HEWLETT PACKARD

HP7974A, HP7978A/B

HP7979A,

HP7980A, HP7980XC

HP-IB INTERFACE

PROTOCOL SPECIFICATIONS

Revision 6.55

Hewlett Packard

Greeley Storage Division

print date: May 8, 1989

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1-1. INTRODUCTION

This manual provides information on the HP7974A, HP7978A/B, HP7979A, HP7980A, and HP7980XC magnetic tape drives. These drives belong to the Hewlett-Packard family of half-inch streaming tape products. They provide backup and data interchange for medium to high-speed applications. Interface to the Host is through the Hewlett-Packard Interface Bus (HP-IB) as described within this manual.

1-2. PRODUCT OPERATION

For information on physical specifications, operation, trouble shooting, operator diagnostics, and tape management, refer to the following manuals:

Manual P.N.	Description
07974-9000	The HP 7974A Magnetic Tape Subsystem Operator's Manual
07978-9000	The HP 7978 Magnetic Tape Subsystem Operator's Manual
07980-9000	The HP 7979A/7980A/7980XC Tape Drive User's Guide.

1-3. PRODUCT DIFFERENCES

Figure 1-1 lists the major differences in the products which determine their date capacity, performance, and any other additional features.

	PRODUCT				
SPECIFICATION	HP7974A	HP7978A	HP7978B	HP7979A	HP7980
R/W Density	1600 PE (800 NRZI option)	6250 GCR 1600 GCR	6250 GCR 1600 PE	1600 PE (800 NRZI option)	(XC option) 6250 GCR 1600 PE (800 NRZI option)
Operating mode	Streaming Start/stop	Streaming	Streaming	Streaming	Streaming
R/W Speed	100 IPS (50IPS S/S)	75 IPS	75 IPS	125 IPS	125 IPS
Rewind Speed	200 IPS	250 IPS	250 IPS	up to 400 IPS	up to 400 IPS
Reposition time	329 MS (7.6MS S/S)	738 MS	738 MS	1600 MS	1600 MS
Data Buffer	32 Kbytes	32 Kbytes	256 Kbytes	512 Kbytes	512 Kbytes
Queue size	20 blocks	20 blocks	75 blocks	250 blocks	250 blocks
Max record size	16 Kbytes	16 Kbytes	60 Kb GCR 32 Kb PE	60 Kbytes	60 Kbytes
DIAGNOSTIC SUPPORT	7978 compatible	7978 compatible	7978 compatible	7980 compatible	7980 compatible

800 NRZI is available on a dual-density option for the HP7974A and HP7979A

800 NRZI is available on a tri-density option for the HP7980A

XC (extra capacity) is a high capacity option for the HP7980

FIGURE 1-1

1-4. TAPE COMMAND DIFFERENCES

Figure 1-2A and 1-2B lists the differences in tape command support. Tape commands which operate identically on ALL products are NOT shown in these figures.

COMMAND SUPPORT BY PRODUCT

TAPE COMMAND	HP7974A	HP7978A	HP7978B	HP7979A	HP7980
#14 Rewind-offline	YES	YES	YES	YES (a)	YES (a)
#15 Set Data Compressed density	(b)	(b)	(b)	NO (f)	YES (d,e,f)
#16 Set 6250 GCR density	(c)	YES	YES	(c)	YES (e)
#17 Set 1600 PE density	YES	YES	YES	YES (e)	YES (e)
#18 Set 800 NRZI	YES (d)	(c)	(c)	YES note (d,e)	YES note (d,e)
#19 Set 6250 GCR no-compress dens.	(b)	(b)	(b)	NO (f)	YES (f)

NOTES

(a) - Rewind offline may be configured to unload the tape after the rewind is complete.

(b) - Command reject, invalid command (error #24)

(c) - Command reject, density not available (error #7)

(d) - YES only if the density option is available, else (c)

(e) - The density ID is NOT written to tape until a Write record, write tape mark, or write gap command is received. The density in the status bytes will not be updated until one of the above mentioned command is received and completed.

(f) - Early versions of the 7979/7980A do not respond properly to this command. Use this command with an HP7980XC only.

FIGURE 1-2A

COMMAND SUPPORT BY PRODUCT

TAPE COMMAND	HP7974A	HP7978A	HP7978B	HP7979A	HP7980
#20 Set Start/stop mode	YES	YES (a)	YES (a)	YES (a)	YES (a)
#21 Enable streaming mode	YES	YES (a)	YES (a)	YES (a)	YES (a)
#25 Remote load	(b)	(b)	YES	YES	YES
#26 Remote unload	(b)	(b)	YES	YES	YES
#28 Remote online	(b)	(b)	(b)	YES	YES
#30 Disable data compression	(b)	(b)	(b)	YES (c)	YES (c)
#31 Enable data compression	(b)	(b)	(b)	YES (c)	YES (c)

NOTES

(a) - This command will do nothing, and return good status.

(b) - Command reject, invalid command (error #24)

(c) - If data compression is not available, or the data compression density is not set for this tape, this command will do nothing, and return good status.

FIGURE 1-2B

1-5. STATUS DIFFERENCES

Figure 1-3 lists the differences in status conditions returned by the drives.

STATUS OR CONDITION	PRODUCT				
	HP7974A	HP7978A	HP7978B	HP7979A	HP7980
HP-IB Amigo ID (configurable) <XC only config>	0174H	0178H	0178H	0179H (0174H)	0180H (0178H) <0181H>
Long record support bit (status byte #2)	not set	not set	SET	SET	SET
density bits (status byte #2 and #3)	Updated when a tape is loaded and whenever a set format command is accepted.			Updated when a tape is loaded, and after the drive has completed the first write operation on a tape.	
Unknown density bit (status byte #2)	Set only when the density of the current tape is unknown or nonsupported. No other density bits are set at the same time.			Also set in conjunction with the GCR format bit to indicate a data compressed tape ONLY when a hard error is also being reported	
Door open condition	Aborts command, sets door open bit and door open error code #55	sends transparent status to host with door open bit set. No error will occur from a door open condition.		Aborts command, sets door open bit and door open error code #55	Aborts command, sets door open bit and door open error code #55

Note : On the HP7979A and HP7980 the operator does not have access to the tape path cover (top door) unless the unit is physically pulled out of the rack.

FIGURE 1-3

1-6. DIAGNOSTIC SUPPORT DIFFERENCES

Figure 1-4 lists the differences in diagnostic function support. Diagnostic functions which are common to all products are NOT shown in this figure.

DIAGNOSTIC FUNCTION	PRODUCT				
	HP7974A	HP7978A	HP7978B	HP7979A	HP7980
RUN SELF TEST	LISTEN SECONDARY 31 and 1 byte of test number			LISTEN SECONDARY 29 and 5 bytes of params	
RETURN SELF-TEST RESULTS	TALK SECONDARY 31 returns 2 bytes of status			TALK SECONDARY 29 returns 5 bytes	
WRITE FIRMWARE UPDATE	LISTEN SECONDARY 6 followed by firmware update			NOT SUPPORTED	
READ FIRMWARE UPDATE	TALK SECONDARY 6 returns firmware update			TALK SECONDARY 6 returns NVRAM	
READ FIRMWARE IDS **	NOT SUPPORTED			TALK SECONDARY 4 returns ROM ids	

** Only available on firmware 6.00 and later

For more information on diagnostic test parameters and status results see:

The HP7974/7978 Diagnostic ERS

The HP7979/7980 Diagnostic ERS

FIGURE 1-4

1-7. PROTOCOL DIFFERENCES FROM HP7976A

The 7974, 7978, 7979, and 7980 family products use a new interface protocol. The interface protocol was leveraged from the protocol of the 7976A tape drive. The major differences between the 7976A tape drive protocol are as follows:

- Explicit command queuing is NOT supported.

- An immediate response mode is implemented. This mode must be used to get good performance from the drive during write operations. Support of immediate response mode includes enable and disable immediate response mode commands, an immediate response status bit, transparent status reports (to report soft or hard errors in immediate response mode), and a request status tape command to verify completion of immediate reported writes.

- An optional parameter has been added to the tape command sequence.

- The write record sequence contains a parallel poll prior to reading the DSJ.

- A sixth byte has been added to the device status. The definitions of some status bytes are also different.

- Two bytes of diagnostic self test status are used instead of one. The 7979 and 7980 products return five bytes of diagnostic self test status using a different secondary command.

- Transparent status reports to inform the host that the tape drive cannot complete an operation because the tape path door is open.

- The 800 NRZI density is supported by a new "set NRZI density" command, and a NRZI density status bit.

- The Data compression is supported by a new "set Data compressed density" command.

- Two tape speed commands have been added to give a host some control over 7974A's dual speeds. These commands are "set start stop mode" and "enable streaming".

