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PMDRV

An RSX-11M/M-Plus Device Driver for the Advanced Computer Communications ACP 5100/6100 Communications Interface

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Preface

This report is a supplement to the RSX-11M/M-Plus I/O Drivers Reference Manual [2]. It is assumed the reader is familiar with the material in Chapter 1, "RSX-11M/M-Plus Input Output," as well as the mechanics of issuing the Queue I/O system directive (QIO) [3]. In addition, it is assumed the reader is familiar with the features of the ACP 5100/6100 and its Command Interface (CIF) Message protocol, as described in the ACP 5100 User's Manual [1]. To purchase a copy, or obtain additional product information, contact the vendor at:

Advanced Computer Communications
720 Santa Barbara Street
Santa Barbara, California 93101

1 Introduction

The Advanced Computer Communications (ACC) ACP 5100 and 6100 are intelligent HDLC communications controllers for Digital Equipment Corp. (DEC) Q-bus and UNIBUS computer systems, respectively. They are capable of driving a single point-to-point synchronous line at speeds up to 1.544 Mbps (T1). Because they implement the CCITT HDLC/LAPB link-level protocol in hardware, the host system is relieved of the processing necessary to obtain reliable, end-to-end transmission of data.

Table 1 summarizes the hardware specifications for the ACP 5100 and 6100.

Table 1. ACP 5100/6100 Interface Specifications.

Type	Serial, synchronous
Interface	RS-232, RS-422, RS-423, V.35
Baud rate	1.2Kb to 2.0Mb, programmable
Data block	Up to 4KB (HDLC data area)
System bus	ACP 5100: Q-bus
	ACP 6100: UNIBUS

PMDRV is a standard RSX-11M/M-Plus device driver that provides non-DECnet access to an ACP 5100/6100 communications interface. It provides for explicit control of the packets sent over the link, allowing a task to send error-free messages to a cooperating task on another system. The driver is modeled on the ACP 5100/6100 class and port drivers supplied by ACC for VAX/VMS: UADRIVER and PMDRIVER, respectively [1].

To access an ACP 5100/6100, a task must first assign an available LUN to the appropriate PM: device. LUNs may be assigned with the Assign LUN system directive [3], at task build time [4], or with the MCR REA [5] or DCL ASSIGN/TASK commands [6]. To use the driver, the task issues QIOs to the assigned PM: device, using the I/O functions and subfunctions described in Section 3 [3].

2 Get LUN Information Macro

Word 2 of the buffer filled by the Get LUN Information system directive [3] is filled with the contents of the first device characteristics word. Table 2 describes the information returned for PM: devices. A bit setting of 1 indicates that the described characteristic is true.

Table 2. ACP 5100/6100 Device Characteristics Word 1.

Bit	Name	Setting	Meaning
0	DV.REC	0	Record-oriented device
1	DV.CCL	0	Carriage-control device
2	DV.TTY	0	Terminal device
3	DV.DIR	0	File-structured device
4	DV.SDI	0	Single-directory device
5	DV.SQD	1	Sequential device
6	DV.MSD	0	Mass storage device
7	DV.UMD	1	User-mode diagnostics supported
8	DV.EXT	0/1	Device supports 22-bit direct addressing (ACP 5100=1, ACP 6100=0)
9	DV.SWL	0	Unit software write-locked
10	DV.ISP	0	Input spooled device
11	DV.OSP	0	Output spooled device
12	DV.PSE	0	Pseudo device
13	DV.COM	0	Device mountable as a communications channel
14	DV.F11	0	Device mountable as a FILES-11 volume
15	DV.MNT	0	Device mountable

Words 3 and 4 (the second and third device characteristics words) consist of four byte fields containing the values of the ACP 5100/6100 hardware status registers and the status returned by the PMDRV unit on-line routine. These fields are shown in Table 3, along with the corresponding ACP 5100/6100 status register name in parenthesis.

Table 3. ACP 5100/6100 Device Characteristics Words 2 and 3.

Word	Byte	Meaning
2	0	ACP Version Number (S_VERS)
2	1	ACP System ID (S_ID)
3	0	ACP Diagnostics Status (S_STAT)
3	1	PMDRV unit on-line status

Table 4. ACP 5100/6100 System ID (S_ID) values.

Hex	Application
00	ACP 6000 with no firmware
01	ACP 6000 with loader capability
06	ACP 6100
08	ACP 6250
20	ACP 5000 with no firmware
21	ACP 5000 with loader capability
26	ACP 5100
28	ACP 5250

Table 5. ACP 5100/6100 Diagnostics Status (S_STAT) values.

Hex	Meaning
00	All tests completed with no errors
82	EPROM checksum test error
83	DRAM parity test error
84	DRAM parity test arror
85	DRAM error (moving inversion test)
86	DRAM error (progressive test)
87	MFP register test error
88	MFP timer test error
89	MFP counter test error
8A	SCR test error
8B	DMAC test error
8C	MPCC loopback test error
8D	MPCC/DMAC test error
FF	Fatal error detected by applications firmware

Table 6. PMDRV Unit On-Line Status Codes.

