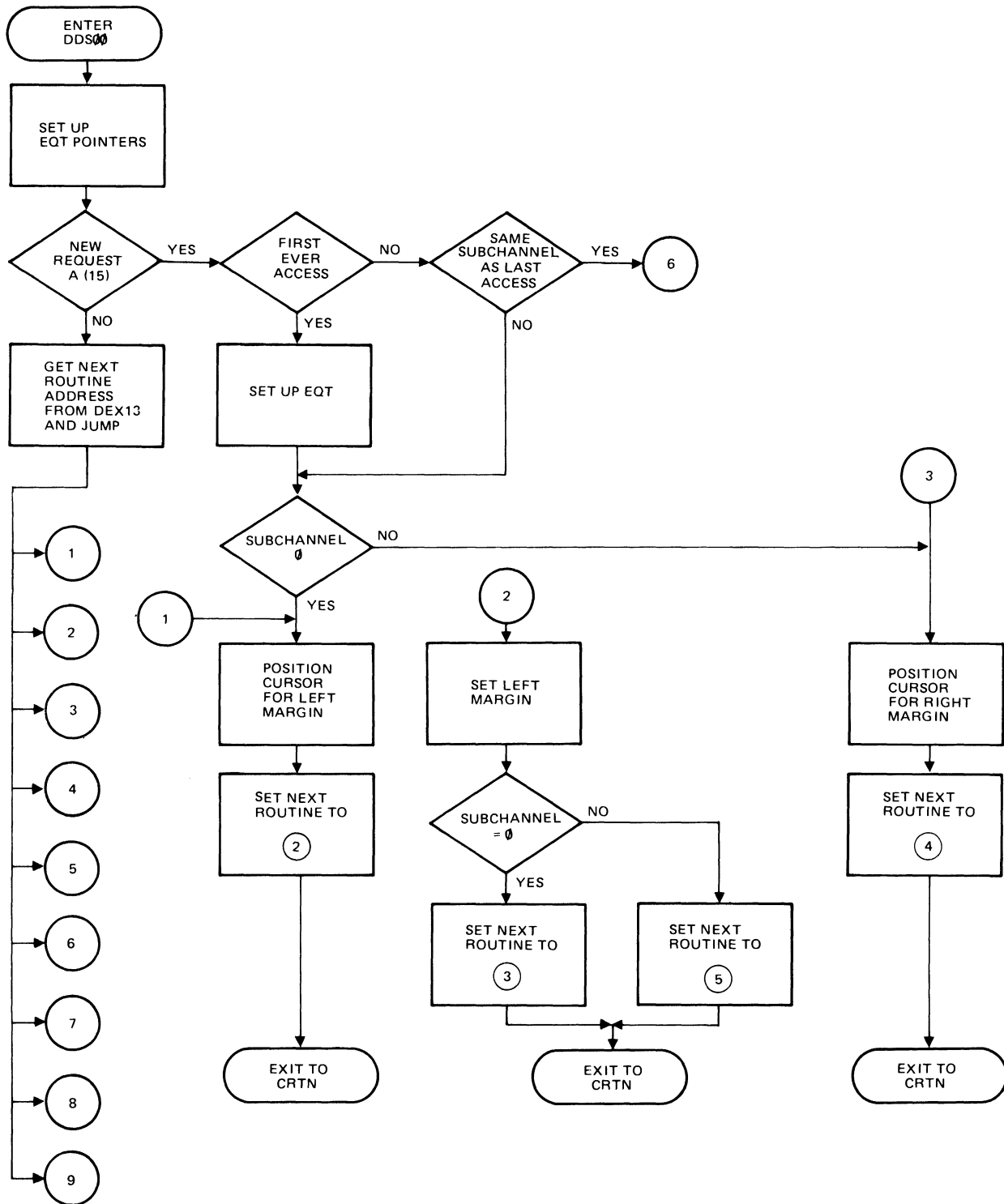
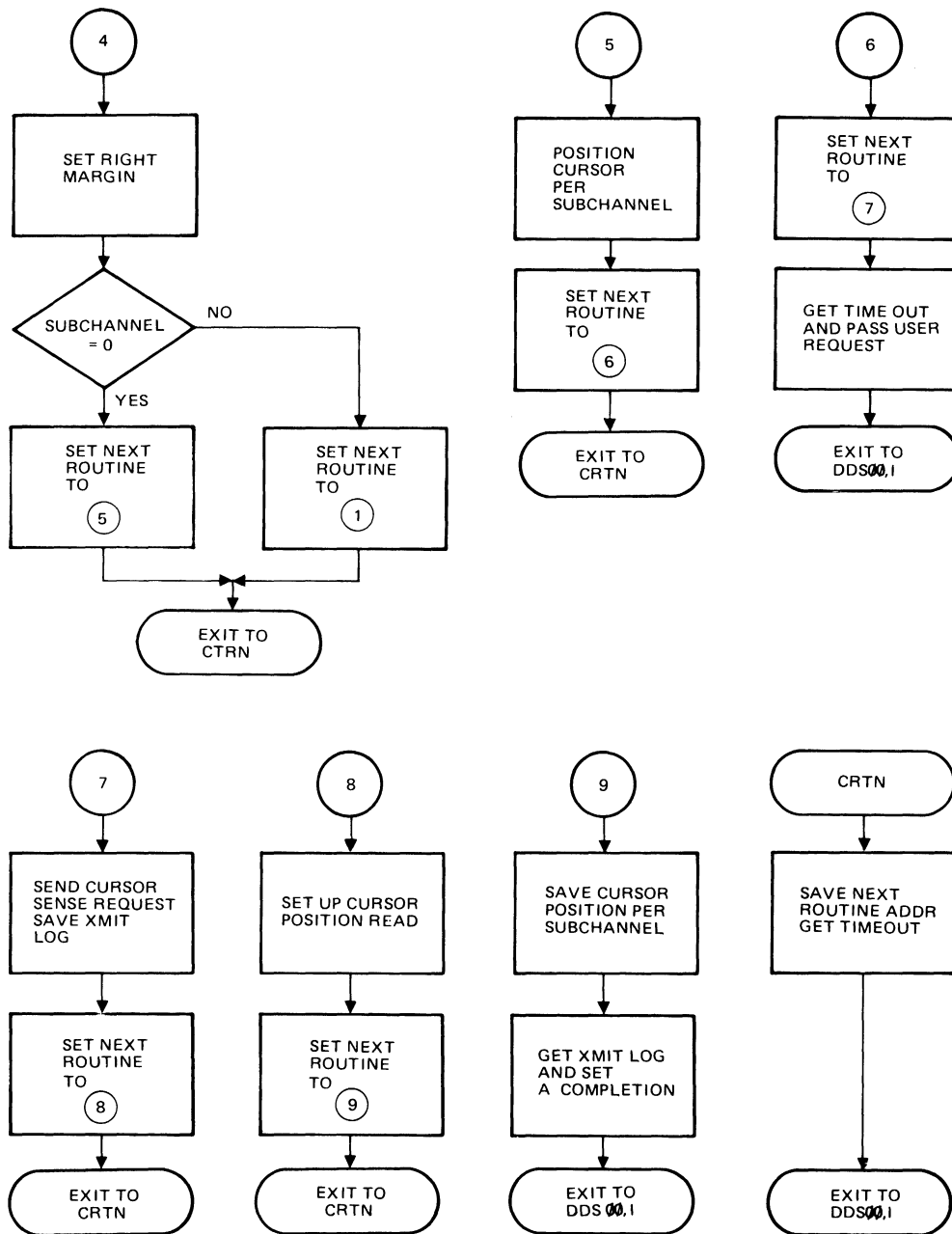


Figure 4-1. Device Driver Flow Chart



7700-570

Figure 4-1 (cont'd). Device Driver Flow Chart

Set Up Device Driver EQT Extent Pointers

On each entry to the device driver the device driver EQT extent addresses are stored into 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 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 - 12. The starting positions, upper left corner of each screen, are hard coded in ASCII in the driver:

```

      .
      .
LDA ASO      GET THE ASCII "SO"
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 SORC     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
SORC 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 what subchannel the request is addressed to. The subchannel is in the EQT word 4 bits 10-6. 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 go 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    GO 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 that set up the terminal are basically the same. They place the request in device driver EQT extent words 2-4 and exit through a common return routine.

Device driver extent word 2 is set up 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 of 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 time out value used for all setup requests.

```

CRTN    STB DEX13,I  SAVE NEXT ROUTINE ADDRESS IN DD EXT WORD 13
        LDB TO       GET TIME OUT 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 only has to 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

Since the original user request is restored to the device driver EQT extent words 2-4 on each entry to the device driver, processing the original request is quite simple. Before returning to the interface driver, the device driver only puts the system defined time out 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 DON'T MODIFY ANYTHING/DO REQUEST
*      IN THE DD EXT MODIFIER/EXIT COMMAND
EQT14  EQU 1773B

```

Since 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 - lower case 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 the 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 12792B 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 SO
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 ASO	CONTAINS ASCII "SO"
0061	00041	000250R	JMP SUBCK	NOT FIRST ACCESS, CHECK SUBCH
0062*				
0063	00042	000277R	LDA ASO	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 SORC	
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	ASO ASC 1,S0	
0266	00300	030060	SORC 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, DON'T MODIFY WRITE.
0275	00315	000005	MODX2 OCT 000005	UNIV. MODIFIER/EXIT COMMAND
0276*				DON'T 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	RMPAO	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	RMPAO	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**

Chapter 5

Device-Specific Considerations

The Multiplexer subsystem supports the following HP terminals: 2621A/P, 2626A, 2631A/B, 2635, 2675A, and 264X, as well as printer support for the 263X and the 7310A.

Other HP or non-HP devices may be used in conjunction with the 12792B 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 interface card uses firmware on the interface card rather than a software driver to accomplish ENQ/ACK handshaking to provide 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 received 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 Control-Q is received by the multiplexer and transmission stops when Control-S is received. Use of XON and XOFF are enabled in the Port Configuration control request (refer to function 34B in Chapter 2).

DDV12 Lineprinter Driver

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

- no vertical form feed except top of form
- no over print carriage control (* 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 a 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 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 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 which is 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 drivers requests.

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 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 to 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.

Appendix A

Device Equipment Table

The HP 12792B 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 17 words, or a total of 32 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 passes information to each other through the EQT entry for that channel. Table A-1 provides the function at each word in the Equipment Table Entry in RTE-IVB and RTE-6/VM operating systems.

Table A-1. Equipment Table Entry.

EQT Words 1-8:	standard in the RTE operating environment.
Word 5:	the status word, bits 7-0 describe the channel's status unless it is altered by a device driver: Bit 7: Last request timed out Bit 6: BREAK key hit Bit 5: EOT (control-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: Reserved for future use, should be set to zero
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:	<p>Port Status Word 1</p> <p>Bit 15: Card is busy processing a command</p> <p>Bit 14: Deferred abort in process (system clear request)</p> <p>Bit 13: Waiting for or using DCPC channel</p> <p>Bit 12: Reserved for future use</p> <p>Bit 11: Using DCPC channel 1 (select code = 6)</p> <p>Bit 10: I/O transfer in process</p> <p>Bit 9: Unsolicited interrupt in progress</p> <p>Bit 8: Defer abort flag</p> <p>Bit 7: End on CR</p> <p>Bit 6: End on RS</p> <p>Bit 5: End on CNTL D</p> <p>Bit 4: End on DC2</p> <p>Bit 3: End on Count</p> <p>Bit 2: End on Character</p> <p>Bit 1: Edit enable</p> <p>Bit 0: Echo enable</p>
Word 12:	<p>Bit 15: This EQT is suspended on itself</p> <p>Bits 14-0: The address of first EQT suspended, waiting for access to the backplane.</p>
Word 13:	Address of EQT extension
Word 14:	Standard usage: EQT time-out 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 power fail recovery
Word 21:	Driver configuration word (from control 33B)
Word 22:	Reserved for future use
Word 23:	Length of typed-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 Bit 14,13: 00 = control-D (terminating character) 01 = <CR> 10 = <DC2> 11 = <RS> Bit 12: Reserved for future use Bit 11: Card reset in progress Bits 10-9: Reserved for future use 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:	Device driver timeout, -10's ms
Word 30:	Device driver EXEC request
Word 31:	Device driver I/O buffer address or control requests optional parameter
Word 32:	Device driver buffer length (+words, -chars)

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

Appendix B

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, etc) are supported. Peripheral devices (CTUs, etc.) 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. Since this subsystem is be able to 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 HP264X or 262X terminal. At boot-up time 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

No support for peripheral devices is given, therefore EQT subchannels are ignored. However, for compatibility with existing and future products, the subchannel field should be set to zero.