- Read backwards is not supported by any drive.

- Selective diagnostic self tests are available.

- CRC's are supported over the HP-IB by an ABI chip. The use of CRCs is optional, and all CRC checking and error recovery shall be done by the host.

- New host diagnostics for reading diagnostic status logs, running downloaded diagnostics, and updating the drive's firmware.

1-8. HP-IB ABBREVIATIONS

The following abbreviations are used throughout this document.

---------- primary address commands ----------		
MTA	- MY TALK ADDRESS	address of device selected to talk.
MLA	- MY LISTEN ADDRESS	address of device selected to listen.
UNL	- UNLISTEN	unaddresses all listeners on bus.
UNT	- UNTALK	unaddresses any talker on bus.
---------- secondary address commands ----------		
MSA	- MY SECONDARY ADDRESS	secondary talk or listen address interpreted by an AMIGO device as a command.
---------- addressed commands ----------		
SDC	- SELECTED DEVICE CLEAR	resets all devices on bus addressed to listen.
---------- universal commands ----------		
DCL	- DEVICE CLEAR	resets all devices on bus.
---------- other HP-IB functions ----------		
DAB	- DATA BYTE	data byte sent over bus.
EOI	- END OR IDENTIFY	interface line used to indicate the last byte in a data transfer. (also used with the attention line to conduct a parallel poll).
IFC	- INTERFACE CLEAR	interface line used to unaddress all devices on the bus.

2-1. PARALLEL POLL (Service Request)

The tape drive interface assumes a dedicated fundamental address of 0 thru 7 (selected through the front panel) and asserts the corresponding request-for-service line DIO 8 thru 1 for a parallel poll request by the host. The following conditions result in a service request by the drive, i.e. Parallel Poll response asserted:

* Power Restored - The tape drive has been powered up or just recovered from a power failure.

* Offline to Online Sequence - The tape drive has just gone online and has been enabled for parallel poll assertion by the appropriate 'End' command.

* Rewind-Offline command acknowledgment. No Parallel Poll response will be asserted upon completion of a this command.

* Write Record data transfer request. The tape drive is ready to accept the write record data, or the write record command has been rejected.

* Immediate response acknowledgment to the following commands while in immediate response mode:
  - Write record, write file mark, or write gap

* Completion of any tape command (except for rewind-offline and immediate responsed write commands mentioned above).

* Transparent status message available. This includes the door open status (7978 only), and soft or hard error status on immediate response write commands.

* Completion of a Run Self Test command.

* Completion of the write phase of the HP-IB Loopback sequence.

* Completion of a Downloaded Diagnostic Test.

* Completion of a Write Firmware Update sequence.

* Any condition requiring a parallel poll response within the 7970E cold load sequence.

* Error conditions that occur during the command processing. This includes protocol errors.

* Device Clear command from the interface.

2-2. SERIAL POLL (SRQ)

No Serial Poll capabilities will be provided. Parallel poll responses are issued to request service from the host.

2-3. SECONDARY ADDRESSES

Following an address to talk or address to listen message, a secondary address is typically sent to the tape drive. The secondary address message is used to specify the meaning of data bytes sent from the host when the device is addressed to listen, or to select the information to be returned to the host when the device is addressed to talk. Any data transfer to or from the device must be qualified by the appropriate secondary address. Figures 8-2 and 8-3 represent the available command and status specifications for the tape drives. After completion of a data transfer the device should be unaddressed with the appropriate unlisten or untalk commands.

2-4. INTERFACE CLEAR (IFC)

This command is used only to unlisten or untalk the HP-IB interface. It is not used to reset any of the tape drive hardware. If a complete reset of the drive's interface is desired--hardware and firmware--the IFC must be followed by a Selected Device Clear (or Device Clear).

2-5. DEVICE CLEAR (DCL/SDC)

These commands are used to initialize the tape drive to a predefined state. There are three device clear commands which can be issued by the Host computer:

1) Device Clear Secondary - When addressed to listen, a secondary of 16 (decimal) is a device clear instruction. This secondary must be followed by a data byte which specifies the reset mode for the device. No action is performed by the drive on receipt of the data byte or this device clear sequence.

2) Device Clear (DCL) - This primary command causes the device clear action to be performed.

3) Selected Device Clear (SDC) - This primary performs the same function as DCL. The only difference is that the drive must be addressed to listen in order to recognize the SDC.

The device clear action will bring the drive into a known state. The drive's protocol will be restarted, the internal command and report queues will be purged, and the data buffer will be cleared. The device clear action will not affect the current tape position or tape status, nor the online status. This action occurs only upon receipt of the DCL or SDC primary bus commands.

2-6. AMIGO IDENTIFY

The ABI chip on tape drive's interface board handles the Amigo Identify function entirely transparent to the drive's controller. This function returns a two byte identity code (see Figure 8-1). All the tape drives return the same peripheral class byte (01) but return different sub class bytes.

The sequence of HP-IB messages is as follows:

```
UNL/IFC
MLA [host]
MTA [31]
MSA [drive's address]
DAB (Identify bytes sent by device)
DAB tagged with EOI                          (see Figure 8-1)
MTA [host]
```

2-7. CYCLICAL REDUNDANCY CHECKING (CRC)

The tape drive's interface will utilize the ABI chip which will automatically generate a CRC for all data transfers. When the drive is addressed to listen and given a secondary address of 17 (decimal) the ABI chip will clear its CRC generator. When the drive is addressed to talk and given a secondary address of 17 (decimal) the ABI chip will send as data bytes the contents of the CRC generator. This will be done in a two byte sequence. The first byte will be the most significant byte of the CRC remainder. The second byte be be the least significant byte of the CRC remainder tagged with an EOI. The host system will be responsible for checking the validity of this CRC. The use of this CRC capability is purely optional.

The HP-IB message sequence for clearing the CRC generator is as follows:

```
UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
MSA [CLEAR CRC]                    (Figure 8-2)
UNL
```

The HP-IB message sequence for reading the CRC generator is as follows:

```
UNL/IFC (if the drive was previously a listener)
MTA [drive's address]
MSA [READ CRC]                     (Figure 8-3)
DAB (CRC - MSB)
DAB tagged with EOI (CRC - LSB)
UNT/IFC
```

The following represents the general software/HP-IB requirements for interfacing to the tape drives.

3-1. DEVICE CLEAR (RESET)

This command is used to reset the drive to a given known state. Either a Device clear (DCL) or a Selected Device Clear (SDC) may be used with or without a Amigo clear secondary. The Amigo clear secondary and data are ignored by the tape drive.

The following sequence includes the Amigo clear secondary and data byte:

```
UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
MSA [AMIGO DEVICE CLEAR] (Figure 8-2)
DAB  tagged with EOI
DCL or SDC
UNL
```

The following sequence does not include the Amigo clear secondary and data byte:

```
UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
DCL or SDC
UNL                          (only necessary with SDC)
```

The two primaries, DCL and SDC, can occur at any point in the communication between the host and device. The secondary can occur at any point in the protocol except during an HP-IB data transfer.

Following is the message protocol for a device clear sequence:

```
Device Clear Command (as shown above)

Service Request by tape drive

READ DSJ                  (see section 3-6)
READ STATUS (optional) (see section 3-7)
END "IDLE"  (optional - enables online parallel poll)
                          (see section 3-9)
```

3-2. POWER ON

When power is first applied to the drive it comes up in a reset state. The DIO line corresponding to the device's fundamental address will be asserted for Parallel Poll response. The host should acknowledge the device's request. The Parallel Poll response (Request-for-Service) is cleared by the device when the DSJ is read.

Following is the power-on HP-IB message sequence:

```
Service Request by tape drive (poweron parallel poll)

Identify (optional)
READ DSJ     ( = 1 )          (see section 3-6)
READ STATUS (not optional)  (see section 3-7)
READ SELF TEST RESULTS (optional)
END "IDLE"     (optional - enables online parallel poll)
                            (see section 3-9)
```

The host is encouraged to insert an Identify command in the above power on sequence. This will insure the host that the device being powered up is supported.

3-3. ONLINE

If the online parallel poll has been enabled by a previous END "IDLE" or END "COMPLETE-IDLE" command, the drive will request service when the operator has pressed the online button after a tape has been loaded.

The HP-IB message sequence to respond to the online parallel poll is:

```
Service Request by tape drive (online parallel poll)

READ DSJ                    (see section 3-6)
READ STATUS (optional)      (see section 3-7)
END "IDLE"  (optional - re-enables the online parallel poll)
                            (see section 3-9)
```

The online parallel poll function must be re-enabled in order for the drive to request service the next time it comes online.

3-4. TRANSPARENT STATUS

Transparent status requests allow the tape drive to report conditions independent of a pending command. This request includes reporting a door open condition, and reporting soft and hard error status on immediate response write commands.