Decimal	Octal	Name	Meaning
1	1	IS.SUC	Successful completion The ACP 5100/6100 was successfully configured into the system.
-22	352	IE.CON	Connect error The CSR address specified in the Status Control Block (SCB) is incorrect (determined by accessing 16 succesive words on the I/O page, starting at the CSR address in the SCB).
-59	305	IE.FHE	Fatal hardware error An error was returned in the ACP 5100/6100 Diagnostics Status byte (S_STAT). The value is returned in the low-order byte of the third device characteristics word in the Unit Control Block (UCB) (see Table 3).
-19	355	IE.ILV	Illegal vector specified The device interrupt base address specified in the Status Control Block is not a multiple of 10 (octal).
-5	373	IE.ONP	Hardware option not present The firmware version number returned in the ACP 5100/6100 Version Number byte (S_VERS) is less than 2.1. The ACP 5100/6100 firmware should be replaced with the current version. The value is returned in the low-order byte of the second device characteristics word in the Unit Control Block (see Table 3).
-98	236	IE.SZE	Unable to size device The device type returned in the ACP hardware System ID byte (S_ID) is not supported. The value is returned in the high-order byte of the second device characteristics word in the Unit Control Block (see Table 3).

The Version Number returned by the ACP 5100/6100 (S_VERS) is encoded as a hexadecimal version number followed by a hexadecimal update number. (For example, 20 hex corresponds to firmware version number 2.0.) PMDRV requires firmware version number 2.1, or later.

The System ID returned by the ACP hardware (S_ID) identifies the firmware application. Table 4 contains the values for this field and their meanings. (See Appendix B for information about adding driver support for devices other than the ACP 5100/6100.)

The Diagnostics Status returned by the ACP 5100/6100 (S_STAT) indicates the results of the powerup diagnostic tests. Table 5 contains the values for this field and their meanings.

The values for the PMDRV unit on-line status byte and their meanings are given in Table 6.

3 Supported I/O Functions and Subfunctions

3.1 Standard I/O Functions

Table 7 lists the standard I/O functions of the QIO macro that are valid for the ACP 5100/6100.

Table 7. Standard I/O Functions for the ACP 5100/6100.

Format	Function
QIO$C IO.ATT!IQ.UMD,...	Attach device
QIO$C IO.DET[!IQ.UMD],...	Detach device
QIO$C IO.KIL,...	Cancel I/O requests
QIO$C IO.RLB[!IQ.UMD],...,<stadd, size,dpn,[tmo],,[regbuf]>	Receive message (READ logical block)
QIO$C IO.WLB[!IQ.UMD],...,<stadd, size,dpn,[tmo],,[regbuf]>	Send message (WRITE logical block)

stadd

The starting address of the data buffer (may be on a byte boundary).

size

The data buffer size, in bytes (must be greater than 0).

dpn

The data path number for the transfer.

tmo

The transfer timeout count, in seconds (0-255, 0=no timeout).

regbuf

A 40 word diagnostic register buffer.

The standard I/O functions are described in greater detail below.

3.1.1 IO.RLB and IO.WLB

Each ACP 5100/6100 appears to the system as a single line, point-to-point interface, e.g., PM0: or PM1:. Internally, the ACP 5100/6100 supports three separate data paths -- 0, 1, and 2 -- which can be used to transfer data and/or control messages.

Each data path can accept a transmit and a receive request simultaneously. Multiple requests to the same data path are internally queued in the driver, which maintains separate transmit and receive queues for each data path.

Every data transfer must include the data path number for the request in the third I/O parameter, which is specified in either relative or absolute format. Regardless of the method used to specify the data path number, a transfer request to a data path without an assigned facility is rejected. (Section 5.1 explains the relationship between data paths and facilities.)

Relative data path numbers specify a facility code number (1-15) in the high-order 4 bits, followed by a facility-relative data path number in the low-order 12 bits. The driver uses the current facility data path assignments to map relative data path numbers to absolute data path numbers.

Absolute data path numbers specify zero in the high-order 4 bits (an illegal facility code number), followed by the absolute data path number in the low-order 12 bits.

The specification of an absolute data path number, or a relative data path number specifying facility-relative data path 0 (the facility "control" path), is a privileged operation (see Section 5.3).

Data messages may be transferred in either packet mode or stream mode (see Section 5.2). Packet-mode data messages must not exceed 4KB, or the current HDLC frame size, whichever is less.

Control messages must be sent in packet mode. The response to a control message may be received in either packet mode or stream mode. Packet-mode control messages must not exceed 1KB.

3.1.2 Subfunction Bits for Standard I/O Functions

3.1.2.1 SF.TMO - The SF.TMO I/O subfunction bit enables transfer timeouts. The desired timeout value, in seconds, is supplied in the fourth I/O parameter (0=no timeout).

The timout countdown commences when the transfer request is submitted to the ACP 5100/6100. Requests queued behind the current transfer are not aged.

The driver performs timeout processing once a second on behalf of all active devices. This restricts the accuracy for any single request to plus or minus 1 second. Therefore, the timeout count specified should be at least one greater than the amount actually required.

3.1.2.2 SF.CIF - The SF.CIF I/O subfunction bit is used to distinguish data messages from control messages. Data messages to the control data paths (relative data path 0 for every assigned facility) are rejected. Control messages must adhere to the Control Interface (CIF) Message format described in Chapter 8 of the ACP 5100 User's Manual [1].

3.1.2.3 IQ.UMD - IQ.UMD is the RSX user-mode diagnostic I/O subfunction bit. If IQ.UMD is set for a data transfer function, the sixth I/O parameter must contain the address of a 40 word register buffer in writeable memory. This is required by RSX, but is not used by the driver.

The IQ.UMD subfunction bit is illegal if the device is not attached for user-mode diagnostics.