Control Request Definition

The control requests accepted by this driver perform various functions. Some requests require additional data which 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/LF's 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 assure correct terminal handshake when doing block reads, etc. 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 char in buffer is NOT "_". "_" is not printed if present as the last char 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 will not be ignored by the interface driver.

I/O transfers use a character format set up by control fuction 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 a 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

Functional Overview

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 Multiplexer Subsystem Configuration Guide.

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

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

It should be noted that no processing of the user data is performed other than that described above. Since the printer always reacts to escape sequences and protocol characters (e.g. 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. (i.e 66 will send 2 lines.)

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

Appendix C

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, Control 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, Control M.
DC1 - Device control	A device control character which is primarily intended for turning on or starting a peripheral device. The host is receiving information, Control Q.
DC2 - Device control	A device control character which is primarily intended for turning on or starting a peripheral device, Control R.

DIRECT MEMORY ACCESS (DMA) A facility that permits I/O transfers 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, Control E.

EOT End-of-Transmission, Control 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

\$DVTB device driver address table, 4-13, 4-14
\$DVTB SAM, 4-14
\$DVTB sample code, 4-23
\$DVTB table area I, 4-14

26XX screen mode device driver
DDV05, 4-4, B-1

7310 line printer device driver
DDV12, 4-3, B-4

A

A-register interface
driver, 4-7
driver returns, 4-6

B

B Register
device driver, 4-10
interface driver returns, 4-7
return to interface driver, 4-10
Baud rate
generators, 2-22
generators port specification, 2-22
specification, 2-23
Binary data reads
device driver EQT extent, 4-7
Black box
compatibility, 5-3
driver considerations, 5-3
handshaking, 5-3
HP support, 5-3
Break key action, 2-27

C

Case study

- cursor position, 4-15
- cursor tracking, 4-16
- device driver writing example, 4-15
- margin set up, 4-15
- minor tasks, 4-16
- task definition, 4-15

Channel transmission, 1-3

Clear extraneous commands

- control 26B, 3-2

Common type-ahead modes, 3-4

Configure driver responses

- break key action, 2-27
- defining a device driver to this port, 2-28
- example, 2-28
- function code, 2-26
- general description, 2-26
- scheduling, 2-27
- sending read configuration into the card, 2-28
- specifying unique read request type, 2-28
- type-ahead action, 2-27
- type-ahead feature specification, 2-27

Continuation entry

- device driver, 4-19
- system abort request, 4-5
- test, 4-19

Control request

- configure driver responses, 2-26
- device initialization, 2-14
- disable schedule, 2-19
- dynamic status, 2-14
- enable scheduling, 2-18
- file manager format, 2-12
- flush input buffer, 2-21
- function codes, 2-13
- general format, 2-12
- required parameters, 2-13
- set port's ID, 2-22
- set program address, 2-21
- set read type, 2-30
- set timeout, 2-20

Control request to the MUX, B-5

- full type-ahead, 3-5
- no type-ahead, 3-5
- write request, B-5

Control word

- general, 2-1
- read request, 2-5
- write request, 2-6

Control Function

- 11B line spacing, B-2
- 25B update terminal configuration, B-2

Cursor

- position, 4-15
- position case study, 4-15
- tracking, 4-16
- tracking case study, 4-16

D

Data

- overrun error, 3-8
- overrun error read error, 3-8
- transfers packing, 4-2
- transfers parity, 4-2
- DC1/DC2, 5-2
- DC1/DC2 handshaking, 5-2
- DDV05 vs DVR05 comparison, B-1
- DDV05
 - block line mode, B-1
 - block mode terminal device driver, 4-4
 - block page mode, B-1
 - block read, 4-4
 - character mode, 4-4, B-1
 - control request definition, B-2
 - data transfers, 5-2
 - DC1, DC2, 4-4
 - editing, 4-4
 - handshaking requirements, 5-2
 - I/O requests, B-2
 - line spacing, B-2
 - read requests, B-3
 - special I/O considerations, B-3
 - status checking, 4-4
 - subchannel assignment, B-2
 - terminal driver, 5-2
 - update terminal configuration, B-2
 - user interface for 26XX terminals, B-1
 - write requests, B-3
 - carriage control, 4-3, B-4
 - changing device type, 4-3
 - control request processing, B-5
 - functional overview, B-4
 - limitations, 5-2
- DDV12
 - line printer driver, 5-2
 - line spacing, B-5
 - normal print mode, B-4
 - paper advance, B-5
 - transparent
 - mode selection, B-5
 - print mode, B-4
 - write request processing, B-4

Device driver

- 26XX screen mode device driver, B-1
- 7310 line printer device driver, B-4
- A-register, 4-6
- adding device drivers, 4-13
- address table \$DVTB, 4-13
- address table format, 4-14
- address table general description, 4-13
- address table valid device driver labels, 4-14
- B Register, 4-6
- base page locations, 4-6
- case study, 4-15
- changing device type, 4-3
- character mode, 4-4
- concept, 4-1
- continuation entry, 4-19
- correct status, 4-3
- customizing, 4-1
- DDV05, 4-4
- DDV12, 4-3
- device address table, 4-13
- device driver address table, 4-23
- device driver writing example, 4-15
- double buffering, 4-12
- dynamic switching, 4-1
- EQT, 4-3
- EQT extent binary data reads, 4-7
- EQT extent general description, 4-7
- EQT extent pointers set up, 4-19
- EQT word 1, 4-7
- EQT word 10, 4-6, 4-13
- EQT word 14, 4-6, 4-13
- EQT word 15, 4-13
- EQT word 2, 4-7
- EQT word 3, 4-7
- EQT word 4, 4-7
- EQT word 5, 4-11
- EQT word 7, 4-12
- EQT word 8, 4-13
- EQT word 9, 4-6, 4-13
- EQT words 2-4, 4-6, 4-7
- EQT words 4-10, 4-6
- EQT words 6-8, 4-6
- equipment type code, 4-11
- exit commands, 4-8
- final completion return to the interface driver, 4-23
- I/O considerations, 4-4
- interface, 4-4
- interface driver concept, 4-1
- interface general definition, 4-4
- location and size of device drivers, 4-14
- modify EQT, 4-10
- operation, 4-16
- operation flow, 4-18
- output a set up string to terminal, 4-20
- perform the original user request, 4-22

- read cursor position, 4-22
- Read/Write control request considerations, 4-4
- request legality, 4-3
- request types, 4-12
- restrictions and requirements, 4-5
- return routine, 4-21
- sample listing, 4-24
- sequence of actions, 4-16
- set up device driver EQT extent pointer, 4-19
- set up on first entry, 4-19
- special sequences, 4-3
- status definitions, 4-11
- subchannel determination, 4-20
- system abort request, 4-5
- tasks, 4-3
- transmission log, 4-3
- unrecognized control request, 4-5
- use, 4-1
- user request, 4-3
- user written device driver considerations, 4-4
- valid labels, 4-14
- writing example, 4-15

Device initialization

- configure driver responses, 2-14
- enable scheduling, 2-14, 2-18
- set port ID, 2-14

Disable schedule

- example, 2-20
- general description, 2-19

DMA, 4-3

DMA interface driver, 4-3

Dumb device, 5-3

DVM00

- interface driver, 4-2

Dynamic status

- character length of any TA data, 2-14
- general, 2-14
- port's status, 2-14

E

Enable scheduling

- conditions, 2-18
- example, 2-19
- general description, 2-18

EQT

- set up on first entry, 4-19
- word 10 device driver, 4-13
- word 10 length of secondary buffer, 4-13
- word 14 device driver, 4-13
- word 15 device driver, 4-13
- word 4 subchannel, 4-10

- word 5 equipment type code and status, 4-11
- word 5 interface driver, 4-7
- word 5 status definitions, 4-11
- word 6 double buffering, 4-12
- word 6 request types, 4-12
- word 7, 4-12
- word 7 device driver, 4-12
- word 8, 4-13
- word 8 device driver, 4-13
- word 9 address of secondary buffer, 4-13
- word 9 device driver, 4-13

EQT

- modify, 4-10
- set up on first entry, 4-19

word

- word 1, 4-7
- word 10, 4-6, 4-13
- word 14, 4-6, 4-13
- word 15, 4-13
- word 2, 4-7
- word 3, 4-7
- word 4, 4-7
- word 5, 4-11
- word 7, 4-12
- word 8, 4-13
- word 9, 4-6, 4-13
- words 2-4, 4-6, 4-7, 4-10, 4-6, 6-8, 4-6

Equipment type

- code, 4-11
- code EQT word 5, 4-11

Error checking

- dynamic status, 3-7
- failure analysis, 3-8
- I/O status, 3-7
- I/O status request returns, 3-9

Error recovery, 3-7

EXEC call

- control word, 2-1
- function code, 2-2
- request codes, 2-1
- from Assembly language, 2-7
- from FORTRAN, 2-8
- from PASCAL, 2-9

Exit commands

- device driver, 4-8
- error types, 4-8
- new device driver request, 4-10

F

Failure analysis, 3-8

Final completion

- return to the interface driver sample code, 4-23

Flush input buffer

- example, 2-21

- flush active, 2-21
- flush all input buffers on that port, 2-21

Full type-ahead

- example, 3-5
- general description, 3-5
- program scheduling, 3-5

Function code

- EXEC call, 2-2

H

Handshaking

- DC1, DC2, 5-1
- enable/disable port for ENQ/ACK, 2-23
- ENQ/ACK, 5-1
- terminal, 5-2

HP supplied

- device driver 26XX screen mode device driver, B-1
- device driver 7310 line printer device driver, B-4
- drivers, 4-3
- drivers DDV05, 4-4
- drivers DDV12, 4-3

Hung up terminals, B-2

I

I/O request

- echoing, 2-4
- editing, 2-4
- general, B-2
- terminators, 2-4

I/O status

- example, 3-7
- general, 3-7
- parameters, 3-7
- request returns, 3-9
- status word 4, 3-7

Interface definitions

- A-register, 4-6
- B Register, 4-6
- base page location, 4-6
- device driver, 4-6
- EQT word 10, 4-6
- EQT word 14, 4-6
- EQT word 9, 4-6
- EQT words 2-4, 4-6
- EQT words 4-10, 4-6
- EQT words 6-8, 4-6
- general description, 4-6

Interface driver, 3-3

- A-register, 4-3
- A-register return, 4-6
- B Register, 4-3
- B Register return, 4-7

- concept. 4-1
- concept device driver, 4-1