Transparent status is distinguished by a DSJ of two.

Transparent status can occur only at the following points within the protocol:

- the report message of any tape command.
- the report message prior to a write record data transfer.
- the report message prior to a read record data transfer.

It is important to note that when a transparent message is received while waiting for a report message, the driver must wait for another parallel poll until a non-transparent status message is received.

3-5. TAPE COMMAND

In order to issue commands to the tape drive must first be addressed to listen. After the listen address has been sent to the drive, the next message expected is a secondary address command (see Figure 8-2) specifying a tape command message. This is followed by a byte representing the actual tape command for the device (Figure 8-4), and an optional parameter byte. The command bytes include unit select, density select, read, write, and all tape motion commands.

The HP-IB message sequence is:

```
UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
MSA [TAPE COMMAND]          (Figure 8-2)
DAB (tape command)    tagged with EOI if no parameter
     is specified           (Figure 8-4)
DAB (parameter) tagged with EOI  (this byte is optional)
UNL/IFC
```

3-6. READ DSJ

To read the DSJ, the interface must be placed in talk mode then the proper secondary is issued (see Figure 8-3). The drive will then return one byte which is a zero indicating no status change, a one indicating that status should be read, and a two indicating a transparent status message.

The HP-IB message sequence is as follows:

```
UNL/IFC (if the drive was previously a listener)
MTA [drive's address]
MSA [READ DSJ]            (Figure 8-3)
DAB  tagged with EOI  (DSJ sent by device, Figure 8-7 and 8-8)
UNT
```

3-7. READ STATUS

To read the status, the interface must be placed in the talk mode and then the proper secondary issued (see Figure 8-3). The drive will return with 6 status bytes (see Section 6-3 or Figure 8-6 for a description of each status byte).

The HP-IB message sequence is as follows:

```
UNL/IFC (if the drive was previously a listener)
MTA [drive's address]
MSA [READ STATUS]          (Figure 8-3)
DAB                      .
DAB ( Status bytes       .
DAB   sent by drive ) .    (Figure 8-6)
DAB
DAB                      .
DAB tagged with EOI      .
UNT/IFC
```

3-8. READ BYTE COUNT

The tape drive's interface allows the host to obtain the number of bytes of data read from or written to the tape. The host obtains the byte count by placing the interface in talk mode, issuing the proper secondary (see Figure 8-3) and handshaking two bytes of information. The first byte represents the most significant byte of the binary count, while the second byte represents the least significant byte. This byte count is available on both read record and write record. For all other commands this register will be zero.

The HP-IB message sequence is as follows:

```
UNL/IFC (if the drive was previously a listener)
MTA [drive's address]
MSA [READ BYTE COUNT]    (Figure 8-3)
DAB (MSB of byte count)
DAB  tagged with EOI (LSB of byte count)
UNT
```

3-9. END COMMAND

The end commands give the host some control over tape drive's interface and assist in protocol coordination between the host and the drive. The End Command consists of an address to listen, followed by a secondary (Figure 8-2), then a data byte indicating the type of end (see Figure 8-5).

The HP-IB message sequence is as follows:

```
UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
MSA [END COMMAND]        (Figure 8-2)
DAB tagged with EOI (Figure 8-5)
UNL
```

3-10. READ DATA FROM TAPE

In order to read data from the tape a read record command is issued. The drive will immediately validate this request. At this time the command can be rejected due to a device reject (drive not online or tape not identified), a protocol error (previous command pending), or due to a self test failure. The command can also fail at this time due to a controller or other hardware error.

If there were no command validation errors the drive will initiate reading from the tape. Data from the tape will be placed in the data buffer. Data transfer to the host will not begin until the entire record is successfully read into the buffer without a read error. If a read error occurs the drive will automatically retry the record until the data is read successfully, 7 retries are attempted, or a hard error occurs.

The drive will assert a parallel poll response when the data is ready to be transferred or when failure status is available. Upon this request the host should read the DSJ. If an error has occurred such that no data is available the DSJ will be 1. The following conditions will cause this DSJ to be set to 1: end of file, command rejected (as described above), tape runaway, unrecovered data, position unrecovered, formatter error, servo error, or controller error. After a DSJ of one the host should read status and terminate the read sequence with an end complete command.

However, if the DSJ is 0, then the host can put the interface into the talk mode and issue the read execute secondary in order to transfer data. The data is transferred and an EOI is asserted with the last byte of data on the bus. Data will be transferred in block mode only, that is, as a single stream of data, with no parallel poll responses given to allow data bursting. The host may terminate the data transfer at any time by sending an END "DATA" command.

Following the data transfer the must request the DSJ. The following conditions will cause the DSJ to be set to 1: beyond EOT, recovered error check, data parity error, protocol error, data timing error, HPIB command parity error, position unrecovered, formatter error, servo error, controller error, or nonzero retry count. Following the DSJ the host may optionally request status and the byte count. The read record sequence must be terminated with an END "COMPLETE" command.

Following a successful read, the drive will attempt a readahead to help maintain streaming. Readaheads transfer data records following the current tape position into the data buffer until a command is received, the data buffer is filled, a read error occurs, EOT is detected, or two consecutive file marks are read. Status for the readahead is keep in a readahead queue. Readaheads do not affect the current tape position or status. If a read command is received, the next record is taken directly from the data buffer. If a forward space record command is received, one record is skipped in the buffer. if a forward space file command is received, records are skipped in the data buffer until the readahead queue points to a tape mark, or the queue is empty. If the readahead queue is not empty, and a command other than a read or forward space command is encountered, the readahead queue is purged and the tape repositioned to the top of the readahead queue.

The HP-IB message sequence required to perform read record is:

```
TAPE COMMAND [Read Record]      (see section 3-5)

Service Request by tape drive   <------------------------+
                                                         |
READ DSJ                                                 |
      If DSJ of two then a read status should be         |
      issued, followed by an END "COMPLETE". The         |
      host should then wait for another service          |
      request from the drive.                 ----------+

READ STATUS - optional
       If DSJ of one then no read data is available
       and this sequence should be terminated with
       an END "COMPLETE".

CLEAR CRC - optional
MTA [drive's address]
MSA [READ EXECUTE]          (Figure 8-3)
DAB (Data Record
 :   read from
DAB  Tape,tagged with EOI)
UNT
END "DATA" - optional
READ CRC - optional
READ DSJ
          Status should be read if the DSJ = 1.
READ STATUS - optional
READ BYTE COUNT - optional
END "COMPLETE" or "COMPLETE-IDLE"
```

3-11. WRITE DATA TO TAPE

In order to write data to the tape the host first issues a write record command. This command should include the optional parameter byte. The parameter should contain (byte count -1) DIV 256. This parameter will allow the tape drive to issue a parallel poll response as soon as there is sufficient room in its data buffer. If the optional parameter byte is not specified, then a 16k byte record is assumed.

The drive will immediately validate the write record request. At this time the command can be rejected due to a device reject (write protected, drive not online, or tape not identified), due to a protocol reject (improper command sequence, record size larger than buffer size), or due to a self test failure. The command can also fail at this time due to a HP-IB command parity error or a controller error. A read DSJ is then performed by the host. The DSJ will be set to 1 for the above error conditions and the host should then read status and terminate with an END "COMPLETE" command.

If there are no errors then the DSJ will be set to 0. The host should then address the drive to listen and issue the secondary command in order to send the data to be written. If the tape is stopped the drive will wait until a complete data record has been received. If the tape is moving the drive will start writing the record as soon as the tape is in position, to help maintain streaming. If a data underrun occurs, the drive will reposition the tape to the beginning of the record, wait for the entire record to be received, and then continue as if the tape had been initially stopped. If an error other than a hardware or servo error occurs in the write, the record will be automatically retried by the drive.

Record sizes of up to 32K in PE and 60K in GCR are supported. The last byte of data must always be tagged with an EOI.

If the drive is in immediate response mode a parallel poll response will be asserted as soon as the drive is capable of accepting another command, otherwise the drive will assert a parallel poll response after the data record has been written and verified or when failure status is available. At this time the DSJ will be set to 1 on the following conditions: beyond EOT, recovered error check, command reject (protocol reject), unrecovered error, data parity error, data timing error, HPIB command parity error, position unrecovered, formatter error, servo error, controller error, or nonzero retry count. Following the read DSJ the host may read status and byte count. The write record sequence must be terminated with an END "COMPLETE" command.