3.1.2.4 SF.DIR - SF.DIR is the direct-I/O I/O subfunction bit. If SF.DIR is set for a data transfer function, the transfer takes place directly to or from the task message buffer. If SF.DIR is clear, the message is buffered in system pool by the driver for the transfer.

NOTE

> The SF.DIR I/O subfunction is provided for compatibility with the ACC UADRIVER and PMDRIVER for VAX/VMS. It has no effect on PMDRV -- all transfers take place directly to and from the task message buffer.

3.1.2.5 SF.STR - The SF.STR I/O subfunction bit is used to distinguish stream-mode message transfers from packet-mode message transfers (see Section 5.2).

3.1.2.6 SF.EOS - The SF.EOS I/O subfunction bit is the end-of-stream indicator for stream-mode message transfers (see Section 5.2).

3.1.2.7 SF.TRG - The SF.TRG I/O subfunction bit controls whether the message buffer address is supplied to the ACP 5100/6100 at the time the request is made, or deferred until the ACP 5100/6100 is ready to perform the transfer (using the Transfer Request/Grant mailbox).

On 18-bit systems and 22-bit Q-bus systems, if SF.TRG is set for a data transfer function, the message buffer address is not supplied to the ACP 5100/6100 until it is ready for the transfer. If SF.TRG is clear, the message buffer address is supplied to the ACP 5100/6100 at the time the request is made.

On 22-bit UNIBUS systems, the SF.TRG I/O subfunction bit is ignored. Data transfers are always performed using the Transfer Request/Grant mailbox so that a single UNIBUS mapping register (UMR) can be permanently allocated to each device for mapping its DMA transfers. (The ACP 6100 performs a single DMA transfer at a time.) Buffer mapping through the assigned UMR is deferred until the ACP 6100 is ready to perform the transfer.

3.1.2.8 SF.BSW - The SF.BSW I/O subfunction bit enables byte-swapping on message transfers.

3.2 Device-Specific I/O Functions

Table 8 lists the device-specific I/O functions of the QIO macro that are valid for the ACP 5100/6100.

Table 8. Device-Specific I/O Functions for the ACP 5100/6100.

Format	Function
QIO$C IO.INL!IQ.UMD,..., <,,,,,regbuf>	Initialize (hardware reset)
QIO$C IO.STC[!IQ.UMD],..., <fac,ndp,dpn,,,[regbuf]>	Set facility characteristics
QIO$C IO.SEC[!IQ.UMD],..., <stadd,size,,,,[regbuf]>	Get device characteristics
QIO$C IO.CON[!IQ.UMD],..., <,,dpn,,,[regbuf]>	Connect to data path
QIO$C IO.DSC[!IQ.UMD],..., <,,dpn,,,[regbuf]>	Disconnect data path

stadd

The starting address of the characteristics buffer (must be word aligned).

size

The size of the characteristics buffer, in bytes (must be even and greater than 0).

dpn

The data path number for a connect or disconnect request.

fac

The facility code number for the assignment or deassignment of data paths to the facility.

ndp

The number of data paths to be assigned to the facility (ndp>0), or a request to deassign the data paths assigned to the facility (ndp=0).

regbuf

A 40 word diagnostic register buffer.

The device-specific I/O functions are described in greater detail below.

3.2.1 IO.INL!IQ.UMD

The IO.INL diagnostic I/O function is used to reset the ACP 5100/6100. A 30 second timeout (the warm-start timeout count) is used -- the operation normally completes in about 20 seconds.

The IQ.UMD user-mode diagnostic subfunction bit is required, and is the only subfunction bit allowed. The sixth I/O parameter must contain the address of a 40 word register buffer in writeable memory. This is required by RSX, but is not used by the driver.

3.2.2 IO.STC[!IQ.UMD]

IO.STC is a privileged I/O function used to assign and deassign data paths to a facility. If the number of data paths requested is zero, the request is a data path deassignment request. Otherwise, it is a data path assignment request.

For data path asssignment requests, if the facility already has data paths assigned, or if any of the requested data paths are in use by another facility, the request is rejected. For data path deassignment requests, if the facility has no data paths assigned, or if the data paths are permanently assigned to the facility (e.g., the data path Allocation facility), the request is rejected.

The facility code number is specified in the first I/O parameter, the number of data paths is specified in the second I/O parameter, and the absolute data path number of the first data path requested is in the third I/O parameter.

3.2.3 IO.SEC[!IQ.UMD]

The IO.SEC I/O function returns a buffer of information to the requesting task which contains the driver database describing the ACP 5100/6100 facility and data path assignments. (Caution: Facilities with data paths assigned in the driver are not necessarily usable; see Section 5.1.) The format of the buffer is given in Table 9.

The buffer address is in the first I/O parameter, which must be on a word boundary. The size of the buffer is in the second I/O parameter, which must be even and greater than zero. If there is not enough space in the buffer to return all the items in the table, the request is truncated to the size of the buffer supplied.

The number of data paths assigned to a facility includes a flag in the high-order bit that is set if the facility is permanently assigned. (For example, the data path Allocation facility is permanently assigned to data path 0.) The number of data paths assigned is in the low-order 12 bits.

Table 9. IO.SEC Get Characteristics Buffer Format.