- device address table, 4-13
- device driver, 4-14
- device driver EQT word 1 return, 4-7
- device driver EQT word 2 return, 4-7
- device driver EQT word 3 return, 4-7
- device driver EQT word 4 return, 4-7
- DMA, 4-3
- DVM00, 4-2
- EQT word 5, 4-7
- EXEC call handling, 4-3
- exit command, 4-8
- memory requirements, 4-14
- program scheduling, 3-3
- read function modifiers, 4-8
- request timer return, 4-7
- return to the interface driver, 4-6
- RTE, 4-3
- status for user, 4-7
- system abort requests, 4-5
- tasks general description, 4-2
- tasks interface control, 4-2
- tasks operating system interface, 4-3
- transmission log, 4-3
- use, 4-1
- user request and continuation entries, 4-6
- user transmission log return, 4-7
- write function modifier bits, 4-8
- write function modifiers, 4-8

L

Line printer

- device carriage control, 4-3
- driver, 5-2
- driver DDV12, 5-2

M

Margin setup

- case study, 4-15

Memory requirements

- requirements interface driver, 4-14

Minor tasks

- case study, 4-16

Modems, 1-4

- limitations, 5-4

- session environment, 5-4

- support, 5-4

- Modes normal mode, 3-1

- Modes type-ahead, 3-1

- Multiplexer interface responsibilities, 4-2

N

No type-ahead mode
 example, 3-5
 general, 3-5
 standard RTE mode, 3-5
Normal mode
 general description, 3-1

O

Operation flow
 device driver, 4-18
Output a set up string to terminal
 sample code, 4-21
Outstanding data, 2-21
Overflow
 error, 3-7
 error error recovery, 3-7

P

Parity
 error, 3-7
 error error recovery, 3-7
PASCAL, 2-9
PASCAL example, 2-9
PRMPT, 3-4
PRMPT program scheduling, 3-4
Program scheduling
 B Register, 3-3
 break key, 3-3
 EQLU, 3-3
 EQT word 4, 3-3
 explanation, 3-3
 normal break mode, 3-3
 PRMPT, 3-4
 programmatic setting, 3-3
 R\$PN\$, 3-4
 TRMLU, 3-3

R

R\$PN\$, 3-4
R\$PN\$ program scheduling, 3-4
Re-enable schedule
 example, 2-20

Read

- cursor position device driver, 4-22
- cursor position sample code, 4-23
- errors, 3-8
- function modifier interface driver, 4-8
- function modifiers bit field definitions, 4-9
- function modifiers read configurations, 4-9
- request, 2-5

Request

- timer interface driver, 4-7
- types EQT word 6, 4-12

Return

- routine, 4-21
- routine device driver, 4-21
- to interface driver A-register, 4-7
- to interface driver B Register, 4-10

RTE interface driver, 4-3

S

SAM, 4-14

SAM \$DVTB, 4-14

Selected EQT definitions

- equipment type code and status, 4-11
- subchannels, 4-10

Set port

- ID baud rate, 2-22, 2-23
- ID ENQ/ACK handshaking, 2-23
- ID example, 2-24
- ID function code, 2-22
- ID general description, 2-22
- ID number of bits/char, 2-22
- ID port number, 2-24
- ID stop bits, 2-22

Set program address

- example, 2-21
- general description, 2-21
- scheduling an unsolicited interrupt, 2-21

Set read type

- configure a read without executing a read request, 2-30
- example, 2-30
- general, 2-30

Set timeout

- example, 2-20
- general description, 2-20

Set device up

- EQT extent pointers, 4-19
- EQT extent pointers sample code, 4-19

Special considerations

- binary transfers, B-3
- character format, B-3

- escape and unit separator treatment, B-3
- screen reads, B-3
- zero length reads, B-3
- Standard RTE mode
 - no type-ahead, 3-5
- Status
 - definitions, 4-11
 - definitions EQT word 5, 4-11
 - for user interface driver, 4-7
 - word 4, 3-7
 - word 4 I/O status, 3-7
- Subchannel determination
 - new request entry, 4-20
 - sample code, 4-20
- System abort request
 - continuation entry, 4-5
 - EQT word 2, 4-5
 - EQT word 6, 4-5
 - general description, 4-5
- System defined timeout
 - EQT word 14, 4-13
- System or subsystem crashes, 4-5

T

- Table area
 - area I \$DVTB, 4-14
- Task definitions
 - definition case study, 4-15
- Terminal driver
 - driver DDV05, 5-2
- Throughput, 1-3
- Timeout clock
 - clock EQT word 15, 4-13
- Timeouts, 3-7
- Timeouts error recovery, 3-7
- Transmission log
 - log B Register, 4-10
- Transparent mode selection, B-5
- Type-ahead with flush on break mode
 - control function 27, 3-6
 - example, 3-6
 - general, 3-6
- Type-ahead
 - control function 27, 3-6
 - cancel type-ahead data, 2-27
 - description, 3-1
 - enable, 2-27
 - example, 3-2
 - schedule, 2-27

U

User transmission log
 interface driver, 4-7
User written device driver considerations, 4-4

W

Write function modifier bits
 bits read related fields, 4-9
Write modifier
 interface driver, 4-8
Write request, 2-6
Write request processing
 normal mode, B-5
 transparent mode, B-5

READER COMMENT SHEET

Update No. _____
(If Applicable)

We welcome your evaluation of this manual. Your comments and suggestions help us improve our publications. Please use additional pages if necessary.

FROM:

Name _____

Company _____

Address _____

Phone No. _____ **Ext.** _____

FOLD

FOLD

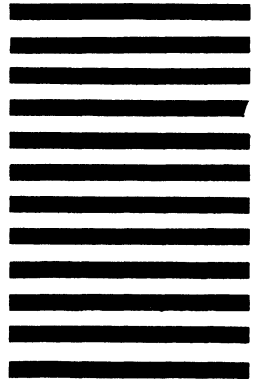


NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 141 CUPERTINO, CA.

— POSTAGE WILL BE PAID BY —

Hewlett-Packard Company
Data Systems Division
11000 Wolfe Road
Cupertino, California 95014
ATTN: Technical Publications



FOLD

FOLD

SALES & SUPPORT OFFICES

Arranged alphabetically by country



Product Line Sales/Support Key

Key Product Line

- A Analytical
- CM Components
- C Computer Systems Sales only
- CH Computer Systems Hardware Sales and Services
- CS Computer Systems Software Sales and Services
- E Electronic Instruments & Measurement Systems
- M Medical Products
- MP Medical Products Primary SRO
- MS Medical Products Secondary SRO
- P Personal Computation Products
- Sales only for specific product line
- ** Support only for specific product line

IMPORTANT: These symbols designate general product line capability. They do not insure sales or support availability for all products within a line, at all locations. Contact your local sales office for information regarding locations where HP support is available for specific products.

HP distributors are printed in italics.

HEADQUARTERS OFFICES

If there is no sales office listed for your area, contact one of these headquarters offices.

NORTH/CENTRAL AFRICA

Hewlett-Packard S.A.
7, Rue du Bois-du-Lan
CH-1217 MEYRIN 2, Switzerland
Tel: (022) 83 12 12
Telex: 27835 hpse
Cable: HEWPACKSA Geneve

ASIA

Hewlett-Packard Asia Ltd.
6th Floor, Sun Hung Kai Centre
30 Harbour Rd.
G.P.O. Box 795

HONG KONG

Tel: 5-832 3211
After Jan. 1, 1984
47th Floor, China Resources Bldg.
26 Harbour Rd., Wanchai

HONG KONG

Tel: 66678 HEWPA HX
Cable: HEWPACK HONG KONG

CANADA

Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
MISSISSAUGA, Ontario L4V 1M8
Tel: (416) 678-9430
Telex: 610-492-4246

EASTERN EUROPE

Hewlett-Packard Ges.m.b.h.
Liebigasse 1
P.O.Box 72
A-1222 VIENNA, Austria
Tel: (222) 2365110
Telex: 1 3 4425 HEPA A

NORTHERN EUROPE

Hewlett-Packard S.A.
Uilenstede 475
P.O.Box 999
NL-1180 AZ AMSTELVEEN
The Netherlands
Tel: 20 437771

SOUTH EAST EUROPE

Hewlett-Packard S.A.
7, Rue du Bois-du-Lan
CH-1217 MEYRIN 2, Switzerland
Tel: (022) 83 12 12
Telex: 27835 hpse
Cable: HEWPACKSA Geneve

OTHER EUROPE

Hewlett-Packard S.A.
P.O. Box
150, Rte du Nant-D'Avril
CH-1217 MEYRIN 2, Switzerland
Tel: (022) 83 8111
Telex: 22486 hpsa
Cable: HEWPACKSA Geneve

MEDITERRANEAN AND MIDDLE EAST

Hewlett-Packard S.A.
Mediterranean and Middle East
Operations
Atrina Centre
32 Kifissias Ave.
Paradissos-Amaroussion, ATHENS
Greece
Tel: 682 88 11
Telex: 21-6588 HPAT GR
Cable: HEWPACKSA Athens

EASTERN USA

Hewlett-Packard Co.
4 Choke Cherry Road
ROCKVILLE, MD 20850
Tel: (301) 258-2000

MIDWESTERN USA

Hewlett-Packard Co.
5201 Tollview Drive
ROLLING MEADOWS, IL 60008
Tel: (312) 255-9800

SOUTHERN USA

Hewlett-Packard Co.
2000 South Park Place
P.O. Box 105005
ATLANTA, GA 30348
Tel: (404) 955-1500

WESTERN USA

Hewlett-Packard Co.
3939 Lankershim Blvd.
P.O. Box 3919
LOS ANGELES, CA 91604
Tel: (213) 506-3700

OTHER INTERNATIONAL AREAS

Hewlett-Packard Co.
Intercontinental Headquarters
3495 Deer Creek Road
PALO ALTO, CA 94304
Tel: (415) 857-1501
Telex: 034-8300
Cable: HEWPACK

ANGOLA

Telectra
Empresa Técnica de Equipamentos
R. Barbosa Rodrigues, 4-1-I DT.
Caixa Postal 6487
LUANDA
Tel: 355 15,355 16
E,P

ARGENTINA

Hewlett-Packard Argentina S.A.
Avenida Santa Fe 2035
Martinez 1640 BUENOS AIRES
Tel: 798-5735, 792-1293
Telex: 17595 BIONAR
Cable: HEWPACKARG
A,E,CH,CS,P
Biotron S.A.C.I.M. e I.
Av Paseo Colon 221, Piso 9
1399 BUENOS AIRES
Tel: 30-4846, 30-1851
Telex: 17595 BIONAR
M

AUSTRALIA

Adelaide, South Australia Office

Hewlett-Packard Australia Ltd.
153 Greenhill Road
PARKSIDE, S.A. 5063
Tel: 272-5911
Telex: 82536
Cable: HEWPAARD Adelaide
A*,CH,CM,,E,MS,P

Brisbane, Queensland Office

Hewlett-Packard Australia Ltd.
10 Payne Road
THE GAP, Queensland 4061
Tel: 30-4133
Telex: 42133
Cable: HEWPAARD Brisbane
A,CH,CM,E,M,P

Canberra, Australia

Capital Territory Office
Hewlett-Packard Australia Ltd.
121 Wollongong Street
FYSHWICK, A.C.T. 2609
Tel: 80 4244
Telex: 62650
Cable: HEWPAARD Canberra
CH,CM,E,P

Melbourne, Victoria Office

Hewlett-Packard Australia Ltd.
31-41 Joseph Street
BLACKBURN, Victoria 3130
Tel: 895-2895
Telex: 31-024
Cable: HEWPAARD Melbourne
A,CH,CM,CS,E,MS,P

Perth, Western Australia Office

Hewlett-Packard Australia Ltd.
261 Stirling Highway
CLAREMONT, W.A. 6010
Tel: 383-2188
Telex: 93859
Cable: HEWPAARD Perth
A,CH,CM,E,MS,P

Sydney, New South Wales Office

Hewlett-Packard Australia Ltd.
17-23 Talavera Road
P.O. Box 308
NORTH RYDE, N.S.W. 2113
Tel: 887-1611
Telex: 21561
Cable: HEWPAARD Sydney
A,CH,CM,CS,E,MS,P

AUSTRIA

Hewlett-Packard Ges.m.b.h.
Grottenhofstrasse 94
A-8052 GRAZ
Tel: (0316) 291 5 66
Telex: 32375
CH,E
Hewlett-Packard Ges.m.b.h.
Liebigasse 1
P.O. Box 72
A-1222 VIENNA
Tel: (0222) 23 65 11-0
Telex: 134425 HEPA A
A,CH,CM,CS,E,MS,P

BAHRAIN

Green Salon
P.O. Box 557
Manama
BAHRAIN
Tel: 255503-255950
Telex: 84419
P

Wael Pharmacy

P.O. Box 648

BAHRAIN

Tel: 256123
Telex: 8550 WAEI BN
E,C,M

BELGIUM

Hewlett-Packard Belgium S.A./N.V.
Blvd de la Woluwe, 100
Woluwedal
B-1200 BRUSSELS
Tel: (02) 762-32-00
Telex: 23-494 paloben bru
A,CH,CM,CS,E,MP,P

BRAZIL

Hewlett-Packard do Brasil I.e.C. Ltda.