The HP-IB message sequence required to perform write record is:

```
TAPE COMMAND [Write Record, optional record size parameter]
                                          (see section 3-5)

Service Request by tape drive    <----------------------+
                                                        |
READ DSJ                                                |
      If DSJ of two then a read status should be        |
      issued, followed by an END "COMPLETE". The        |
      host should then wait for another service         |
      request from the drive.                 ----------+

READ STATUS - optional
     If the DSJ is one then the write sequence
     should be terminated here with an END "COMPLETE".

CLEAR CRC - optional

MLA [drive's address]
MSA [WRITE EXECUTE]      (Figure 8-2)
DAB (Data Record
 :   to be written to
DAB  Tape, tagged with EOI)
UNL

READ CRC - optional

Service Request by tape drive    <----------------------+
                                                        |
READ DSJ                                                |
      If DSJ of two then a read status should be        |
      issued, followed by an END "COMPLETE". The        |
      host should then wait for another service         |
      request from the drive.                 ----------+

READ STATUS - optional

READ BYTE COUNT - optional

END "COMPLETE" or "COMPLETE-IDLE"
```

3-12. MOTION AND CONTROL COMMANDS

The motion and control commands all use the same protocol format. The HP-IB message sequence for sending a tape command was described above. The protocol sequence below applies to the following tape commands: write file mark, write gap, forward space record, backspace record, forward space file, backspace file, rewind, rewind and go offline, set GCR format, set PE format, set NRZI format, set data compressed format, set GCR non-compressed format, set start/stop mode, enable streaming mode, enable immediate response mode, disable immediate response mode, request status, enable data compression, disable data compression, remote load, remote unload, and remote online.

Upon receiving a motion or density command the drive will immediately validate the request. For all commands except the rewind - offline command, the drive will assert a parallel poll response after the completion of the command or when failure status is available (Although in immediate response mode write file mark and write gap are exceptions). For the rewind-offline command, the drive will assert a parallel poll response after command validation. The parallel poll response should cause the host to read the DSJ which will be set in accordance to the need to read status.

For all of these commands the following conditions will cause a DSJ of 1: command rejected (drive not online), protocol reject (improper command sequence, indistinguishable command byte, or command pending), HPIB command parity error, position unrecovered, formatter error, servo error, controller error, self test failure, or recovered error. Additional conditions which will cause the DSJ to be 1, and additional causes of the command rejected error are described below on a command dependent basis.

- Write File Mark and Write Gap.

  The DSJ will be additionally set to 1 for beyond EOT, unrecovered error, or nonzero retry count. The command rejected error will occur due to device reject if write protected or the tape is not identified.

- Forward Space Record and Forward Space File.

  The DSJ will be additionally set to 1 for end of file (on forward space record only), unrecovered error, beyond EOT, or tape runaway. The command rejected error will occur due to device reject if the tape is not identified.

- Backspace Record and Backspace File.

  The DSJ will be additionally set to 1 for end of file (on backspace record only), or tape runaway. The end of file (on backspace record only) and tape runaway The command rejected error will occur due to device reject if the tape is not identified, or the tape is already at BOT.

- Rewind and Rewind-Offline.

  No additional conditions.

- Set GCR format, set PE format, set NRZI format, and set data compressed format

The DSJ will additionally be set to 1 for unrecovered error. The command rejected error will occur due to device reject if write protected, the tape is not at BOT, or the requested density is not supported or the density option is not present.

- Start/Stop and Enable Streaming commands.

No additional conditions.

- Disable and Enable Immediate Response commands.

No additional conditions.

- Request status.

No additional conditions.

The HP-IB message sequence required to perform a motion or density operation is:

```
TAPE COMMAND [desired motion or density command]
                          (see section 3-5)

Service Request by tape drive    <----------------------+
                                                        |
READ DSJ                                                |
      If DSJ of two then a read status should be        |
      issued, followed by an END "COMPLETE". The        |
      host should then wait for another service         |
      request from the drive.                 ----------+

READ STATUS      - optional

END "COMPLETE" or "COMPLETE-IDLE"
```

3-13. COLD LOAD SEQUENCE

The tape drive's Cold Load Sequence is compatible with the 7970E HP-IB Cold Load Sequence. Data transfer for the 7970E read is done in burst mode (64 bytes per burst).

The following sequence enters the drive into the 7970E cold load mode:

```
UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
MSA  [TAPE COMMAND]                          (Figure 8-2)
DAB tagged with EOI, 7970 Unit Select,       (figure 8-4)
UNL

Service Request by tape drive

READ DSJ (can be repeated)
READ STATUS (7970 type status; 3 bytes) optional
```

After 7970 mode is entered, reads and forward-space-blocks may be done using the following protocol sequences:

```
    UNT/IFC
+-> TAPE COMMAND [Forward Space Record]
|   Service Request by tape drive
|   READ DSJ (can be repeated)
+-- READ STATUS (7970 type status; 3 bytes) optional
                                  *

    TAPE COMMAND [Read Record]
+-> Service Request by tape drive
|   READ DSJ (can be repeated)
|   READ STATUS (7970 type status; 3 bytes) optional
|                                 *
|   MTA [drive's address]
|   MSA [READ EXECUTE]        (Figure 8-3)
|   DAB
|    .   (data burst, 64 bytes without EOI, or
|   DAB   1 to 64 bytes with the last byte
|   DAB   tagged with an EOI at end of record)
+--  (loop back for more if no EOI yet)
    END [(data = 4, 19, or 21 decimal)]
    READ BYTE COUNT (optional)
    Service Request by tape drive
    READ DSJ (can be repeated)
    READ STATUS (7970 type status; 3 bytes) optional
```

Note: * means the protocol can revert to native protocol here with a Select Unit 0 command.

DIAGNOSTIC SUPPORT REQUIREMENTS

Extensive diagnostics are supported by the tape drives to help verify correct operation, or locate faults if failures occur.

4-1. HP-IB LOOPBACK

In order to assure correct operation of the HP-IB communication link (ABI and data buffer), all data bytes are received by the interface from the host, stored internally in the data buffer and echoed back to the host when requested to do so. Detection of "stuck" data or control lines as well as a faulty ABI or data buffer is possible by exercising the I/O system at normal operating speeds. The Amigo recommended data patterns result in a complete exercising of 13 of the 16 HP-IB signal lines. Internally the loopback operation exercises the ABI, bus transceivers, data buffer, handshake logic and buffer memory, all at operating speed. The Loopback test fails if data bytes are not of the correct sequence. It must be noted that the Loopback information stored in the buffer must be read back before it is destroyed with Read or Write commands. This loopback test is only one part of a complete diagnostic test strategy. See the Diagnostic ERS for information on other tests.

The HP-IB message sequence is as follows:

```
UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
MSA [WRITE HP-IB LOOPBACK] (Figure 8-2)
DAB (256 bytes with the following bit patterns
 :   377,000,001,002,.....,376 (octal)
DAB  tagged with EOI)
UNL

Service Request by tape drive

READ DSJ (optional) (If DSJ=1,sequence can be terminated
                     with End-complete.)
MTA [drive's address]
MSA [READ HP-IB LOOPBACK] (Figure 8-3)
DAB (256 bytes returned to user.
 :   Byte 256 is tagged with EOI)
DAB
UNT
```

4-2. SELF TEST

There are three ways in which self tests are initiated:

1) The operator selects a diagnostic self test while the drive is offline. At the completion of this self test the front panel will indicate pass or fail. If the test has failed then the front panel display will show a diagnostic failure message. No interactions will occur with the host.

2) The Host program can initiate selective self tests with the run self test command. (See Figure 8-11 for information on self test numbers).

The HP-IB message sequence is as follows:

```
UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
MSA [RUN SELF TEST]       (Figure 8-2)
DAB tagged with EOI (self test number, table 9)
UNL
Service Request by tape drive
READ DSJ ( zero if test passed )

READ SELF TEST STATUS (optional, shown below)

          MTA [drive's address]
          MSA [READ SELF TEST STATUS] (Figure 8-3)
          DAB
          DAB tagged with EOI (test results, Figure 8-12)
          UNT
```

3) At Power-up the tape drive will perform a power-on self test sequence. A parallel poll will be asserted after the sequence is complete. Self test status may be requested by the host upon receiving power-up status. If the drive's status does not indicate successful completion of this self test the tape drive can not be used for normal operations. The results of this self test will also be displayed on the front panel.

4-3. DIAGNOSTIC DOWNLOAD AND EXECUTION

The tape drives allow the host to download diagnostic test routines and read back the test results.

The HP-IB protocol for downloaded diagnostics is as follows:

```
      UNT/IFC  (if the drive was previously a talker)
+-->  MLA [drive's address]
|     MSA  [DOWNLOAD DIAGNOSTIC TEST]  (Figure 8-2)
|     DAB
|      :       data for test routine
|      :
|     DAB      tagged with EOI
|     UNL
|     Service Request by tape drive (when test complete)
|     READ DSJ
|     READ STATUS (optional)
|     MTA [drive's address]
|     MSA [READ DIAGNOSTIC RESULTS]  (Figure 8-3)
|     DAB
|      :       results from test
|      :
|     DAB      tagged with EOI
|     UNL
+---  Optional END "IDLE"
```

Downloaded diagnostics are product specific, and require knowledge of the drive internals to generate.