Word	Contents
0	Number of facilities (N$$FAC)
1	Number of data paths (N$$DPN)
:	For each facility (1..N$$FAC):
	Number of data paths assigned (low-order 12 bits only; bit 15 is the "permanent facility" flag)
	First data path number assigned
:	For each data path (0..N$$DPN-1):
	Owning task's TCB address (only if bit 0 is clear -- bit 0 is the "data path unassigned" flag)

If a data path is unassigned, the owning task's TCB address is set to 1 (an invalid address). If a data path is assigned to a facility, but is not owned, the owning task's TCB address is set to 0. Otherwise, the data path is assigned to a facility and is connected to the task identified by the owning task's TCB address.

3.2.4 IO.CON[!IQ.UMD]

The IO.CON I/O function is used to connect a task to a data path to enable the sending and receiving of messages. If the data path is not assigned to a facility, or is already in use by another task, the request is rejected.

The data path number is supplied in the third I/O parameter using the format described in section 3.1.1.

3.2.5 IO.DSC[!IQ.UMD]

The IO.DSC I/O function is used to disconnect a task from a data path. If the data path is not owned by the task, the request is rejected.

The data path number is supplied in the third I/O parameter using the format described in section 3.1.1.

The driver implicitly issues a disconnect request for every data path owned by the task when the task exits (requires Executive I/O Rundown support), or as a result of data path deassignment (see Section 3.2.2). (Executive I/O Rundown support is a SYSGEN option on RSX-11M; it is always included in an RSX-11M-Plus system.)

3.2.6 Subfunction Bits for Device-Specific I/O Functions

3.2.6.1 IQ.UMD - IQ.UMD is the RSX user-mode diagnostic I/O subfunction bit. If IQ.UMD is set, the sixth I/O parameter must contain the address of a 40 word register buffer in writeable memory. This is required by RSX, but is not used by the driver.

The IQ.UMD subfunction bit is illegal if the device is not attached for user-mode diagnostics.

4 Status Returns

Figure 1 shows the format of the values returned in the I/O status block by the driver.

```
15              8 7              0
+----------------+----------------+
|      I/O       |      I/O       |
|   Completion   |   Completion   |
|   Substatus    |     Status     |
+----------------+----------------+
|   Number of Bytes Transferred   |
|     ( Data Transfer or     )    |
|     ( Get Characteristics )     |
+---------------------------------+
```

Figure 1. I/O Status Block Format.

For non-transfer requests, or for any requests rejected by the driver, the first word contains the I/O completion status, and the second word is zero.

For a successful get characteristics request, the second word contains the actual number of bytes written.

For data transfer requests which are completed by the ACP 5100/6100, the first word of the I/O status block contains the ACP 5100/6100 completion status (C_STATUS) and substatus (C_SBSTAT) codes.

Table 10 contains the error and status conditions returned by the driver. The meaning of the values returned by the ACP 5100/6100 are described in Tables 11 and 12. (The ACP 5100/6100 completion status codes follow the RSX convention that success codes are greater than 0, and failure codes are less than 0.) To determine if an error has been returned by the driver versus the ACP 5100/6100: the high-order byte of the first I/O status word will always be all ones (-1 decimal or 377 octal) for errors returned by the driver, but will never be all ones for errors returned by the ACP 5100/6100 (see Tables 10 and 11).

Table 10. PMDRV I/O Status Codes.

Decimal	Octal	Name	Meaning
1	1	IS.SUC	Successful completion The operation completed successfully. The second word of the I/O status block contains the number of bytes transferred for read and write operations.
0	0	IS.PND	I/O request pending The operation has not yet completed. The I/O status block is filled with zeros.
-15	177761	IE.ABO	Operation aborted The operation was cancelled by an IO.KIL request, or as a result of a hardware failure, power failure, or device reconfiguration.
-8	177770	IE.DAA	Device already attached A request was issued either to assign data paths to a facility that already had data paths assigned, or to connect to a data path that was already in use.
-7	177771	IE.DNA	Device not attached A transfer request was issued to a data path not owned by the task. A request was issued either to deassign data paths from a facility that had no data paths assigned, or to disconnect a data path that was not owned by the issuing task.
-3	177775	IE.DNR	Device not ready The device was not ready to perform the requested operation.
-9	177767	IE.DUN	Device not attachable A request was issued to deassign data paths from a permanent facility.

Table 10. PMDRV I/O Status Codes (con't).

Decimal	Octal	Name	Meaning
-92	177644	IE.IDU	Illegal device or unit A request specified an invalid facility code number or data path number.
-2	177776	IE.IFC	Illegal function A request specified an invalid I/O function code or subfunction code.
-65	177677	IE.OFL	Device off line When the system was booted, the physical device was either not in the configuration or was otherwise unusable. The ACP 5100/6100 firmware has detected a fatal error.
-16	177760	IE.PRI	Privilege violation A request specified the diagnostic I/O subfunction bit (IQ.UMD) and the device is not attached for user-mode diagnostics. A privileged request was issued and either: o The device is public, or o The requesting task does not have the privilege to perform the operation. (See Section 5.3.)
-17	177757	IE.RSU	Resource in use A request was issued to assign data paths to a facility that were already assigned to another facility.
-6	177772	IE.SPC	Illegal buffer The buffer specified for a read, write, diagnostic, or get characteristics request was partially or totally outside the address space of the issuing task.

Table 10. PMDRV I/O Status Codes (con't).