Alameda Rio Negro, 750
Alphaville
06400 BARUERI SP
Tel: (011) 421.1311
Telex: (011) 33872 HPBR-BR
Cable: HEWPACK Sao Paulo
A,CH,CM,CS,E,M,P
Hewlett-Packard do Brasil I.e.C. Ltda.
Avenida Epitacio Pessoa, 4664
22471 RIO DE JANEIRO-RJ
Tel: (021) 286.0237
Telex: 021-21905 HPBR-BR
Cable: HEWPACK Rio de Janeiro
A,CH,CM,E,MS,P*
ANAMED I.C.E.I. Ltda.
Rua Bage, 103
04012 SAO PAULO
Tel: (011) 570-5726
Telex: 021-21905 HPBR-BR
M



SALES & SUPPORT OFFICES

Arranged alphabetically by country

CANADA

Alberta

Hewlett-Packard (Canada) Ltd.
3030 3rd Avenue N.E.
CALGARY, Alberta T2A 6T7
Tel: (403) 235-3100
A,CH,CM,E*,MS,P*

Hewlett-Packard (Canada) Ltd.
11120A-178th Street
EDMONTON, Alberta T5S 1P2
Tel: (403) 486-6666
A,CH,CM,CS,E,MS,P

British Columbia

Hewlett-Packard (Canada) Ltd.
10691 Shellbridge Way
RICHMOND,

British Columbia V6X 2W7
Tel: (604) 270-2277
Tel: 610-922-5059
A,CH,CM,CS,E*,MS,P*

Manitoba

Hewlett-Packard (Canada) Ltd.
380-550 Century Street
WINNIPEG, Manitoba R3H 0Y1
Tel: (204) 786-6701
A,CH,CM,E,MS,P*

Nova Scotia

Hewlett-Packard (Canada) Ltd.
P.O. Box 931
900 Windmill Road
DARTMOUTH, Nova Scotia B2Y 3Z6
Tel: (902) 469-7820
CH,CM,CS,E*,MS,P*

Ontario

Hewlett-Packard (Canada) Ltd.
3325 N. Service Rd., Unit 6
BURLINGTON, Ontario P3A 2A3
Tel: (416) 335-8644
CS,M*

Hewlett-Packard (Canada) Ltd.
552 Newbold Street
LONDON, Ontario N6E 2S5
Tel: (519) 686-9181
A,CH,CM,E*,MS,P*

Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
MISSISSAUGA, Ontario L4V 1M8
Tel: (416) 678-9430
A,CH,CM,CS,E,MP,P

Hewlett-Packard (Canada) Ltd.
2670 Queensview Dr.
OTTAWA, Ontario K2B 8K1
Tel: (613) 820-6483
A,CH,CM,CS,E*,MS,P*

Hewlett-Packard (Canada) Ltd.
220 Yorkland Blvd., Unit #11
WILLOWDALE, Ontario M2J 1R5
Tel: (416) 499-9333
CH

Quebec

Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
KIRKLAND, Quebec H9J 2M5
Tel: (514) 697-4232
A,CH,CM,CS,E,MP,P*

Hewlett-Packard (Canada) Ltd.
Les Galeries du Vallon
2323 Du Versant Nord
STE. FOY, Quebec G1N 4C2
Tel: (418) 687-4570
CH

CHILE

Jorge Calcagni y Cia. Ltda.
Av. Italia 634 Santiago
Casilla 16475
SANTIAGO 9
Tel: 222-0222
Telex: Public Booth 440001
A,CM,E,M

Olympia (Chile) Ltda.
Av. Rodrigo de Araya 1045
Casilla 256-V
SANTIAGO 21
Tel: (02) 22 55 044
Telex: 240-565 OLYMP CL
Cable: Olympiachile Santiagochile
CH,CS,P

CHINA, People's Republic of

China Hewlett-Packard Rep. Office
P.O. Box 418
1A Lane 2, Luchang St.
Beiwei Rd., Xuanwu District
BEIJING
Tel: 33-1947, 33-7426
Telex: 22601 CTSHP CN
Cable: 1920
A,CH,CM,CS,E,P

COLOMBIA

Instrumentación
H. A. Langebaek & Kier S.A.
Carrera 4A No. 52A-26
Apartado Aereo 6287
BOGOTA 1, D.E.
Tel: 212-1466
Telex: 44400 INST CO
Cable: AARIS Bogota
CM,E,M
Casa Humboldt Ltda.
Carrera 14, No. 98-60
Apartado Aereo 51283
BOGOTA 1, D.E.
Tel: 256-1686
Telex: 45403 CCAL CO.
A

COSTA RICA

Científica Costarricense S.A.
Avenida 2, Calle 5
San Pedro de Montes de Oca
Apartado 10159
SAN JOSÉ
Tel: 24-38-20, 24-08-19
Telex: 2367 GALGUR CR
CM,E,M

CYPRUS

Telexera Ltd.
P.O. Box 4809
14C Stassinou Avenue
NICOSIA
Tel: 62698
Telex: 2894 LEVIDO CY
E,M,P

DENMARK

Hewlett-Packard A/S
Datavej 52
DK-3460 BIRKEROD
Tel: (02) 81-66-40
Telex: 37409 hpas dk
A,CH,CM,CS,E,MS,P
Hewlett-Packard A/S
Rølighedsvej 32
DK-8240 RISSKOV, Aarhus
Tel: (06) 17-60-00
Telex: 37409 hpas dk
CH,E

DOMINICAN REPUBLIC

Microprog S.A.
Juan Tomás Mejía y Cotes No. 60
Arroyo Hondo
SANTO DOMINGO
Tel: 565-6268
Telex: 4510 ARENTA DR (RCA) P

ECUADOR

CYEDE Cia. Ltda.
Avenida Eloy Alfaro 1749
Casilla 6423 CCI
QUITO
Tel: 450-975, 243-052
Telex: 2548 CYEDE ED
CM,E,P

Hospitalar S.A.

Robles 625
Casilla 3590
QUITO
Tel: 545-250, 545-122
Telex: 2485 HOSPTL ED
Cable: HOSPITALAR-Quito
M

EGYPT

International Engineering Associates
24 Hussein Hegazi Street
Kasr-el-Aini
CAIRO
Tel: 23829, 21641
Telex: IEA UN 93830
CH,CS,E,M
EGYPOR
P.O. Box 2558
42 El Zahraa Street
CAIRO, Egypt
Tel: 65 00 21
Telex: 93 337
P

EL SALVADOR

IPESA de El Salvador S.A.
29 Avenida Norte 1216
SAN SALVADOR
Tel: 26-6858, 26-6868
Telex: 20539 IPESASAL
A,CH,CM,CS,E,P

FINLAND

Hewlett-Packard Oy
Revontulentie 7
PL 24
SF-02101 ESPOO 10
Tel: (90) 4550211
Telex: 121563 hewpa sf
CH,CM,CS,P
Hewlett-Packard Oy
(Olarinluoma 7)
PL 24
02101 ESPOO 10
Tel: (90) 4521022
A,E,MS

Hewlett-Packard Oy
Aatoksenkatv 10-C
SF-40720-72 JYVASKYLA
Tel: (941) 216318
CH

Hewlett-Packard Oy
Kainuntie 1-C
SF-90140-14 OULU
Tel: (981) 338785
CH

FRANCE

Hewlett-Packard France
Z.I. Mercure B
Rue Berthelot
F-13763 Les Milles Cedex
AIX-EN-PROVENCE
Tel: 16 (42) 59-41-02
Telex: 410770F
A,CH,E,MS,P*

Hewlett-Packard France
64, rue Marchand Saillant
F-61000 ALENCON
Tel: 16 (33) 29 04 42

Hewlett-Packard France
Boite Postale 503
F-25026 BESANCON
28 rue de la Republique
F-25000 BESANCON
Tel: 16 (81) 83-16-22
CH,M

Hewlett-Packard France
13, Place Napoleon III
F-29000 BREST
Tel: 16 (98) 03-38-35

Hewlett-Packard France
Chemin des Mouilles
Boite Postale 162
F-69130 ECULLY Cedex (Lyon)
Tel: 16 (78) 833-81-25
Telex: 310617F
A,CH,CS,E,MP

Hewlett-Packard France
Tour Lorraine
Boulevard de France
F-91035 EVRY Cedex
Tel: 16 6 077-96-60
Telex: 692315F
E

Hewlett-Packard France
Parc d'Activite du Bois Briard
Ave. du Lac
F-91040 EVRY Cedex
Tel: 16 6 077-8383
Telex: 692315F
E

Hewlett-Packard France
5, avenue Raymond Chanas
F-38320 EYBENS (Grenoble)
Tel: 16 (76) 25-81-41
Telex: 980124 HP GRENOB EYBE
CH

Hewlett-Packard France
Centre d'Affaire Paris-Nord
Bâtiment Ampère 5 étage
Rue de la Commune de Paris
Boite Postale 300
F-93153 LE BLANC MESNIL
Tel: 16 (1) 865-44-52
Telex: 211032F
CH,CS,E,MS

Hewlett-Packard France
Parc d'Activités Caderea
Quartier Jean Mermoz
Avenue du Président JF Kennedy
F-33700 MERIGNAC (Bordeaux)
Tel: 16 (56) 34-00-84
Telex: 550105F
CH,E,MS

Hewlett-Packard France
Immuable "Les 3 B"
Nouveau Chemin de la Garde
ZAC de Bois Briand
F-44085 NANTES Cedex
Tel: 16 (40) 50-32-22
CH**



FRANCE (Cont'd)

Hewlett-Packard France
Geschäftsstelle
125, rue du Faubourg Bannier
F-45000 **ORLEANS**
Tel: 16 (38) 68 01 63

Hewlett-Packard France
Zone Industrielle de Courtaoef
Avenue des Tropiques
F-91947 Les Ulis Cedex **ORSAY**
Tel: (6) 907-78-25
Telex: 600048F
A,CH,CM,CS,E,MP,P

Hewlett-Packard France
Paris Porte-Maillot
15, Avenue de L'Amiral Bruix
F-75782 **PARIS CEDEX 16**
Tel: 16 (1) 502-12-20
Telex: 613663F
CH,MS,P

Hewlett-Packard France
124, Boulevard Tourasse
F-64000 **PAU**
Tel: 16 (59) 80 38 02

Hewlett-Packard France
2 Allée de la Bourgonnette
F-35100 **RENNES**
Tel: 16 (99) 51-42-44
Telex: 740912F
CH,CM,E,MS,P*

Hewlett-Packard France
98 Avenue de Bretagne
F-76100 **ROUEN**
Tel: 16 (35) 63-57-66
CH** ,CS

Hewlett-Packard France
4 Rue Thomas Mann
Boite Postale 56
F-67033 **STRASBOURG Cedex**
Tel: 16 (88) 28-56-46
Telex: 890141F
CH,E,MS,P*

Hewlett-Packard France
Le Péripole
20, Chemin du Pigeonnier de la
Cépière
F-31083 **TOULOUSE Cedex**
Tel: 16 (61) 40-11-12
Telex: 531639F
A,CH,CS,E,P*

Hewlett-Packard France
9, rue Baudin
F-26000 **VALENCE**
Tel: 16 (75) 42 76 16

Hewlett-Packard France
Carolor
ZAC de Bois Briand
F-57640 **VIGY (Metz)**
Tel: 16 (8) 771 20 22
CH

Hewlett-Packard France
Immeuble Péricentre
F-59658 **VILLENEUVE D'ASCQ Cedex**
Tel: 16 (20) 91-41-25
Telex: 160124F
CH,E,MS,P*

GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH
Geschäftsstelle
Keithstrasse 2-4
D-1000 **BERLIN 30**
Tel: (030) 24-90-86
Telex: 018 3405 hpbln d
A,CH,E,M,P

Hewlett-Packard GmbH
Geschäftsstelle
Herrenberger Strasse 130
D-7030 **BOBLINGEN**
Tel: (7031) 14-0
Telex:
A,CH,CM,CS,E,MP,P

Hewlett-Packard GmbH
Geschäftsstelle
Emanuel-Leutze-Strasse 1
D-4000 **DUSSELDORF**
Tel: (0211) 5971-1
Telex: 085/86 533 hpdd d
A,CH,CS,E,MS,P

Hewlett-Packard GmbH
Geschäftsstelle
Schleefstr. 28a
D-4600 **DORTMUND-Aplerbeck**
Tel: (0231) 45001

Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Bernner Strasse 117
Postfach 560 140
D-6000 **FRANKFURT 56**
Tel: (0611) 50-04-1
Telex: 04 13249 hpffm d
A,CH,CM,CS,E,MP,P

Hewlett-Packard GmbH
Geschäftsstelle
Aussenstelle Bad Homburg
Louisenstrasse 115
D-6380 **BAD HOMBURG**
Tel: (06172) 109-0

Hewlett-Packard GmbH
Geschäftsstelle
Kapstadtring 5
D-2000 **HAMBURG 60**
Tel: (040) 63804-1
Telex: 021 63 032 hphd d
A,CH,CS,E,MS,P

Hewlett-Packard GmbH
Geschäftsstelle
Heidering 37-39
D-3000 **HANNOVER 61**
Tel: (0511) 5706-0
Telex: 092 3259
A,CH,CM,E,MS,P

Hewlett-Packard GmbH
Geschäftsstelle
Rosslauer Weg 2-4
D-6800 **MANNHEIM**
Tel: (0621) 70050
Telex: 0462105
A,C,E

Hewlett-Packard GmbH
Geschäftsstelle
Messerschmittstrasse 7
D-7910 **NEU ULM**
Tel: 0731-70241
Telex: 0712816 HP ULM-D
A,C,E*

Hewlett-Packard GmbH
Geschäftsstelle
Ehhericherstr. 13
D-8500 **NÜRNBERG 10**
Tel: (0911) 5205-0
Telex: 0623 860
CH,CM,E,MS,P

Hewlett-Packard GmbH
Geschäftsstelle
Eschenstrasse 5
D-8028 **TAUFKIRCHEN**
Tel: (089) 6117-1
Telex: 0524985
A,CH,CM,E,MS,P

GREAT BRITAIN

See United Kingdom

GREECE

Kostas Karayannis S.A.