4-4. READ LOG

For diagnostic purposes a host can access the drives' internal log. For information on the contents of this log see the Diagnostic ERS. To read the status log the interface is placed in the talk mode and then the proper secondary is issued (see Figure 8-3). The drive will then return the entire status log.

The read status log request sequence of HP-IB messages is:

```
UNL/IFC (if the drive was previously a listener)
MTA [drive's address]
MSA [READ STATUS LOG]    (Figure 8-3)
DAB
DAB ( tape drive's diagnostic log )
DAB
 :
 :
DAB   tagged with EOI
UNT/IFC
```

4-5. WRITE FIRMWARE UPDATE

The HP 7978B / 7974A's firmware allow for updating by placing changes in their EEPROM. This can be done by an operator via a firmware update tape, or remotely by the host. For information on the format of the firmware update see the Diagnostic ERS. To send a remote firmware update the interface is placed in the listen mode and then the proper secondary (Figure 8-2) is issued followed by the firmware update record. Write firmware update is not supported by either the HP 7979A or 7980.

The write firmware update sequence of HP-IB messages is:

```
UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
MSA [WRITE FIRMWARE UPDATE]  (Figure 8-2)
DAB
DAB   (Firmware update record to be
 |       loaded into EEPROM        )
 |
DAB  tagged with EOI
UNL/IFC

Service Request by tape drive (when update complete)
```

4-6. READ FIRMWARE UPDATE

The HP 7978B / 7974A allow their firmware update code to be read by the host. For information on the format of this code see the Diagnostic ERS. To read the firmware update the interface is placed in the listen mode and then the proper secondary (Figure 8-3) is issued. The drive will return with the current firmware update record. Firmware updates are not supported by either the HP 7979A or 7980, but this secondary is used to return the entire NVRAM (non-volatile RAM) which contains logs and configuration information.

The sequence of HP-IB messages is:

```
UNL/IFC (if the drive was previously a listener)
MTA [drive's address]
MSA [READ FIRMWARE UPDATE]  (Figure 8-3)
DAB
 |       (Firmware update record
 |          sent by drive       )
DAB
DAB  tagged with EOI
UNT/IFC
```

4-7. READ FIRMWARE IDS (HP7980XC)

For diagnostic purposes a host can access the drives' ROM IDs. The first byte returned contains the number of controllers, the second byte is not used, and the following bytes are four-byte controller entries. The first byte of the controller entry contains the controller ID, the second byte contains the ROM version, the third byte contains the ROM revision, and the last byte contains the controller FRU number. To read the firmware IDs the interface is placed in the talk mode and then the proper secondary is issued (see Figure 8-3). The drive will then return the firmware ID information. This command is also supported on the HP7979A and HP7980A with firmware revisions 6.00 or above.

The read firmware IDS request sequence of HP-IB messages is:

```
UNL/IFC (if the drive was previously a listener)
MTA [drive's address]
MSA [READ FIRMWARE IDS]     (Figure 8-3)
DAB
DAB ( tape drive's firmware IDs )
DAB
 :
 :
DAB   tagged with EOI
UNT/IFC
```

IMMEDIATE RESPONSE SUPPORT

Immediate response reporting of write operations provides an effective way to get good performance from a streaming mode device without the need for command queuing. Readaheads are a method to get good performance on read and move operations without the need for command queuing. These two features will be described below.

5-1. IMMEDIATE RESPONSE ON WRITES

Immediate response mode allows for immediate reporting of Write Record, Write File Mark, and Write Gap commands. An Immediate report is given if the command was accepted, the tape is not beyond end of tape, and there is room in the internal command queue for the next command. If the command once executed has a soft or hard error then a transparent status message will be sent to the host.

The use of immediate response mode is highly encouraged to get good performance from the drive. The only caution needed while using immediate response is that the utility issue a request status command after completing the last write to make sure that there is no outstanding failure status.

5-2. READAHEADS

Once a read or move operation is successfully completed a readahead will be performed. During a readahead, data from the tape is read and placed in the data buffer. Read and forward move requests by the host are taken directly from the readahead report queue. For more information see section 3-10.

The functions performed and status returned for the computer, as implemented within the drive, are described here. See tables 4 thru 5 for a complete summary of available command functions. See Figure 8- 6 thru 7 for available status information.

6-1. COMMAND REGISTER

VALUE (decimal)

0 = Select unit 0

This command selects logical tape drive "0". This is the only unit supported. This command is only needed to exit the Cold Load sequence.

1 = Select cold load unit 0

This command causes the drive to enter the Cold Load sequence. Refer to the section above entitled Cold Load Sequence for details about the use of this command.

2 = Reserved

3 = Reserved

4 = Reserved

5 = Write record

This command allows the user to write a data record to the tape. Refer to the section above entitled Write Data to Tape for details about the use of this command.

6 = Write file mark (EOF)

This command causes a File Mark to be written on tape. Refer to the section above entitled Motion and Control Operations for details about the use of this command. The EOF bit in the status word is set to 1 (not causing a DSJ of 1) to confirm this operation.

7 = Write gap

This command allows the user to forward space and erase approximately 3.5 inches of tape. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

8 = Read record

This command is used to transfer data from the tape to the host. Refer to the section above entitled Read Data from Tape for details about the use of this command.

9 = Forward space record

When this command is received by the drive, the tape is moved in the forward direction until the next interblock gap is detected. If an EOT is encountered tape motion will continue. No data is transferred during this operation. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

10 = Backspace record

When this command is processed by the drive, the tape is moved in the reverse direction until the next interblock gap is detected. If the tape is position beyond EOT at the completion of this operation, the beyond EOT status bit will be set. This condition will not cause the DSJ to be set to one. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

11 = Forward space file

When this command is processed by the drive, the tape is moved in the forward direction until an end of file mark is detected. If this operation is successful the tape will be "logically" positioned following this end of file mark. If an EOT is encountered tape motion will continue. No data is transferred during this operation. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

12 = Backspace file

When this command is processed by the drive, the tape is moved in the reverse direction until an end of file mark is detected. If this operation is successful the tape will be "logically" positioned in front of this end of file mark. If the tape is position beyond EOT at the completion of this operation, the beyond EOT status bit will be set. This condition will not cause the DSJ to be set to one. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

13 = Rewind

This command causes the transport to rewind the tape until Load Point (Beginning-of-Tape) is detected. The tape is then re-identified and then positioned logically after the tape identification burst. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

14 = Rewind and go offline

Similar to Rewind except that the drive will go offline. Note, however, that this is unlike the 7976 HP-IB command which takes the unit off-line and unloads the tape. After the receipt of this command, a Parallel Poll response is issued for acknowledgment. No Parallel Poll response is issued at the completion of this command. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

15 = Set data compressed GCR (6250 BPI) format

This command sets the density of tape to be written as data compressed 6250 GCR. This command is only accepted by the HP 7980 with the data compression option, and all other tape drives will return an error on this command. The HP 7980 will not write the density ID until an actual write command is received. The format of the tape will be 6250 GCR with identification records written after BOT to indicate that the tape contains compressed data. A write format command must be sent in order to write on a unidentified tape. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

16 = Set GCR (6250 BPI) format

This command sets the density of tape to be written as 6250 GCR. On the HP 7978 the density ID is written immediately, whereas the HP 7980 will not write the density ID until an actual write command is received. This command will be rejected by HP 7974A and 7979A. A write format command must be sent in order to write on a unidentified tape. On the HP 7980 with the data compression option, compression will be set based on the front panel compression configuration. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

17 = Set PE (1600 BPI) format

This command sets the density of tape to be written as 1600 PE. On the HP 7974A and 7978 the density ID is written immediately, whereas the HP 7979A and 7980 will not write the density ID until an actual write command is received. A write format command must be sent in order to write on a unidentified tape. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

18 = Set NRZI (800 BPI) format

This command sets the density of tape to be written as 800 NRZI. This command is only accepted by the HP 7974A or HP 7979A with the dual density option or the HP 7980A with the tri-density option. The HP 7974A will write the density ID immediately (which is actually an erasure); however, the HP 7979A and HP 7980A will not write the density ID until an actual write command is received. A write format command must be sent in order to write on a unidentified tape. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

19 = Set GCR (6250 BPI) non-compressed format

This command sets the density of tape to be written as 6250 GCR. It is only valid on the HP 7980 tape drive. It overrides any front panel selection of data compression, forcing a 6250 GCR interchange format tape. The HP 7980 will not write the density ID until an actual write command is received. This command will be rejected by HP 7974A, 7978A, and 7979A. A write format command must be sent in order to write on a unidentified tape. Refer to the section above entitled Motion and Control Operations for details about the use of this command.