Decimal	Octal	Name	Meaning
-6	177772	IE.SPC	Illegal buffer (con't.) A request specified a packet-mode data transfer exceeding 4KB, or a CIF-format write exceeding 1KB. A request specified a zero-length buffer or an odd-length or byte-aligned characteristics buffer.
-95	177641	IE.TMO	Timeout on request The timeout count specified in a data transfer request has expired.

Table 11. ACP 5100/6100 Completion Substatus Codes (C_SBSTAT).

Binary	Meaning
00000000	No error
00000001	Configuration error
00000010	Operation timing error
00000011	(undefined, reserved)
000001rr	Address error
000010rr	Bus error
000011rr	Count error
00010000	External abort
00010001	Software abort

rr	Meaning
01	Memory address or memory counter
10	Device address
11	Base address or base counter

Table 12. ACP 5100/6100 Completion Status Codes (C_STATUS).

Decimal	Octal	Meaning
1	1	Successful completion The operation completed successfully. For stream-mode receives, EOS was specified from the ACP 5100/6100 and the write buffer has been emptied.
2	2	Successful operation A stream-mode receive request completed, but EOS has not yet been seen from the ACP 5100/6100.
-1	377	Aborted The request was aborted by the driver.
-3	375	Overrun A packet-mode receive specified a byte count that was not sufficient to hold the message transmitted.
-4	374	Transfer count zero A transfer requesting 0 bytes has been issued to the ACP 5100/6100.[1]
-5	373	DMA completion error The reason for the error is contained in the ACP 5100/6100 completion substatus (C_SBSTAT), which is in the high-order byte of the first I/O status word (see Table 11).
-7	371	Listen collision An invalid listen request was issued.[1]
-8	370	Invalid function The function specified by the driver is invalid.[1]
-9	367	Invalid DPN A request was issued to a data path number other than 0, 1, or 2.[1]

[1] Indicates a driver error -- please notify the author.

5 Programming Considerations

5.1 Data Paths and Facilities

The ACP 5100/6100 provides services through the use of agents, called facilities. Each facility has a name and a corresponding facility code number, shown in Table 13.

Table 13. ACP 5100/6100 Facilities.

No.	Facility
1	Allocation
2	Sytem
3	HDLC

To perform a data transfer, the I/O request must specify the destination data path number (DPN), and whether the message contains data or control information. The destination data path may be specified either by absolute data path number, or by relative data path number.

Absolute data path numbers are stored in the low-order 12 bits of a 16-bit word; the high-order 4 bits must be zero. Relative data path numbers are stored with the facility code number in the high-order 4 bits, and the relative data path number in the low-order 12 bits. The use of absolute data path numbers and "control" data paths (relative data path 0) requires privilege, as explained in Section 5.3.

The ACP 5100/6100 is a shareable resource, but data paths are not. Before a data path can be used, a task must "connect" to it using the IO.CON I/O function code (see Section 3.2.4). Furthermore, a data path must have a facility "assigned" to it before a task can connect to it (see Section 3.2.2).

Data paths are assigned by sending control messages to the Allocation facility. Since the Allocation facility is required in order to assign data paths to facilities, it is permanently assigned by the ACP 5100/6100 firmware to (absolute) data path 0.

Facility control and status information is obtained by sending and receiving messages to and from the facility "control" data path. Facility data services, if applicable, are obtained by sending and receiving messages to and from facility "data" data paths.

The ACP 5100/6100 requires that the facility "control" data path be assigned before any "data" data paths can be assigned. By convention, the first data path assigned to a facility (relative data path 0) is the "control" data path, and any subsequently assigned data paths are "data" data paths.

The assignment of data paths to facilities is static, i.e., it survives controller resets, etc. However, this does not imply that the facility is active (i.e., currently usable) -- that is the responsibility of the owner of the facility "control" data path (relative data path 0).

Figure 2 illustrates the relationship between facilities, data paths, and tasks. Tasks A and B are privileged "monitor" tasks. Task A is responsible for the overall health of the ACP 5100/6100, while task B is responsible for monitoring the status of the HDLC link. Task C is the application task, which communicates with a corresponding partner, task C' (not shown), across the HDLC link. The Allocation facility (facility code number 1) is permanently assigned to data path 0 and the HDLC facility (facility code number 3) is currently assigned to data paths 1 and 2 -- data path 1 is the HDLC "control" data path and data path 2 is the HDLC "data" data path.

```
      +------+  +------+  +------+
      |  A*  |  |  B*  |  |   C  |  Task (*privileged)
      +------+  +------+  +------+
     /       \ |      | /      /
    /         \|      |/      /
   +-----------+------+------+
   |    1:0    |  3:0 |  3:1 |     Relative DPN
   |     0     |   1  |   2  |     Absolute DPN
   +-----------+------+------+
   |           |\      \      \
   |            \ \     \      \
   +-------------+ +-----+------+
   | Allocation* | |    HDLC    |  Facility (*permanent)
   +-------------+ +-----+------+
                          \
                           \
                       HDLC Link
```

Figure 2. Example Facility and Data Path Assignments.

5.2 Packet-Mode and Stream-Mode Transfers

Message transfers take place in one of two modes, packet mode or stream mode, as specified by the I/O subfunction modifier bit, SF.STR (see Section 3.1.2.5).

In packet mode, transmits and receives are paired one-for-one. The receive buffer must be large enough to fully contain the transmitted message. If it is not large enough, it is filled to capacity, and the data overrun error is returned in the completion status byte (C_STATUS) for both the sender and receiver (see Table 12).