8 Omirou Street
ATHENS 133
Tel: 32 30 303, 32 37 371
Telex: 215962 RKAR GR
A,CH,CM,CS,E,M,P

PLAISIO S.A.
G. Gerardos
24 Stournara Street
ATHENS
Tel: 36-11-160
Telex: 221871
P

GUATEMALA

IPESA
Avenida Reforma 3-48, Zona 9
GUATEMALA CITY
Tel: 316627, 314786
Telex: 4192 TELTRO GU
A,CH,CM,CS,E,M,P

HONG KONG

Hewlett-Packard Hong Kong, Ltd.
G.P.O. Box 795
5th Floor, Sun Hung Kai Centre
30 Harbour Road
HONG KONG
Tel: 5-8323211
Telex: 66678 HEWPA HX
Cable: HEWPACK HONG KONG
E,CH,CS,P

CET Ltd.

1402 Tung Wah Mansion
199-203 Hennessy Rd.
Wanchia, **HONG KONG**
Tel: 5-729376
Telex: 85148 CET HX
CM

Schmidt & Co. (Hong Kong) Ltd.
Wing On Centre, 28th Floor
Connaught Road, C.

HONG KONG

Telex: 5-455644
Telex: 74766 SCHMX HX
A,M

ICELAND

Elding Trading Company Inc.
Hafnarvölli-Tryggvagotú
P.O. Box 895
IS-REYKJAVIK
Tel: 1-58-20, 1-63-03
M

INDIA

Computer products are sold through Blue Star Ltd. All computer repairs and maintenance service is done through Computer Maintenance Corp.

Blue Star Ltd.
Sabri Complex II Floor
24 Residency Rd.
BANGALORE 560 025
Tel: 55660
Telex: 0845-430
Cable: BLUESTAR
A,CH*,CM,CS*,E

Blue Star Ltd.
Band Box House
Prabhadevi
BOMBAY 400 025
Tel: 422-3101
Telex: 011-3751
Cable: BLUESTAR
A,M

Blue Star Ltd.
Sahas
414/2 Vir Savarkar Marg
Prabhadevi
BOMBAY 400 025
Tel: 422-6155
Telex: 011-4093
Cable: FROSTBLUE
A,CH*,CM,CS*,E,M

Blue Star Ltd.
Kalyan, 19 Vishwas Colony
Alkapuri, **BORODA, 390 005**
Tel: 65235
Cable: BLUE STAR
A

Blue Star Ltd.
7 Hare Street
CALCUTTA 700 001
Tel: 12-01-31
Telex: 021-7655
Cable: BLUESTAR
A,M

Blue Star Ltd.
133 Kodambakkam High Road
MADRAS 600 034
Tel: 82057
Telex: 041-379
Cable: BLUESTAR
A,M

Blue Star Ltd.
Bhandari House, 7th/8th Floors
91 Nehru Place
NEW DELHI 110 024
Tel: 682547
Telex: 031-2463
Cable: BLUESTAR
A,CH*,CM,CS*,E,M

Blue Star Ltd.
15/16:C Wellesley Rd.
PUNE 411 011
Tel: 22775
Cable: BLUE STAR
A

Blue Star Ltd.
2-2-47/1108 Bolarum Rd.
SECUNDERABAD 500 003
Tel: 72057
Telex: 0155-459
Cable: BLUEFROST
A,E

Blue Star Ltd.
T.C. 7/603 Poornima
Maruthankuzhi
TRIVANDRUM 695 013
Tel: 65799
Telex: 0884-259
Cable: BLUESTAR
E
Computer Maintenance Corporation Ltd.
115, Sarojini Devi Road
SECUNDERABAD 500 003
Tel: 310-184, 345-774
Telex: 031-2960
CH**



SALES & SUPPORT OFFICES

Arranged alphabetically by country

INDONESIA

BERCA Indonesia P.T.
P.O.Box 496/Jkt.
Jl. Abdul Muis 62
JAKARTA
Tel: 21-373009
Telex: 46748 BERSAL IA
Cable: BERSAL JAKARTA
P

BERCA Indonesia P.T.
P.O.Box 2497/Jkt
Antara Bldg., 17th Floor
Jl. Medan Merdeka Selatan 17
JAKARTA-PUSAT
Tel: 21-344-181
Telex: BERSAL IA
A,CS,E,M

BERCA Indonesia P.T.
P.O. Box 174/SBY.
Jl. Kutei No. 11
SURABAYA
Tel: 68172
Telex: 31146 BERSAL SB
Cable: BERSAL-SURABAYA
A*,E,M,P

IRAQ

Hewlett-Packard Trading S.A.
Service Operation
Al Mansoor City 9B/3/7
BAGHDAD
Tel: 551-49-73
Telex: 212-455 HEPAIRAQ IK
CH,CS

IRELAND

Hewlett-Packard Ireland Ltd.
82/83 Lower Leeson Street
DUBLIN 2
Tel: 0001 608800
Telex: 30439
A,CH,CM,CS,E,M,P
Cardiac Services Ltd.
Kilmore Road
Artane
DUBLIN 5
Tel: (01) 351820
Telex: 30439
M

ISRAEL

Eldan Electronic Instrument Ltd.
P.O.Box 1270
JERUSALEM 91000
16, Ohaliav St.
JERUSALEM 94467
Tel: 533 221, 553 242
Telex: 25231 AB/PAKRD IL
A
Electronics Engineering Division
Motorola Israel Ltd.
16 Kremenski Street
P.O. Box 25016
TEL-AVIV 67899
Tel: 3 88 388
Telex: 33569 Motil IL
Cable: BASTEL Tel-Aviv
CH,CM,CS,E,M,P

ITALY

Hewlett-Packard Italiana S.p.A
Traversa 99C
Via Giulio Petroni, 19
I-70124 **BARI**
Tel: (080) 41-07-44
M

Hewlett-Packard Italiana S.p.A.
Via Martin Luther King, 38/III
I-40132 **BOLOGNA**
Tel: (051) 402394
Telex: 511630
CH,E,MS

Hewlett-Packard Italiana S.p.A.
Via Principe Nicola 43G/C
I-95126 **CATANIA**
Tel: (095) 37-10-87
Telex: 970291
C,P

Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio 9
I-20063 **CERNUSCO SUL NAVIGLIO**
(Milano)
Tel: (02) 923691
Telex: 334632
A,CH,CM,CS,E,MP,P
Hewlett-Packard Italiana S.p.A.
Via C. Colombo 49
I-20090 **TREZZANO SUL NAVIGLIO**
(Milano)
Tel: (02) 4459041
Telex: 322116
C,M

Hewlett-Packard Italiana S.p.A.
Via Nuova San Rocco a
Capodimonte, 62/A
I-80131 **NAPOLI**
Tel: (081) 7413544
Telex: 710698
A,CH,E

Hewlett-Packard Italiana S.p.A.
Viale G. Modugno 33
I-16156 **GENOVA PEGLI**
Tel: (010) 68-37-07
Telex: 215238
E,C

Hewlett-Packard Italiana S.p.A.
Via Pelizzo 15
I-35128 **PADOVA**
Tel: (049) 664888
Telex: 430315
A,CH,E,MS

Hewlett-Packard Italiana S.p.A.
Viale C. Pavese 340
I-00144 **ROMA EUR**
Tel: (06) 54831
Telex: 610514
A,CH,CM,CS,E,MS,P*

Hewlett-Packard Italiana S.p.A.
Via di Casellina 57/C
I-50018 **SCANDICCI-FIRENZE**
Tel: (055) 753863
Hewlett-Packard Italiana S.p.A.
Corso Svizzera, 185
I-10144 **TORINO**
Tel: (011) 74 4044
Telex: 221079
CH,E

JAPAN

Yokogawa-Hewlett-Packard Ltd.
152-1, Onna
ATSUGI, Kanagawa, 243
Tel: (0462) 28-0451
CM,C*,E
Yokogawa-Hewlett-Packard Ltd.
Meiji-Seimei Bldg. 6F
3-1 Hon Chiba-Cho
CHIBA, 280
Tel: 472 25 7701
E,CH,CS

Yokogawa-Hewlett-Packard Ltd.
Yasuda-Seimei Hiroshima Bldg.
6-11, Hon-dori, Naka-ku
HIROSHIMA, 730
Tel: 82-241-0611

Yokogawa-Hewlett-Packard Ltd.
Towa Building
2-3, Kaigan-dori, 2 Chome Chuo-ku
KOBE, 650
Tel: (078) 392-4791
C,E

Yokogawa-Hewlett-Packard Ltd.
Kumagaya Asahi 82 Bldg
3-4 Tsukuba
KUMAGAYA, Saitama 360
Tel: (0485) 24-6563
CH,CM,E

Yokogawa-Hewlett-Packard Ltd.
Asahi Shinbun Daiichi Seimei Bldg.
4-7, Hanabata-cho
KUMAMOTO, 860
Tel: (0963) 54-7311
CH,E

Yokogawa-Hewlett-Packard Ltd.
Mito Mitsui Bldg
Shin-Kyoto Center Bldg.
614, Higashi-Shiokoji-cho
Karasuma-Nishiiru
Shiokoji-dori, Shimogyo-ku
KYOTO, 600
Tel: 075-343-0921
CH,E

Yokogawa-Hewlett-Packard Ltd.
Mito Mitsui Bldg
4-73, Sanno-maru, 1 Chome
MITO, Ibaraki 310
Tel: (0292) 25-7470
CH,CM,E

Yokogawa-Hewlett-Packard Ltd.
Sumitomo Seimei 14-9 Bldg.
Meieki-Minami, 2 Chome
Nakamura-ku
NAGOYA, 450
Tel: (052) 571-5171
CH,CM,CS,E,MS

Yokogawa-Hewlett-Packard Ltd.
Chuo Bldg.,
4-20 Nishinakajima, 5 Chome
Yodogawa-ku
OSAKA, 532
Tel: (06) 304-6021
Telex: YHPOSA 523-3624
A,CH,CM,CS,E,MP,P*

Yokogawa-Hewlett-Packard Ltd.
27-15, Yabe, 1 Chome
SAGAMIHARA Kanagawa, 229
Tel: 0427 59-1311

Yokogawa-Hewlett-Packard Ltd.