20 = Start/Stop mode

This command selects start/stop operation only. Streaming operation will be disabled. This mode can be cleared with an Enable Streaming command. This command is valid for the HP 7974A only, and all other drives will perform no operation upon the receipt of the this command.

21 = Enable streaming

This command allows a drive to select between start/stop or streaming mode to improve performance. This selection is done on an adaptive basis by an automatic speed selection algorithm. This command is valid for the HP 7974A only, and all other drives will perform no operation upon the receipt of the this command.

22 = Disable immediate response mode

This command disables immediate reporting of write operations. The report for a write operation will nit be issued until it is completed.

23 = Enable immediate response mode

This command allows the drive to issue immediate reports on write operations to improve performance. The report for a write operation can be issued prior to the actual completion of the command. Any soft or hard errors on the write will be reported thru a transparent status message.

24 = Request status

This command returns the current status of the drive. The response to this command will not be issued until all outstanding immediate reported writes have completed.

25 = Remote load

This command will cause the tape to be re-tensioned. On the HP 7978B the tape must be threaded, and On the HP 7979A and 7980 the front tape door must be closed before this command will succeed. All other drives do not support this command.

26 = Remote unload

This command will cause the tape to be unloaded. On the HP 7978B the tape is unthreaded, and on the HP 7979A and 7980 the tape is unthreaded and the front tape door is opened. All other drives do not support this command.

28 = Remote online

This command will cause the tape to go online. The tape must be loaded before this command will succeed. This command is only supported by the HP 7979A and 7980.

30 = Disable data compression

This command disables the use of the data compression hardware while writing a data compressed tape. The tape format is still data compressed, but the records are written with 1 to 1 compression. This command is useful if the host expects the data to expand. If the tape is non compressed this command will not cause an error. This command is accepted by the HP 7980 (and the HP7979A), all other drives will reject this command.

31 = Enable data compression

This command allows the drive to use the data compression hardware while writing a data compressed tape. If the tape is non compressed this command will not cause an error. This command is accepted by the HP 7980 (and the HP7979A), all other drives will reject this command.

6-2. END COMMANDS

The end command gives the host some control over the protocol. Any one bit or combination of the bits of this register may be asserted.

DIO 1 : 1 = Clear parallel poll response.
0 = No action

Valid for Cold Load Only. This bit is used to programmatically clear the Parallel Poll response issued by a device. PP responses are also cleared automatically whenever a DSJ is requested by a user. The DSJ will not be affected by the assertion of this bit.

DIO 2 : 1 = stop transferring read data.
0 = No action

This bit is used to terminate a data transfer by the selected device while a data transfer from tape is in progress, e.g. the host wants to truncate the record before the logical end of data. (In the command sequences shown this line is referred to as an END "DATA" command).

DIO 3 : 1 = Enable parallel poll response for coming online
0 = No action

Assertion of this bit will enable the drive to issue one poll response when it is placed online. If this End command is issued after the drive has been placed online then the drive will issue an online parallel poll response the next time it is has been taken offline, and then brought back on-line. To clear the resulting poll response it must be acknowledged by reading the DSJ. Once an online parallel poll is enabled it will not be cleared by following end commands without this line asserted. (In the command sequences shown this line is referred to as END "IDLE").

DIO 4 : 1 = End of transaction (END COMPLETE)
0 = No action

This command is used to mark the end of the report phase of a command. (In the sequences shown it is referred to as the END "COMPLETE" command, and when used in conjunction with DIO 3 it is referred to as the END "COMPLETE-IDLE" command).

DIO 5 : 1 = Reset DSJ register to 0
0 = No action

Valid for Cold Load only. This bit is used to programmatically clear the DSJ Register for the selected device. The DSJ is also automatically reset whenever a DSJ is requested by a host. The Parallel Poll response is not affected.

DIO 6-8 : Reserved

6-3. STATUS REQUEST REGISTERS

Status Register #1

DIO 8	DIO 7	DIO 6	DIO 5	DIO 4	DIO 3	DIO 2	DIO 1
EOF	BOT	EOT	Recov. Error	Command Reject	Write Protect	Unrec. Error	Online

DIO 1: 1 = Online
0 = Offline

This bit indicates the current status of the tape drive. It is set after the operator has loaded a tape and pressed the online button. It is cleared when the operator presses the reset button, upon acceptance of the rewind-offline command, or when a tape has lost tension. The tape drive must be online in order to accept tape commands. This condition is only checked when the command is being validated. If a tape command is issued when this bit is cleared, then the command rejected bit will be set, the command reject error class will indicate device reject, and register #5 will indicate drive not online.

Corrective action for this condition should be to prompt the user to bring the drive online and wait.

DIO 2: 1 = Unrecovered data/format error
0 = No unrecovered data/format error

This bit is set for any unrecovered recording error encountered during read or write operations. This condition can only exist after all retries have been exhausted. These errors include tape velocity or tension out of spec, formatter errors, multiple tracks in error, failure to verify a write, data format error, gap before end of data, redundancy check error. The highest priority cause for the setting of this bit is contained in the contents of status register #5.

The multiple tracks in error condition occurs when two or more tracks were in error for a PE read or write, when two or more tracks were in error for GCR write, or when three or more tracks were in error for a GCR read.

Corrective action for this condition would be replacement of the tape, and the job run again. When this error occurs data is written or read the best the drive can.

DIO 3: 1 = Write protected
0 = Write enabled

This bit indicates that the write enable ring is missing. This bit is set when the operator has loaded a tape which has no write enable ring and is cleared when this tape is unloaded. If a write operation is attempted when this bit is set, then the command rejected bit will be set, the command rejected error class will indicate device reject, and register #5 will indicate tape is write protected.

Corrective action for this condition should be to issue a rewind offline command and request that the operator insert a write enable ring or load another tape.

DIO 4: 1 = Command rejected
0 = Command accepted

This bit is set when a command has been rejected by the drive due to a device setup error, protocol error, or self test failure. The reason the command was rejected can be found in status register #4. Register #5 will have further error description.

Corrective action for these conditions are discussed under register #4's description.

DIO 5: 1 = Recovered error
0 = No recovered errors

This bit is used to indicate that error correction and/or retries have taken place during a tape read or write operation.

No corrective action is needed. The host may wish to log the state of this bit along with the retry count.

DIO 6: 1 = Beyond End of tape (EOT)
0 = Not beyond end of tape

This bit indicates whether the tape is currently positioned beyond the end of tape marker. This bit is set when the EOT marker is detected during the processing of a forward motion tape command. This bit is cleared when the EOT marker is detected during the processing of a reverse motion tape command. This status bit is a warning that there is 10 feet of usable recording area left and 25 feet to the end of tape.

Corrective action for this condition is to inform the user's program of this condition. If writing to tape, the user's program should write an end of volume mark (two tape marks) and then rewind the tape. If reading from tape, the user's program should continue until an end of volume mark is read and then rewind the tape.

DIO 7: 1 = At load point (BOT)
0 = Not at load point

This bit indicates whether the tape is currently positioned at load point (beginning of tape). It is set upon the loading of the tape or after a rewind operation. It is cleared when a forward motion command is processed or when the tape is unloaded. When this bit is set the drive will reject backspace record and backspace file commands. When this bit is not set the drive will reject write format commands. If either of these conditions occur the command reject bit will be set, the command reject error class will indicate device reject, and register #5 will indicate either drive at BOT or drive not at BOT.

Corrective action for this condition is to inform the user's program.

DIO 8: 1 = At end of file (EOF)
0 = Not at end of file

This bit is set when the drive has detected an EOF on the tape during a read record, forward space record, or backspace record operation. This bit is also set upon successful completion of write file mark, forward space file, or backspace file operations. The end of file is also known as a tape mark or a file mark.

Corrective action for this condition should be to inform the user's program.

Status Register #2

DIO 8	DIO 7	DIO 6	DIO 5	DIO 4	DIO 3	DIO 2	DIO 1
6250 GCR format	Unknown Density	Data Parity Error	Data Timing Error	Tape Runaway	Door Open	Long Record Support	I.R. Mode

DIO 1: 1 = Immediate response mode.
0 = Non-immediate response mode.

This bit indicates whether immediate response to write operations is enabled. This bit is set when an enable_immediate_response mode command is received and accepted. This bit is cleared when a disable_immediate_response mode command is received and accepted, or when a tape is unloaded. The default mode at power up is that this bit is cleared.

DIO 2: 1 = Long records supported
0 = Long records not supported

This bit indicates that records up to 32K in PE and 60K in GCR are supported. If not set the maximum is 16K. The HP 7978B, 7979A, and 7980 set this bit, all other drives do not.