In stream mode, the data path is a sequential stream of bytes with buffer boundaries removed. Transmits and receives no longer are paired one-for-one -- one receive can span multiple transmits, and one transmit can span multiple receives. However, the transmitting task can force a boundary in the stream by setting the end-of-stream (EOS) I/O subfunction bit, SF.EOS, on the IO.WLB request. When the EOS is encountered, the current receive request is completed, even if the byte count specified on the IO.RLB request is not satisfied.

Overruns cannot occur in stream mode. The completion status on the receive request indicates whether the receive completed on an EOS boundary (see Table 12). If the receive completes with EOS indication, the completion byte count is not necessarily equal to the request byte count. However, when the receive completes with no EOS indication, the completion byte count always equals the request byte count. For transmits, the completion byte count always equals the request byte count.

A message may be transmitted in packet mode and received in stream mode. In that case, the end of the packet is treated as an EOS.

5.3 Privileges

User-mode diagnostic operations, e.g., IO.ATT and IO.INL (and the ACP 5000/6000 loader-specific I/O functions described in Appendix B), require exclusive use of the device. Normally, all PM: units are set PUBLIC for shareable access, which prevents them from being allocated to a specific terminal or from being attached for user-mode diagnostics. Before user-mode diagnostic operations can be performed, a privileged user must remove the PUBLIC attribute from the PM: unit by issuing the MCR command SET /NOPUB=PMn: or the DCL command SET DEVICE PMn:/NOPUBLIC. An attach for user-mode diagnostics request will then be granted, provided the issuing task satisfies the privilege criteria described below.

Other operations, e.g., IO.STC, and any requests specifying an absolute data path number or relative data path 0, require that the issuing task satisfy the following privilege tests:

1. The device must be non-shareable (i.e., not PUBLIC), and

2. The requesting task must be either:

   a. A privileged task, or
   b. Run from a privileged terminal, or
   c. Run from the terminal which owns the device (i.e., has issued the MCR command ALL PMn: or the DCL command ALLOCATE PMn:).

Any task may freely issue connect, disconnect, transmit and receive I/O requests, provided the IQ.UMD user-mode diagnostics I/O subfunction bit is clear, and only relative data path numbers greater than 0 are specified.

5.4 Powerfail Recovery

If a power failure occurs, and RSX is able to successfully recover (requires Executive Powerfail Recovery support), the driver will reset the ACP 5100/6100 and complete pending requests with an abort status (IE.ABO). All data path connections are severed, but the facility data path assignments are not, as was mentioned in Section 5.1. (Executive Powerfail Recovery support is a SYSGEN option on RSX-11M; it is always included in an RSX-11M-Plus system.)

The task which owns the facility control path (relative data path 0) is usually responsible for restoring the operation of the facility and notifying any application tasks so they can retry any incomplete operations. The $PWRUP system directive [3] may be called to obtain notification of powerfail recovery. Alternatively, the facility control task may leave a read pending on the control path, which will complete with an abort status if the power fails or if a fatal hardware error is encountered.

6 Acknowledgements

I would like to thank Mr. Lars Poulsen of Advanced Computer Communications for his invaluable assistance in providing timely and knowledgeable answers to my many questions, for his patience in explaining the complexities of the ACP 5100 to a novice user of the device, and for making every conversation so pleasurable.

7 References

[1] Advanced Computer Communications, 1987, ACP 5100 User's Manual: Part no. 1500051, Advanced Computer Communications, Santa Barbara, California.

[2] Digital Equipment Corp., 1985, RSX-11M/M-Plus I/O Drivers Reference Manual: Order no. AA-FD09A-TC, Digital Equipment Corp., Maynard, Massachusetts.

[3] Digital Equipment Corp., 1985, RSX-11M/M-Plus and Micro/RSX Executive Reference Manual: Order no. AA-FR95A-TC, Digital Equipment Corp., Maynard, Massachusetts.

[4] Digital Equipment Corp., 1983, RSX-11M/M-Plus and Micro/RSX Task Builder Manual: Order no. AA-AB46A-TC, Digital Equipment Corp., Maynard, Massachusetts.

[5] Digital Equipment Corp., 1985, RSX-11M/M-Plus MCR Operations Manual: Order no. AA-FD10A-TC, Digital Equipment Corp., Maynard, Massachusetts.

[6] Digital Equipment Corp., 1985, RSX-11M/M-Plus Command Language Manual: Order no. AA-FD04A-TC, Digital Equipment Corp., Maynard, Massachusetts.

APPENDIX A

PMDRV I/O Functions and Subfunctions

Table A-1. PMDRV I/O Function Codes.

Decimal	Octal	Half-Word Octal	Name
0	000000	000 000	IO.KIL
256	000400	001 000	IO.WLB
512	001000	002 000	IO.RLB
768	001400	003 000	IO.ATT
1024	002000	004 000	IO.DET
1280	002400	005 000	IO.INL
1344	002500	005 100	IO.STC
1360	002520	005 120	IO.SEC
1536	003000	006 000	IO.CON
1792	003400	007 000	IO.DSC
2056	004010	010 010	IO.BLS
2160	004160	010 160	IO.WPD
2168	004170	010 170	IO.RPD

Table A-2. PMDRV I/O Subfunction Bits.