Daiichi Seimei Bldg.
7-1, Nishi Shinjuku, 2 Chome
Shinjuku-ku, **TOKYO** 160
Tel: 03-348-4611
CH,E

Yokogawa-Hewlett-Packard Ltd.
29-21 Takaido-Higashi, 3 Chome
Suginami-ku **TOKYO** 168
Tel: (03) 331-611
Telex: 232-2024 YHPTOK
A,CH,CM,CS,E,MP,P*

Yokogawa-Hewlett-Packard Ltd.
Daiichi Asano Building
2-8, Odori, 5 Chome
UTSUNOMIYA, Tochigi 320
Tel: (0286) 25-7155
CH,CS,E

Yokogawa-Hewlett-Packard Ltd.
Yasuda Seimei Nishiguchi Bldg.
30-4 Tsuruya-cho, 3 Chome
YOKOHAMA 221
Tel: (045) 312-1252
CH,CM,E

JORDAN

Mouasher Cousins Company
P.O. Box 1387
AMMAN
Tel: 24907, 39907
Telex: 21456 SABCO JO
CH,E,M,P

KENYA

ADCOM Ltd., Inc., Kenya
P.O.Box 30070
NAIROBI
Tel: 331955
Telex: 22639
E,M

KOREA

Samsung Electronics HP Division
12 Fl. Kinam Bldg.
San 75-31, Yeoksam-Dong
Kangnam-Ku
Yeongdong P.O. Box 72
SEOUL
Tel: 555-7555, 555-5447
Telex: K27364 SAMSAN
A,CH,CM,CS,E,M,P

KUWAIT

Al-Khaldiya Trading & Contracting
P.O. Box 830 Safat
KUWAIT
Tel: 42-4910, 41-1726
Telex: 22481 Areeg kt
CH,E,M
Photo & Cine Equipment
P.O. Box 270 Safat
KUWAIT
Tel: 42-2846, 42-3801
Telex: 22247 Matin kt
P

LEBANON

G.M. Dolmadjian
Achrafieh
P.O. Box 165.167
BEIRUT
Tel: 290293
MP**
Computer Information Systems
P.O. Box 11-6274
BEIRUT
Tel: 89 40 73
Telex: 22259
C

LUXEMBOURG

Hewlett-Packard Belgium S.A./N.V.
Blvd de la Woluwe, 100
Woluwedal
B-1200 **BRUSSELS**
Tel: (02) 762-32-00
Telex: 23-494 paloben bru
A,CH,CM,CS,E,MP,P

MALAYSIA

Hewlett-Packard Sales (Malaysia)
Sdn. Bhd.
1st Floor, Bangunan British
American
Jalan Semantan, Damansara Heights
KUALA LUMPUR 23-03
Tel: 943022
Telex: MA31011
A,CH,E,M,P*



MAYLAISIA (Cont'd)

Protel Engineering
P.O.Box 1917
Lot 6624, Section 64
23/4 Pending Road
Kuching, **SARAWAK**
Tel: 36299
Telex: MA 70904 PROMAL
Cable: PROTELENG
A,E,M

MALTA

Philip Toledo Ltd.
Notabile Rd.
MRIEHEL
Tel: 447 47, 455 66
Telex: Media MW 649
E,P

MEXICO

Hewlett-Packard Mexicana, S.A.
de C.V.
Av. Periferico Sur No. 6501
Tepepan, Xochimilco
16020 **MEXICO D.F.**
Tel: 6-76-46-00
Telex: 17-74-507 HEWPACK MEX
A,CH,CS,E,MS,P
Hewlett-Packard Mexicana, S.A.
de C.V.
Ave. Colonia del Valle 409
Col. del Valle
Municipio de Garza Garcia
MONTERREY, Nuevo Leon
Tel: 78 42 41
Telex: 038 410
CH
ECISA
José Vasconcelos No. 218
Col. Condesa Deleg. Cuauhtémoc
MEXICO D.F. 06140
Tel: 553-1206
Telex: 17-72755 ECE ME
M

MOROCCO

Dolbeau
81 rue Karatchi
CASABLANCA
Tel: 3041-82, 3068-38
Telex: 23051, 22822
E
Gerep
2 rue d'Agadir
Boite Postale 156
CASABLANCA
Tel: 272093, 272095
Telex: 23 739
P

NETHERLANDS

Hewlett-Packard Nederland B.V.
Van Heuven Goedhartlaan 121
NL 1181KK **AMSTELVEEN**
P.O. Box 667
NL1180 AR **AMSTELVEEN**
Tel: (020) 47-20-21
Telex: 13 216 HEPA NL
A,CH,CM,CS,E,MP,P
Hewlett-Packard Nederland B.V.
Bongerd 2
NL 2906VK **CAPELLE A/D IJSSEL**
P.O. Box 41
NL 2900AA **CAPELLE A/D IJSSEL**
Tel: (10) 51-64-44
Telex: 21261 HEPAC NL
A,CH,CS,E

Hewlett-Packard Nederland B.V.
Pastoor Petersstraat 134-136
NL 5612 LV **EINDHOVEN**
P.O. Box 2342
NL 5600 CH **EINDHOVEN**
Tel: (040) 326911
Telex: 51484 hepae nl
A,CH*,E,M

NEW ZEALAND

Hewlett-Packard (N.Z.) Ltd.
5 Owens Road
P.O. Box 26-189
Epsom, **AUCKLAND**
Tel: 687-159
Cable: HEWPACK Auckland
CH,CM,E,P*
Hewlett-Packard (N.Z.) Ltd.
4-12 Cruickshank Street
Kilbirnie, **WELLINGTON 3**
P.O. Box 9443
Courtenay Place, **WELLINGTON 3**
Tel: 877-199
Cable: HEWPACK Wellington
CH,CM,E,P
Northrop Instruments & Systems Ltd.
369 Khyber Pass Road
P.O. Box 8602
AUCKLAND
Tel: 794-091
Telex: 60605
A,M
Northrop Instruments & Systems Ltd.
110 Mandeville St.
P.O. Box 8388
CHRISTCHURCH
Tel: 486-928
Telex: 4203
A,M
Northrop Instruments & Systems Ltd.
Sturdee House
85-87 Ghuznee Street
P.O. Box 2406
WELLINGTON
Tel: 850-091
Telex: NZ 3380
A,M

NORTHERN IRELAND

See United Kingdom

NORWAY

Hewlett-Packard Norge A/S
Folke Bernadottes vei 50
P.O. Box 3558
N-5033 **FYLLINGSDALEN** (Bergen)
Tel: 0047/5/16 55 40
Telex: 16621 hpnas n
CH,CS,E,MS
Hewlett-Packard Norge A/S
Østerdalen 16-18
P.O. Box 34
N-1345 **ØSTERÅS**
Tel: 0047/2/17 11 80
Telex: 16621 hpnas n
A,CH,CM,CS,E,M,P
OMAN
Khirmijil Ramdas
P.O. Box 19
MUSCAT
Tel: 722225, 745601
Telex: 3289 BROKER MB MUSCAT
P
Suhail & Saud Bahwan
P.O.Box 169
MUSCAT
Tel: 734 201-3
Telex: 3274 BAHWAN MB

PAKISTAN

Mushko & Company Ltd.
1-B, Street 43
Sector F-8/1
ISLAMABAD
Tel: 51071
Cable: FEMUS Rawalpindi
A,E,M
Mushko & Company Ltd.
Oosman Chambers
Abdullah Haroon Road
KARACHI 0302
Tel: 524131, 524132
Telex: 2894 MUSKO PK
Cable: COOPERATOR Karachi
A,E,M,P*

PANAMA

Electrónico Balboa, S.A.
Calle Samuel Lewis, Ed. Alfa
Apartado 4929
PANAMA 5
Tel: 63-6613, 63-6748
Telex: 3483 ELECTRON PG
A,CM,E,M,P

PERU

Cía Electro Médica S.A.
Los Flamencos 145, San Isidro
Casilla 1030
LIMA 1
Tel: 41-4325, 41-3703
Telex: Pub. Booth 25306
CM,E,M,P

PHILIPPINES

The Online Advanced Systems Corporation
Rico House, Amorsolo Cor. Herrera Street
Legaspi Village, Makati
P.O. Box 1510
Metro **MANILA**
Tel: 85-35-81, 85-34-91, 85-32-21
Telex: 3274 ONLINE
A,CH,CS,E,M
Electronic Specialists and Proponents Inc.
690-B Epifanio de los Santos Avenue
Cubao, **QUEZON CITY**
P.O. Box 2649 Manila
Tel: 98-96-81, 98-96-82, 98-96-83
Telex: 40018, 42000 ITT GLOBE
MACKAY BOOTH
P

PORTUGAL

Mundinter
Intercambio Mundial de Comércio
S.A.R.L.
P.O. Box 2761
Av. Antonio Augusto de Aguiar 138
P-LISBON
Tel: (19) 53-21-31, 53-21-37
Telex: 16691 munter p
M
Soquimica
Av. da Liberdade, 220-2
1298 **LISBOA** Codex
Tel: 56 21 81/2/3
Telex: 13316 SABASA
P
Telectra-Empresa Técnica de Equipamentos Eléctricos S.A.R.L.
Rua Rodrigo da Fonseca 103
P.O. Box 2531
P-LISBON 1
Tel: (19) 68-60-72
Telex: 12598
CH,CS,E,P

PUERTO RICO

Hewlett-Packard Puerto Rico
Ave. Muñoz Rivera #101
Esq. Calle Ochoa
HATO REY, Puerto Rico 00918
Tel: (809) 754-7800
Hewlett-Packard Puerto Rico
Calle 272 Edificio 203
Urb. Country Club
RIO PIEDRAS, Puerto Rico
P.O. Box 4407
CAROLINA, Puerto Rico 00628
Tel: (809) 762-7255
A,CH,CS

QATAR

Computebarbia
P.O. Box 2750
DOHA
Tel: 883555
Telex: 4806 CHPARB
P
Eastern Technical Services
P.O.Box 4747
DOHA
Tel: 329 993
Telex: 4156 EASTEC DH
Nasser Trading & Contracting
P.O.Box 1563
DOHA
Tel: 22170, 23539
Telex: 4439 NASSER DH
M

SAUDI ARABIA

Modern Electronic Establishment
Hewlett-Packard Division
P.O. Box 22015
Thuobah
AL-KHOBAR
Tel: 895-1760, 895-1764
Telex: 671 106 HPMEEK SJ
Cable: ELECTA AL-KHOBAR
CH,CS,E,M
Modern Electronic Establishment
Hewlett-Packard Division
P.O. Box 1228
Redec Plaza, 6th Floor
JEDDAH
Tel: 644 38 48
Telex: 4027 12 FARNAS SJ
Cable: ELECTA JEDDAH
CH,CS,E,M
Modern Electronic Establishment
Hewlett-Packard Division
P.O.Box 22015
RIYADH
Tel: 491-97 15, 491-63 87
Telex: 202049 MEERYD SJ
CH,CS,E,M
Abdul Ghani El Ajou
P.O. Box 78
RIYADH
Tel: 40 41 717
Telex: 200 932 EL AJOU
P

SCOTLAND

See United Kingdom

SINGAPORE

Hewlett-Packard Singapore (Sales)
Pte. Ltd.
#08-00 Inchcape House
450-2 Alexandra Road
P.O. Box 58 Alexandra Rd. Post Office
SINGAPORE, 9115
Tel: 631788
Telex: HPSGSO RS 34209
Cable: HEWPACK, Singapore
A,CH,CS,E,MS,P



SALES & SUPPORT OFFICES

Arranged alphabetically by country

SINGAPORE (Cont'd)

Dynamar International Ltd.
Unit 05-11 Block 6
Kolam Ayer Industrial Estate
SINGAPORE 1334
Tel: 747-6188
Telex: RS 26283
CM

SOUTH AFRICA

Hewlett-Packard So Africa (Pty.) Ltd.
P.O. Box 120
Howard Place **CAPE PROVINCE 7450**
Pine Park Center, Forest Drive,
Pinelands

CAPE PROVINCE 7405

Tel: 53-7954
Telex: 57-20006
A,CH,CM,E,MS,P

Hewlett-Packard So Africa (Pty.) Ltd.