DIO 3: 1 = Door open
0 = Door not open

This bit is set when the tape path door is open. It is cleared when the door is closed. This bit will only be set in a transparent status message (DSJ = 2).

DIO 4: 1 = Tape runaway
0 = Not tape runaway

This bit indicates that the drive has read approximately 4.6 meters (15 ft) GCR tape, or 7.6 meters (25 ft) of PE or NRZI tape, without detecting a recorded block. At this point tape motion will stop. Tape runaway is detected for read record and on all space type commands.

Corrective action for this condition should be to inform the user's program. The user's program should issue the appropriate commands to move the tape where data is recorded. This is normally done with either the rewind, the backspace record, or the backspace file command.

DIO 5: 1 = Data timing error
0 = No data timing error

This bit indicates when a read or write timing error (overrun/underrun) has occurred. Because of the tape drive's data buffer this condition should never occur.

DIO 6: 1 = Data parity error
0 = No data parity error

This bit indicates when data parity error on the drive's internal data bus has been detected. This error can exist on any read record or write record operation. The drive will have completed all possible retries.

Corrective action for this condition should be to issue a backspace record command and then reissue the failed command. If this error persists then there is a hardware problem and the service man should be called.

DIO 7: 1 = UNKNOWN density detected
0 = not UNKNOWN density

This bit will be set when the drive cannot identify the tape as GCR, PE, or NRZI, and the tape is not blank. This bit will be also be set if the density on the tape is not available on the drive. This bit will be cleared when the tape is unloaded or by setting the drive to GCR, PE or NRZI with a valid wrote mode command while at load point. This bit will also be set along with the GCR format bit when reporting a hard error on a data compressed tape.

DIO 8: 1 = GCR (6250 BPI) format
0 = Not GCR format

This bit is set upon the identification of a GCR tape or the setting of the tape drive into the GCR format at load point.

When this bit is cleared there could be no tape loaded or the tape loaded is PE, NRZI, blank, or an unknown density. This bit can only be set by the HP 7978A, 7978B, and 7980.

Status Register #3

1600 PE format	800 NRZI format	Power just Restored	HP-IB command Parity Error	Position Unrecov-ered	Formatt-er Error	Servo Error	Contrl. Error
DIO 8	DIO 7	DIO 6	DIO 5	DIO 4	DIO 3	DIO 2	DIO 1

DIO 1: 1 = Controller error
0 = No controller error

This bit indicates that the drive has detected an error in its controller. Register #5 will elaborate on this error condition.

Corrective action for this condition should be to log this error and call service if the failure persists.

DIO 2: 1 = Servo error.
0 = No servo error.

This bit indicates that the drive has detected an error in its servo subsystem. Register #5 will elaborate on this error condition.

Corrective action for this condition should include a visual inspection of the drive by the operator. A poorly loaded tape or defective could cause this error. This error should be logged and the service called if necessary.

DIO 3: 1 = Formatter error.
0 = No formatter error.

This bit indicates that a hardware error has been detected on the drive's formatter board or subsystem. Register #5 will elaborate on this error.

Corrective action for this condition should be to log this error and call service if the error persists.

DIO 4: 1 = Position unrecovered
0 = Position known and correct

This bit will be set when position on the tape (media) is no longer known. Normally, even on an error condition, the tape is positioned to a known place. However, it is possible for the drive to lose its place in which case this bit will be set. The tension shutdown circuitry will also cause this error. If tape tension is lost the drive will go offline.

DIO 5: 1 = HP-IB command parity error
0 = Correct parity

This bit indicates that the drive's ABI chip has detected a parity error in a HP-IB command byte. These commands include primary bus commands, secondary address bus commands, and universal bus commands. Normal command parity is an odd number of 1's on the DIO lines 1 thru 8.

Corrective action for this condition should be to log the condition. If this error persists, the service man should be called.

DIO 6: 1 = Power has been restored
0 = Normal power condition

This bit is set to 1 whenever power is applied to the drive, either during the normal power up sequence with the on/off switch or during a power fail/recovery sequence. This bit is also set immediately following the execution of a device clear.

Corrective action should be to undergo the power up protocol sequence.

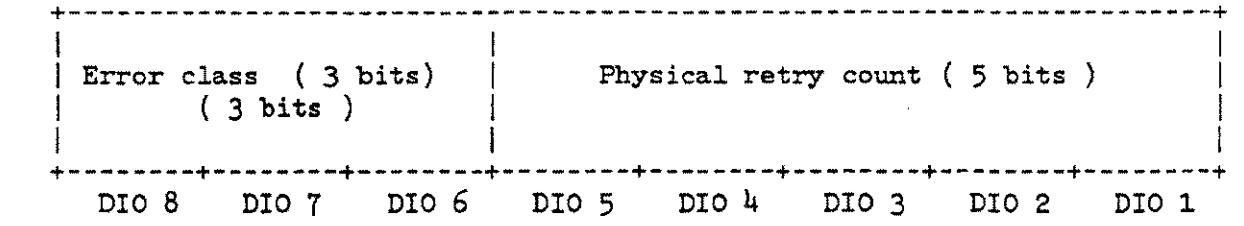
DIO 7: 1 = NRZI (800 BPI) format
0 = Not NRZI format

This bit is set upon the identification of a NRZI tape or the setting of the tape drive into the NRZI format at load point. When this bit is cleared, no tape is loaded or the tape loaded is GCR, PE, blank, or an unknown density. This bit can only be set by an 7974A, 7979A or 7980A with the 800 NRZI option.

DIO 8: 1 = PE (1600 BPI) format
0 = Not PE format

This bit is set upon the identification of a PE tape or the setting of the tape drive into the PE format at load point. When this bit is cleared, no tape is loaded or the tape loaded is GCR, blank, or an unknown density.

Status Register #4



DIO 1-5: Retry Count

These five status bits indicates the number of retries performed by the tape drive. These bytes are the same as for the 7976.

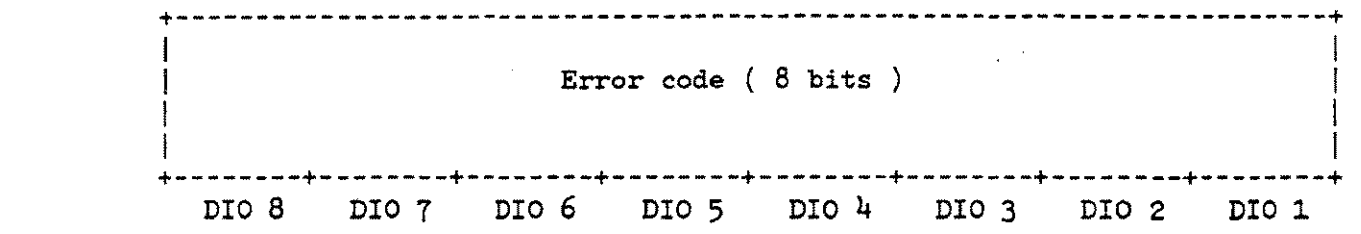
0 = Successful operation complete on first try.
1 = Correctable error detected on first try.
>1 = Number of tries to finally complete the operation, where the success or failure is indicated elsewhere.

DIO 6-8: Error class

These status bits indicate the reason for a command reject error.

0 = No command reject.
1 = Reserved.
2 = Device reject (register #5 contains the reject code).
3 = Protocol reject (register #5 contains the reject code).
4 = Reserved.
5 = Reserved.
6 = Reserved.
7 = Self test failure.

Status Register #5



The contents of this register is dependent on the particular error being reported.

If command reject (status reg. #1, DIO 4) is asserted and register #4 indicates a device reject, this register will define the specific error condition as follows:

5 = Device is write protected when a write type command was initiated.

6 = Tape was not loaded when the command was received.

7 = Write density command given but the requested density is not available.

9 = The tape to be read was unidentifiable as to format. The density read may not be available, or the tape may have an unreadable density ID, or may be blank.

10 = The tape to be written is unidentifiable as to format. A Write Record, Write File Mark, or Write Gap command was received but cannot be processed without a Write Format command if the tape was unidentified at load point.

11 = Drive not online.

16 = A write format command was issued but the tape is not positioned at BOT.

19 = A backward type command (except rewind) was just initiated but the tape was already positioned at BOT.

23 = Protocol not synced.

24 = The tape command byte received was unknown to the drive.

31 = The length of a write record requested exceeded the maximum record size supported by the drive.

32 = Tape is beyond ten feet past EOT, cannot write to tape.

33 = Self test failure. Drive will not accept tape commands.

37 = Tape positioning failure while removing readaheads.