Decimal	Octal	Name
1	001	SF.TMO
2	002	SF.CIF
4	004	IQ.UMD
8	010	SF.DIR
16	020	SF.STR
32	040	SF.EOS
64	100	SF.TRG
128	200	SF.BSW

APPENDIX B

PMDRV Installation

B.1 Executive Prerequisites

PMDRV is a loadable driver with a loadable data base -- a resident version of the driver cannot be generated from the sources supplied. The driver assembly code checks for the Executive conditional assembly symbol L$$DRV and generates an assembly-time error if it is not defined. PMDRV always declares itself loadable by defining LD$PM=0.

Since loadable driver support also requires a mapped target system, PMDRV does not support unmapped systems. (There is no additional test for the Executive conditional assembly symbol M$$MGE.) However, PMDRV is conditionalized to support 18-bit and 22-bit RSX-11M systems; RSX-11M-Plus systems are always 22-bit systems.

PMDRV makes extensive use of the PDP-11 Extended Instruction Set (EIS). The driver assembly code checks for the Executive conditional assembly symbol R$$EIS and generates an assembly-time error if it is not defined.

The top of the interrupt vector area in the Executive must be set high enough to allow for two device interrupt vectors at the selected base interrupt vector address. The default base interrupt vector addresses in Table B-1 cannot be used if the standard top address is used (400 octal). If the base interrupt vector address exceeds the top of the Executive interrupt vector area, the controller on-line request will fail (either the RSX-11M MCR LOA command or the RSX-11M-Plus CON ONLINE command).

B.2 Device Data Base

The ACP 5100/6100 hardware CSR address is selected using on-board switch packs and must match the CSR address in the device data base. The hardware base interrupt vector address is programmable and is loaded using the interrupt vector address in the device data base.

Table B-1. Default ACP 5100/6100 Device Configuration Values.

Symbol	Meaning
P$$M11	The number of ACP 5100 and/or ACP 6100 communications interfaces generated into the system (named PM0:, PM1:, etc.). Default: P$$M11=1.
PMcCSR	The CSR address for controller "c", where c is A for the first controller, B for the second controller, etc. (The DEC standard controller alphabet is A, B, C, D, E, F, H, J, K, L, M, N, P, R, S, T.) Each ACP 5100/6100 occupies 16 words on the I/O page, starting with the CSR. Default: PMACSR=167000, PMBCSR=167040, PMCCSR=167100, PMDCSR=167140.
PMcVEC	The base interrupt vector address for controller "c" (must be a multiple of 10 octal). Each ACP 5100/6100 uses two consecutive interrupt vectors. Default: PMAVEC=400, PMBVEC=410, PMCVEC=420, PMDVEC=430.

Several conditionals are provided for tailoring the device data base. These are typically defined in an assembly prefix file, PMPre.mac, not in the driver source files, PMDrv.mac and PMTab.mac. For a single ACP 5100 or ACP 6100 at the standard factory address, PMPre.mac can be eliminated or simply be an empty file. If multiple devices are required, or if the default values given in Table B-1 are unsuitable, PMPre.mac must be edited to supply the desired values.

B.3 MCR Commands

To assemble and link PMDRV (assuming, for example, the source code is placed in SY:[100,10]), enter the following MCR commands:

```
>SET /NONAMED
>SET /UIC=[100,10]
>LBR ACPDef/cr:24.:::Macro=ACPDef
>MAC PMDrv,PMDrv/-sp=LB:[1,1]ExeMC/ml,[11,10]RSXMC/pa:1,-
->SY:[100,10]ACPDef/ml,PMPre,PMDrv
>MAC PMTab,PMTab/-sp=LB:[1,1]ExeMC/ml,[11,10]RSXMC/pa:1,-
->SY:[100,10]ACPDef/ml,PMPre,PMTab
>TKB
TKB>PMDrv/-mm/-hd,PMDrv/-sp,PMDrv=PMDrv,PMTab
```

```
TKB>LB:[1,54]RSX11M.stb/ss,[1,1]ExeLib/lb
TKB>/
Enter Options:
TKB>Stack=0
TKB>Par=DRVPAR:120000:20000
TKB>//
```

To load PMDRV into the DRVPAR partition, enter the following MCR commands:

```
>SET /UIC=[1,54]
>PIP LB:/nv=[100,10]PMDrv.tsk,PMDrv.stb
>LOA PM:
```

On RSX-11M-Plus, the devices must be brought on line with the following MCR commands:

```
>CON ONLINE PMA,PM0:
>CON ONLINE PMB,PM1:
> :
```

The ACP 5100/6100 takes about 20 seconds to complete its internal self-tests following the RSX-11M LOA command or the RSX-11M-Plus CON ONLINE command.

B.4 PMDRV Variants

PMDRV attempts to support two variants of the ACP 5100/6100: the ACP 5250/6250 and the ACP 5000/6000 with firmware loader. These devices may be supported by the driver in addition to, or instead of, the ACP 5100/6100. By default, if none of the conditionals in Table B-2 are defined, the driver supports only the ACP 5100/6100. If any other devices are supported, then support for the ACP 5100/6100 is not automatically included, and must be manually selected for support, if required.

B.4.1 ACP 5250/6250 Support

If PM$250 is defined, the HDLC facility is permanently assigned to all legal data paths (0-65) on an ACP 5250/6250.

Table B-2. PMDRV Optional Device Support.