P.O. Box 37099
92 Overport Drive
DURBAN 4067
Tel: 28-4178, 28-4179, 28-4110
Telex: 6-22954
CH,CM

Hewlett-Packard So Africa (Pty.) Ltd.
6 Linton Arcade
511 Cape Road
Linton Grange
PORT ELIZABETH 6000
Tel: 041-302148
CH

Hewlett-Packard So Africa (Pty.) Ltd.
P.O. Box 33345
Glenstantia 0010 **TRANVAAL**
1st Floor East
Constancia Park Ridge Shopping
Centre
Constancia Park
PRETORIA
Tel: 982043
Telex: 32163
CH,E

Hewlett-Packard So Africa (Pty.) Ltd.
Private Bag Wendywood
SANDTON 2144
Tel: 802-5111, 802-5125
Telex: 4-20877
Cable: HEWPACK Johannesburg
A,CH,CM,CS,E,MS,P

SPAIN

Hewlett-Packard Española S.A.
Calle Entenza, 321
E-BARCELONA 29
Tel: 322.24.51, 321.73.54
Telex: 52603 hpbee
A,CH,CS,E,MS,P

Hewlett-Packard Española S.A.
Calle San Vicente S/No
Edificio Albia II
E-BILBAO 1
Tel: 423.83.06
A,CH,E,MS

Hewlett-Packard Española S.A.
Crta. de la Coruña, Km. 16, 400
Las Rozas
E-MADRID
Tel: (1) 637.00.11
CH,CS,M

Hewlett-Packard Española S.A.
Avda. S. Francisco Javier, S/No
Planta 10. Edificio Sevilla 2,
E-SEVILLA 5
Tel: 64.44.54
Telex: 72933
A,CS,MS,P

Hewlett-Packard Española S.A.
Calle Ramon Gordillo, 1 (Entlo.3)
E-VALENCIA 10
Tel: 361-1354
CH,P

SWEDEN

Hewlett-Packard Sverige AB
Sunnanvagen 14K
S-22226 **LUND**
Tel: (046) 13-69-79
Telex: (854) 17886 (via Spånga
office)
CH

Hewlett-Packard Sverige AB
Östra Tullgatan 3
S-21128 **MALMÖ**
Tel: (040) 70270
Telex: (854) 17886 (via Spånga
office)

Hewlett-Packard Sverige AB
Våstra Vintergatan 9
S-70344 **ÖREBRO**
Tel: (19) 10-48-80
Telex: (854) 17886 (via Spånga
office)
CH

Hewlett-Packard Sverige AB
Skalholtsgatan 9, Kista
Box 19
S-16393 **SPÅNGA**
Tel: (08) 750-2000
Telex: (854) 17886
Telefax: (08) 7527781
A,CH,CM,CS,E,MS,P

Hewlett-Packard Sverige AB
Frötällisgatan 30
S-42132 **VÄSTRA-FRÖLUNDA**
Tel: (031) 49-09-50
Telex: (854) 17886 (via Spånga
office)
CH,E,P

SWITZERLAND

Hewlett-Packard (Schweiz) AG
Clarastrasse 12
CH-4058 **BASEL**
Tel: (61) 33-59-20
A

Hewlett-Packard (Schweiz) AG
7, rue du Bois-du-Lan
Case Postale 365
CH-1217 **MEYRIN 2**
Tel: (0041) 22-83-11-11
Telex: 27333 HPAG CH
CH,CM,CS

Hewlett-Packard (Schweiz) AG
Allmend 2
CH-8967 **WIDEN**
Tel: (0041) 57 31 21 11
Telex: 53933 hpag ch
Cable: HPAG CH
A,CH,CM,CS,E,MS,P

SYRIA

General Electronic Inc.
Nuri Basha Ahnaf Ebn Kays Street
P.O. Box 5781
DAMASCUS
Tel: 33-24-87
Telex: 411 215
Cable: **ELECTROBOR DAMASCUS**
E

Middle East Electronics
P.O. Box 2308
Abu Rumnaneh
DAMASCUS
Tel: 33 4 5 92
Telex: 411 304
M

TAIWAN

Hewlett-Packard Far East Ltd.
Kaohsiung Office
2/F 68-2, Chung Cheng 3rd Road
KAOSIUNG
Tel: (07) 241-2318
CH,CS,E

Hewlett-Packard Far East Ltd.
Taiwan Branch
8th Floor
337 Fu Hsing North Road
TAIPEI

Tel: (02) 712-0404
Telex: 24439 HEWPACK
Cable: HEWPACK Taipei
A,CH,CM,CS,E,M,P
Ing Lih Trading Co.
3rd Floor, 7 Jen-Ai Road, Sec. 2
TAIPEI 100
Tel: (02) 3948191
Cable: **INGLIH TAIPEI**
A

THAILAND

Unimesa
30 Patpong Ave., Suriwong
BANGKOK 5
Tel: 235-5727
Telex: 84439 Simonco TH
Cable: **UNIMESA Bangkok**
A,CH,CS,E,M
Bangkok Business Equipment Ltd.
5/5-6 Dejo Road
BANGKOK
Tel: 234-8670, 234-8671
Telex: 87669-BEQUIPT TH
Cable: **BUSIQUIPT Bangkok**
P

TRINIDAD & TOBAGO

Caribbean Telecoms Ltd.
50/A Jerningham Avenue
P.O. Box 732
PORT-OF-SPAIN
Tel: 62-44213, 62-44214
Telex: 235,272 HUGCO WG
CM,E,M,P

TUNISIA

Tunisie Electronique
31 Avenue de la Liberté
TUNIS
Tel: 280-144
E,P

Corema
1 ter. Av. de Carthage
TUNIS

Tel: 253-821
Telex: 12319 CABAM TN
M

TURKEY

Teknim Company Ltd.
Iran Caddesi No. 7
Kavaklidere, **ANKARA**
Tel: 275800
Telex: 42155 TKNM TR
E

E.M.A.
Medina Eldem Sokak No.4/1/6
Yüksel Caddesi
ANKARA
Tel: 175 622
Telex: 42 591
M

UNITED ARAB EMIRATES

Emitac Ltd.
P.O. Box 2711
ABU DHABI
Tel: 82 04 19-20
Cable: **EMITAC ABUDHABI**
Emitac Ltd.
P.O. Box 1641
SHARJAH
Tel: 591 181
Telex: 68136 Emitac Sh
CH,CS,E,M,P

UNITED KINGDOM

GREAT BRITAIN

Hewlett-Packard Ltd.
Trafalgar House
Navigation Road
ALTRINCHAM
Cheshire WA14 1NU
Tel: 061 928 6422
Telex: 668068
A,CH,CS,E,M,MS,P
Hewlett-Packard Ltd.
Elstree House, Elstree Way
BOREHAMWOOD, Herts WD6 1SG
Tel: 01 207 5000
Telex: 8952716
E,CH,CS,P

Hewlett-Packard Ltd.
Oakfield House, Oakfield Grove
Clifton **BRISTOL**, Avon BS8 2BN
Tel: 0272 736806
Telex: 444302
CH,CS,E,P

Hewlett-Packard Ltd.
Bridewell House
Bridewell Place
LONDON EC4V 6BS
Tel: 01 583 6565
Telex: 298163
CH,CS,P

Hewlett-Packard Ltd.
Fourier House
257-263 High Street
LONDON COLNEY
Herts. AL2 1HA, St. Albans
Tel: 0727 24400
Telex: 1-8952716
CH,CS

Hewlett-Packard Ltd.
Pontefract Road
NORMANTON, West Yorkshire WF6 1RN
Tel: 0924 895566
Telex: 557355
CH,CS,P

Hewlett-Packard Ltd.
The Quadrangle
106-118 Station Road
REDHILL, Surrey RH1 1PS
Tel: 0737 68655
Telex: 947234
CH,CS,E,P

SALES & SUPPORT OFFICES

Arranged alphabetically by country

7



GREAT BRITAIN (Cont'd)

Hewlett-Packard Ltd.
Avon House
435 Stratford Road
Shirley, SOLIHULL, West Midlands
B90 4BL

Tel: 021 745 8800
Telex: 339105
CH,CS,E,P

Hewlett-Packard Ltd.
West End House
41 High Street, West End

SOUTHAMPTON
Hampshire SO3 3DQ
Tel: 04218 6767
Telex: 477138
CH,CS,P

Hewlett-Packard Ltd.
Eskdale Rd.

Winnersh, **WOKINGHAM**
Berkshire RG11 5DZ
Tel: 0734 696622
Telex: 848884
E

Hewlett-Packard Ltd.
King Street Lane
Winnersh, **WOKINGHAM**
Berkshire RG11 5AR
Tel: 0734 784774

Telex: 847178
A,CH,CS,E,M,MP,P

Hewlett-Packard Ltd.
Nine Mile Ride
Easthampstead, **WOKINGHAM**
Berkshire, 3RG11 3LL
Tel: 0344 773100
Telex: 848805
CH,CS,E,P

IRELAND

NORTHERN IRELAND

Hewlett-Packard Ltd.
Cardiac Services Building
95A Finaghy Road South
BELFAST BT10 0BY
Tel: 0232 625-566
Telex: 747626
CH,CS

SCOTLAND

Hewlett-Packard Ltd.
SOUTH QUEENSFERRY
West Lothian, EH30 9TG
Tel: 031 331 1188
Telex: 72682
CH,CM,CS,E,M,P

UNITED STATES

Alabama

Hewlett-Packard Co.
700 Century Park South, Suite 128
BIRMINGHAM, AL 35226
Tel: (205) 822-6802
A,CH,M

Hewlett-Packard Co.
420 Wynn Drive
HUNTSVILLE, AL 35805
P.O. Box 7700
HUNTSVILLE, AL 35807
Tel: (205) 830-2000
CH,CM,CS,E,M*

Arizona

Hewlett-Packard Co.
8080 Pointe Parkway West
PHOENIX, AZ 85044
Tel: (602) 273-8000
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
2424 East Aragon Road
TUCSON, AZ 85706
Tel: (602) 889-4631
CH,E,MS**

California

Hewlett-Packard Co.
99 South Hill Dr.
BRISBANE, CA 94005
Tel: (415) 330-2500
CH,CS

Hewlett-Packard Co.
P.O. Box 7830 (93747)
5060 E. Clinton Avenue, Suite 102
FRESNO, CA 93727
Tel: (209) 252-9652
CH,CS,MS

Hewlett-Packard Co.
P.O. Box 4230
1430 East Orangethorpe
FULLERTON, CA 92631
Tel: (714) 870-1000
CH,CM,CS,E,MP

Hewlett-Packard Co.
320 S. Kellogg, Suite B
GOLETA, CA 93117
Tel: (805) 967-3405
CH

Hewlett-Packard Co.
5400 W. Rosecrans Boulevard
LAWDALE, CA 90260
P.O. Box 92105
LOS ANGELES, CA 90009
Tel: (213) 970-7500
Telex: 910-325-6608
CH,CM,CS,MP

Hewlett-Packard Co.
3155 Porter Oaks Drive
PALO ALTO, CA 94304
Tel: (415) 857-8000
CH,CS,E

Hewlett-Packard Co.
4244 So. Market Court, Suite A
P.O. Box 15976
SACRAMENTO, CA 95852
Tel: (916) 929-7222
A*,CH,CS,E,MS

Hewlett-Packard Co.
9606 Aero Drive
P.O. Box 23333
SAN DIEGO, CA 92139
Tel: (619) 279-3200
CH,CM,CS,E,MP

Hewlett-Packard Co.
2305 Camino Ramon "C"
SAN RAMON, CA 94583
Tel: (415) 838-5900
CH,CS

Hewlett-Packard Co.
3005 Scott Boulevard
SANTA CLARA, CA 95050
Tel: (408) 988-7000
Telex: 910-338-0586
A,CH,CM,CS,E,MP

Hewlett-Packard Co.
5703 Corsa Avenue
WESTLAKE VILLAGE, CA 91362
Tel: (213) 706-6800
E*,CH*,CS*

Colorado

Hewlett-Packard Co.