Symbol	Meaning
PM$100	Driver support for the ACP 5100/6100. Default: If no other devices are supported, PM$100=0; otherwise, PM$100 is undefined.
PM$250	Driver support for the ACP 5250/6250. Default: PM$250 is undefined.
PM$LDR	Driver support for the ACP 5000/6000 with firmware loader. Default: PM$LDR is undefined.
N$$DPN	Number of data paths per controller (at least 3). Default: N$$DPN=3.
N$$FAC	Number of facilities per controller (at least 3). Default: N$$FAC=3.

B.4.2 ACP 5000/6000 with Firware Loader Support

If PM$LDR is defined, the additional device-specific I/O functions in Table B-3 are valid for an ACP 5000/6000 with firmware loader.

Table B-3. Device-Specific ACP 5000/6000 Loader I/O Functions.

Format	Function
QIO$C IO.WPD!IQ.UMD,...,<stadd, size,,addlo,addhi,regbuf>	Write microprocessor memory
QIO$C IO.RPD!IQ.UMD,...,<stadd, size,,addlo,addhi,regbuf>	Read microprocessor memory
QIO$C IO.BLS!IQ.UMD,..., <,,,addlo,addhi,regbuf>	Start microprocessor

stadd

The starting address of the microprocessor memory data buffer.

size

The data buffer size, in bytes (must be greater than 0).

addlo

The low-order 16 bits of the 24-bit ACP 5000/6000 microprocessor memory address.

addhi

The high-order 8 bits of the 24-bit ACP 5000/6000 microprocessor memory address.

regbuf

A 40 word diagnostic register buffer.

B.4.2.1 IO.RPD!IQ.UMD and IO.WPD!IQ.UMD

The IO.RPD and IO.WPD diagnostic I/O functions read from and write to the front-end microprocessor memory of an ACP 5000/6000 with firmware loader. The driver supplies a 30 second timeout for each transfer.

The data buffer is specified in the first I/O parameter, which must be in read/write memory, even if it is used exclusively for writing, and must be on a word boundary. The number of bytes is in the second I/O parameter, which must be even and greater than zero. The memory data must be in the format expected by the ACP 5000/6000 firmware loader.

The 24-bit microprocessor memory address is provided in the fourth and fifth I/O parameter words. The high-order 8 bits of the 32-bit address are ignored, but should be specified as zero for compatibility with any future expansion to 32-bit addressing.

The IQ.UMD user-mode diagnostic subfunction bit is required, and is the only subfunction bit allowed. The sixth I/O parameter must contain the address of a 40 word register buffer in writeable memory. This is required by RSX, but is not used by the driver.

B.4.2.2 IO.BLS!IQ.UMD

The IO.BLS diagnostic I/O function instructs the ACP 5000/6000 firmware loader to start execution of the front-end microprocessor at the address specified in the fourth and fifth I/O parameters. A 30 second timeout (the warm-start timeout count) is used. Following a succesful initialization interrupt, the unit on-line routine in the driver is called to attempt to recognize the new application.

The IQ.UMD user-mode diagnostic subfunction bit is required, and is the only subfunction bit allowed. The sixth I/O parameter must contain the address of a 40 word register buffer in writeable memory. This is required by RSX, but is not used by the driver.

B.4.3 Loadable Applications Support

PMDRV contains a table of supported devices, labeled DEVTBL (shown below), which contains an extra entry, labeled $DT6XX, when PM$LDR is defined.

```
DEVTBL:                          ; Supported System IDs table

        .Macro  ACPDev  DType,PermDP
        .Byte   DType,PermDP-PRMTBL
        .EndM   ACPDev

.IIf DF PM$100, ACPDev  DT$610,PRM100    ; ACP 5100/6100
.IIf DF PM$250, ACPDev  DT$625,PRM250    ; ACP 5250/6250
        .If DF  PM$LDR
        ACPDev  DT$6LD,PRMLDR    ; ACP 5000/6000 w/loader
                                 ; Slot for downloaded System ID:
$DT6XX::ACPDev  -1,PRMLDR        ; ACP 5XXX/6XXX
        .EndC   ; DF PM$LDR

        .Word   0                ; End of table
```

To prepare the driver for a new application, $DT6XX may be patched to define a new System ID and optionally point to a new permanent facility data paths table. When the application is committed to ROM, DEVTBL should be modified to define it permanently, using the ACPDev macro.

For example, the following task builder option will define a new System ID, numbered 5, that uses the same data path allocation scheme as the ACP 5100/6100:

```
        TKB>GblPat=PMDRV:$DT6XX:5
```

B.5 Miscellaneous Conditionals

Three other conditionals are used in the driver: CLASS, DEBUG, and MBXOPT.

The CLASS conditional is intended to configure the driver to support a class (i.e., facility) driver interface in addition to the port driver interface supplied by PMDRV. However, this has not yet been implemented, so this conditional should not be defined.

The DEBUG conditional adds additional sanity checks and console outpu to the driver for use during debugging. This conditional should no defined for normal driver operation.

The MBXOPT conditional causes the interrupt "a" fork routine to pol all ACP 5100/6100 mailboxes until no more work can be performed. I then waits for another interrupt "a". Also, code is added to th interrupt "a" service routine to eliminate the transition to for level if no mailboxes require service (i.e., the work has already bee done). If MBXOPT is undefined, the driver behaves exactly as the AC PMDRIVER for VAX/VMS, which polls all three mailboxes once pe interrupt. This conditional is permanently defined in the drive source code for optimal performance.

B.6 Distribution

Readers interested in obtaining a machine-readable copy of the ACP 5100/6100 device driver may contact the author at:

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