24 Inverness Place, East
ENGLEWOOD, CO 80112
Tel: (303) 649-5000
A,CH,CM,CS,E,MS

Connecticut

Hewlett-Packard Co.
47 Barnes Industrial Road South
P.O. Box 5007
WALLINGFORD, CT 06492
Tel: (203) 265-7801
A,CH,CM,CS,E,MS

Florida

Hewlett-Packard Co.
2901 N.W. 62nd Street
P.O. Box 24210
FORT LAUDERDALE, FL 33307
Tel: (305) 973-2600
CH,CS,E,MP

Hewlett-Packard Co.
6177 Lake Ellenor Drive
P.O. Box 13910
ORLANDO, FL 32859
Tel: (305) 859-2900
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
5750B N. Hoover Blvd., Suite 123
P.O. Box 15200
TAMPA, FL 33614
Tel: (813) 884-3282
A*,CH,CM,CS,E*,M*

Georgia

Hewlett-Packard Co.
2000 South Park Place
P.O. Box 105005
ATLANTA, GA 30348
Tel: (404) 955-1500
Telex: 810-766-4890
A,CH,CM,CS,E,MP

Hawaii

Hewlett-Packard Co.
Kawaiahao Plaza, Suite 190
567 South King Street
HONOLULU, HI 96813
Tel: (808) 526-1555
A,CH,E,MS

Illinois

Hewlett-Packard Co.
304 Eldorado Road
P.O. Box 1607
BLOOMINGTON, IL 61701
Tel: (309) 662-9411
CH,MS**

Hewlett-Packard Co.
1100 31st Street, Suite 100
DOWNERS GROVE, IL 60515
Tel: (312) 960-5760
CH,CS

Hewlett-Packard Co.
5201 Tollview Drive
ROLLING MEADOWS, IL 60008
Tel: (312) 255-9800
Telex: 910-687-1066
A,CH,CM,CS,E,MP

Indiana

Hewlett-Packard Co.
7301 No. Shadeland Avenue
P.O. Box 50807
INDIANAPOLIS, IN 46250
Tel: (317) 842-1000
A,CH,CM,CS,E,MS

Iowa

Hewlett-Packard Co.
1776 22nd Street, Suite 1
WEST DES MOINES, IA 50265
Tel: (515) 224-1435
CH,MS**

Kansas

Hewlett-Packard Co.
7804 East Funston Road, #203
WICHITA, KS 67207
Tel: (316) 684-8491
CH

Kentucky

Hewlett-Packard Co.
10300 Linn Station Road, #100
LOUISVILLE, KY 40223
Tel: (502) 426-0100
A,CH,CS,MS

Louisiana

Hewlett-Packard Co.
160 James Drive East
ST. ROSE, LA 70087
P.O. Box 1449
KENNER, LA 70063
Tel: (504) 467-4100
A,CH,CS,E,MS

Maryland

Hewlett-Packard Co.
3701 Koppers Street
BALTIMORE, MD 21227
Tel: (301) 644-5800
Telex: 710-862-1943
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
2 Choke Cherry Road
ROCKVILLE, MD 20850
Tel: (301) 948-6370
A,CH,CM,CS,E,MP

Massachusetts

Hewlett-Packard Co.
1775 Minuteman Road
ANDOVER, MA 01810
Tel: (617) 682-1500
A,C,CH,CS,CM,E,MP,P*
Hewlett-Packard Co.
32 Hartwell Avenue
LEXINGTON, MA 02173
Tel: (617) 861-8960
CH,CS,E

Michigan

Hewlett-Packard Co.
4326 Cascade Road S.E.
GRAND RAPIDS, MI 49506
Tel: (616) 957-1970
CH,CS,MS

Hewlett-Packard Co.
1771 W. Big Beaver Road
TROY, MI 48084
Tel: (313) 643-6474
CH,CS

Minnesota

Hewlett-Packard Co.
2025 W. Larpenteur Ave.
ST. PAUL, MN 55113
Tel: (612) 644-1100
A,CH,CM,CS,E,MP

Missouri

Hewlett-Packard Co.
11131 Colorado Avenue
KANSAS CITY, MO 64137
Tel: (816) 763-8000
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
13001 Hollenberg Drive
BRIDGETON, MO 63044
Tel: (314) 344-5100
A,CH,CS,E,MP



SALES & SUPPORT OFFICES

Arranged alphabetically by country

UNITED STATES (Cont'd)

Nebraska

Hewlett-Packard
10824 Old Mill Rd., Suite 3
OMAHA, NE 68154
Tel: (402) 334-1813
CM,MS

New Jersey

Hewlett-Packard Co.
120 W. Century Road
PARAMUS, NJ 07652
Tel: (201) 265-5000
A,CH,CM,CS,E,MP
Hewlett-Packard Co.
60 New England Av. West
PISCATAWAY, NJ 08854
Tel: (201) 981-1199
A,CH,CM,CS,E

New Mexico

Hewlett-Packard Co.
11300 Lomas Blvd., N.E.
P.O. Box 11634
ALBUQUERQUE, NM 87112
Tel: (505) 292-1330
CH,CS,E,MS

New York

Hewlett-Packard Co.
5 Computer Drive South
ALBANY, NY 12205
Tel: (518) 458-1550
A,CH,E,MS

Hewlett-Packard Co.
9600 Main Street
P.O. Box AC
CLARENCE, NY 14031
Tel: (716) 759-8621
CH

Hewlett-Packard Co.
200 Cross Keys Office Park
FAIRPORT, NY 14450
Tel: (716) 223-9950
CH,CM,CS,E,MS

Hewlett-Packard Co.
7641 Henry Clay Blvd.
LIVERPOOL, NY 13088
Tel: (315) 451-1820
A,CH,CM,E,MS

Hewlett-Packard Co.
No. 1 Pennsylvania Plaza
55th Floor
34th Street & 8th Avenue
MANHATTAN NY 10119
Tel: (212) 971-0800
CH,CS,E*,M*

Hewlett-Packard Co.
250 Westchester Avenue
WHITE PLAINS, NY 10604
Tel: (914) 684-6100
CM,CH,CS,E

Hewlett-Packard Co.
3 Crossways Park West
WOODBURY, NY 11797
Tel: (516) 921-0300
A,CH,CM,CS,E,MS

North Carolina

Hewlett-Packard Co.
5605 Roanne Way
P.O. Box 26500
GREENSBORO, NC 27420
Tel: (919) 852-1800
A,CH,CM,CS,E,MS

Ohio

Hewlett-Packard Co.
9920 Carver Road
CINCINNATI, OH 45242
Tel: (513) 891-9870
CH,CS,MS

Hewlett-Packard Co.
16500 Sprague Road
CLEVELAND, OH 44130
Tel: (216) 243-7300
A,CH,CM,CS,E,MS

Hewlett-Packard Co.
962 Crupper Ave.
COLUMBUS, OH 43229
Tel: (614) 436-1041
Eff: Nov. 25, 1983
675 Brooksedge Blvd.
WESTERVILLE, OH 43081
CH,CM,CS,E*

Hewlett-Packard Co.
330 Progress Rd.
DAYTON, OH 45449
Tel: (513) 859-8202
A,CH,CM,E*,MS

Oklahoma

Hewlett-Packard Co.
304 N. Meridian, Suite A
P.O. Box 75609
OKLAHOMA CITY, OK 73147
Tel: (405) 946-9499
A*,CH,E*,MS

Hewlett-Packard Co.
3840 S. 103rd E. Avenue, #100
P.O. Box 35747
TULSA, OK 74153
Tel: (918) 665-3300
A**,CH,CS,M*

Oregon

Hewlett-Packard Co.
9255 S. W. Pioneer Court
P.O. Box 328
WILSONVILLE, OR 97070
Tel: (503) 682-8000
A,CH,CS,E*,MS

Pennsylvania

Hewlett-Packard Co.
111 Zeta Drive
PITTSBURGH, PA 15238
Tel: (412) 782-0400
A,CH,CS,E,MP

Hewlett-Packard Co.
2750 Monroe Boulevard
P.O. Box 713
VALLEY FORGE, PA 19482
Tel: (215) 666-9000
A,CH,CM,E,M

South Carolina

Hewlett-Packard Co.
Brookside Park, Suite 122
1 Harbison Way
P.O. Box 21708
COLUMBIA, SC 29221
Tel: (803) 732-0400
CH,E,MS

Hewlett-Packard Co.
Koger Executive Center
Chesterfield Bldg., Suite 124
GREENVILLE, SC 29615
Tel: (803) 297-4120

Tennessee

Hewlett-Packard Co.
224 Peters Road, Suite 102
P.O. Box 22490
KNOXVILLE, TN 37922
Tel: (615) 691-2371
A*,CH,MS

Hewlett-Packard Co.
3070 Directors Row
MEMPHIS, TN 38131
Tel: (901) 346-8370
A,CH,MS

Texas

Hewlett-Packard Co.
4171 North Mesa
Suite C-110
EL PASO, TX 79902
Tel: (915) 533-3555
CH,E*,MS**

Hewlett-Packard Co.
10535 Harwin Drive
P.O. Box 42816
HOUSTON, TX 77042
Tel: (713) 776-6400
A,CH,CM,CS,E,MP

Hewlett-Packard Co.
930 E. Campbell Rd.
P.O. Box 1270
RICHARDSON, TX 75080
Tel: (214) 231-6101
A,CH,CM,CS,E,MP

Hewlett-Packard Co.
1020 Central Parkway South
P.O. Box 32993
SAN ANTONIO, TX 78216
Tel: (512) 494-9336
CH,CS,E,MS

Utah

Hewlett-Packard Co.
3530 W. 2100 South
SALT LAKE CITY, UT 84119
Tel: (801) 974-1700
A,CH,CS,E,MS

Virginia

Hewlett-Packard Co.
4305 Cox Road
GLEN ALLEN, VA 23060
P.O. Box 9669
RICHMOND, VA 23228
Tel: (804) 747-7750
A,CH,CS,E,MS

Washington

Hewlett-Packard Co.
15815 S.E. 37th Street
BELLEVUE, WA 98006
Tel: (206) 643-4000
A,CH,CM,CS,E,MP
Hewlett-Packard Co.
Suite A
708 North Argonne Road
SPOKANE, WA 99212
Tel: (509) 922-7000
CH,CS

West Virginia

Hewlett-Packard Co.
4604 MacCorkle Ave.
P.O. Box 4297
CHARLESTON, WV 25304
Tel: (304) 925-0492
A,MS

Wisconsin

Hewlett-Packard Co.
150 S. Sunny Slope Road
BROOKFIELD, WI 53005
Tel: (414) 784-8800
A,CH,CS,E*,MP

URUGUAY

*Pablo Ferrando S.A.C. e I.
Avenida Italia 2877
Casilla de Correo 370
MONTEVIDEO
Tel: 80-2586
Telex: Public Booth 901
A,CM,E,M*

VENEZUELA

Hewlett-Packard de Venezuela C.A.
3RA Transversal Los Ruices Norte
Edificio Segre 1, 2 & 3
Apartado 50933
CARACAS 1071
Tel: 239-4133
Telex: 251046 HEWPACK
A,CH,CS,E,MS,P
Hewlett-Packard de Venezuela C.A.
Calle-72-Entre 3H y 3Y, No. 3H-40
Edificio Ada-Evelyn, Local B
Apartado 2646
4001, MARACAIBO, Estado Zulia
Tel: (061) 80.304
C,E*

Hewlett-Packard de Venezuela C.A.
Calle Vargas Rondon
Edificio Seguros Carabobo, Piso 10
VALENCIA
Tel: (041) 51 385
CH,CS,P

*Bioelectronica Medica C.A.
Calle Buen Pastor
Edif. Cota Mil-Piso 2 y Semi Sotano 1
Boleita Norte
Apartado 50710 CARACAS 1050A
Tel: 239 84 41
Telex: 26518*

ZIMBABWE

*Field Technical Sales
45 Kelvin Road, North
P.B. 3458
SALISBURY
Tel: 705 231
Telex: 4-122 RH
C,E,M,P*

July 1983 5952-6900

Indicates main office

HP distributors are printed in italics.