40 = Door open reject. The door was opened during a long gap while the tape was beyond the end of tape marker. This condition is non-retriable to prevent unspooling of the tape.

If unrecovered data/format error (status reg. #1, DIO 2) is asserted this register will specify the particular error encountered. The status is defined as:

41 = The tape velocity was out of specification.

45 = Multiple tracks were in error. Either two or more tracks were in error for a PE or NRZI write, or two or more tracks were in error for a GCR write.

47 = Failure to verify a tape mark or density ID just written.

48 = Noise on detect. Indistinguishable flux transitions were detected while attempting to detect a recorded block.

49 = Data format error. Flux transitions were found or were missing in the appropriate tracks for a block detect.

50 = Failure to identify tape following a rewind command.

51 = Gap detected before end of data. The read formatter detected a full tape width dropout within the data portion of a data block.

52 = Data block dropout. A full tape width dropout was detected within the preamble or postamble of a data block.

53 = Redundancy check error. The read formatter detected either a CRC, ACRC, LRC, or residual error while reading or verifying a data block.

54 = Read parity error. The read formatter detected an unrecovered parity error within a data block. For PE this error could include multiple tracks in error, and for GCR this error could also include a redundancy check error. (7978B, 7979A, 7980 only).

55 = Abnormal command abort, door opened (7974A only).

57 = Maximum skew exceeded (7974A only).

58 = False preamble or postamble detected (7974A only).

59 = Corrected data error on write.

60 = Buffer overrun. The record size exceeded the maximum record size supported on a read.

61 = Data block timeout. Could not detect the gap following a data block. Could be caused by a record length longer than what the drive supports on read.

62 = Tape mark dropout. A full tape width dropout was detected within a tape mark.

63 = Tape mark unverified. A tape mark was detected which does not meet ANSI specifications in terms of flux transitions and erasure in the appropriate tracks.

64 = Tape mark timeout. Could not detect the gap following a detected tape mark.

If position unrecovered (status reg. #3, DIO 4) or Servo error (status reg. #3 DIO 2) is asserted, this register will define the specific error condition as follows:

81 = Servo controller unresponsive. The servo will not take data from the master controller.

82 = Servo failed to reach the desired state requested by the master controller.

83 = Servo shutdown. The servo system lost tape tension unexpectedly.

84 = Servo controller hard failure. The servo controller has detected a hard failure within itself.

85 = Servo protocol error. An invalid byte was received by the servo from the master controller.

86 = A run time error was detected by the servo.

87 = In position interrupt not received. Master controller did not get the in position interrupt it expected.

88 = No gap detected by the servo after reading or writing a data block or tape mark.

89 = Safety shutdown of motor driver.

90 = No BOT detected on load or rewind.

91 = Speed out of specifications.

92 = The desired state requested by the master controller was invalid for the current context.

94 = Tape positioning failure.

If a Formatter error (status reg. #3, DIO 3) is asserted this register will define the specific error condition as follows:

101 = 7978 Read Formatter unresponsive. The read formatter did not respond with end of record status after a data block was detected.

102 = 7978 Read Formatter hardware error.

103 = Bad block type detected on a write operation.

104 = Erase failure. Flux transitions were detected in a portion of tape currently being erased.

105 = No data detected after write.

106 = Tracks out of sync on write verify.

107 = 7974A formatter hardware error.

108 = 7974A formatter unresponsive.

109 = No gap timeout. The gap timer did not count down, or was never started.

110 = Formatter byte count mismatch with data buffer.

If controller error (status reg. #3 DIO 1) is asserted then this register indicates the specific error condition as follows:

121 = Transaction ID mismatch between command sent to Device program and the returned report.

122 = No pending command found for report received from Device program.

123 = Invalid report message received from Device program.

124 = Report queue overflow.

125 = Unknown command received by Device program.

126 = Command queue overflow.

128 = Missing End Of Record flag in data buffer.

129 = Data buffer parity error.

130 = Data buffer underrun during a write operation

131 = Byte count mismatch between putting a record into the data buffer and removing it.

132 = Bad message type received by channel program from device program.

133 = Processor handshake abort between HP-IB interface board and channel program.

134 = Unknown HP-IB interface exception detected.

137 = Illegal access to the servo controller registers detected.

138 = Device program firmware error.

139 = Hardware utilities firmware error.

140 = Channel program firmware error.

141 = One line encoder inoperative.

150 = Tape position synchronization error.

151 = Tape deblocking error (HP7980XC only).

152 = Compression/decompression hardware/firmware error (HP7980XC only).

If command reject (status reg. #1 DIO 4) is asserted and register #4 indicates a protocol error, this register will define the specific error condition as follows:

161 = Command queue not empty. Cannot accept new tape command or diagnostic request.

162 = Request DSJ expected

163 = Request status expected

165 = Unknown unit select.

166 = Tape command secondary expected.

167 = Data byte expected.

168 = Missing EOI on tape command data byte, self test number, or END command data byte.

170 = Command phase protocol error for write record.

172 = Read record report phase protocol error.

173 = Report phase protocol error.

174 = Cold load sequence protocol error.

175 = HP-IB protocol sequence error.

176 = END "COMPLETE" or "COMPLETE-IDLE" expected.

178 = END "DATA" expected.

180 = Unknown interface secondary command.

181 = Misplaced data byte.

184 = Interface loopback protocol error.

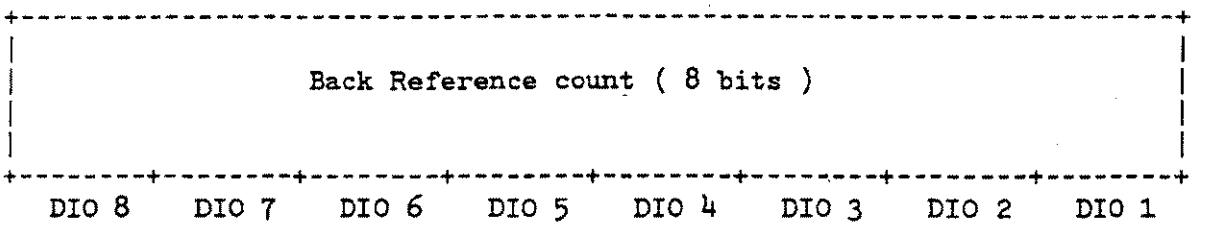
185 = Run self test protocol error.

188 = HP-IB command parity error.

189 = Reset by operator during a protocol sequence.

190 = Device clear received. (Internal error code only).

Status Register #6



This register is used only when reporting transparent status of hard and soft errors while in immediate response mode. When an immediate reported write has a soft error (retries were necessary) or a hard error (write failure) this register indicates which command had the error. It contains the number of commands sent and reported since the command in question was issued. If the immediate reported write had a hard error all of the commands issued after the failure also fail (they will be aborted). Thus on a hard error this register actually indicates the number of preceding commands that failed.

6-4. DEVICE SPECIFIED JUMP (DSJ)

The DSJ register has two normal values, 0 and 1. When a value of 0 is returned for a DSJ request, the indication is that a normal completion of a command has occurred. Additional status is not necessary. When a value of 1 is returned, additional status information should be obtained and checked. The command may have been rejected, an abnormal condition may exist, or an error was found. The actual conditions causing a DSJ of one are command dependent. Refer to the description of each command, or to the Command DSJ Figure 8-8. The exact causes of the DSJ being set to 1 are different than for the 7976.

During tape command operations a DSJ value of two can also be returned. This DSJ indicates a transparent status message. There are two types of transparent status messages: a door open message, and a soft error message on an immediately reported write operation.

If the host attempts to read the report DSJ for a command prior to receiving a parallel poll response, the DSJ will be set to 2. This will not cause a protocol error. If the host attempts to read the DSJ during a protocol sequence and the drive was expecting a different secondary, the DSJ will also be set to 2, and a protocol error will then exist (see Protocol Errors).

Procedures are defined in this section for recovery from abnormal situations, such as tape errors, protocol errors, or power failures. Some recovery is done entirely by the drive, such as tape data errors. In other situations, synchronization between the Host and the drive must be re-established. Protocol errors are a prime example.

7-1. AUTO ERROR RECOVERY

Some error conditions are automatically recovered by the tape drives transparent to the Host. Errors which the drive is able to fix will be called soft errors and errors it cannot fix will be called hard errors. Retry will be attempted only for soft errors and if an error cannot be fixed through retry, it will become a hard error. There are some general rules followed by the drive for auto-recovery. There is no programmable time limit on these procedures. They will go to the completion of the appropriate algorithm.

1) All read, write, and space type commands use recovery on 7978, 7979A, and 7980. Read record, write record and write file mark commands will use recovery on 7974A. All errors occurring in rewind, or rewind-offline are classified as hard errors.

2) After a hard error, the final position of the tape (media) will be at the end of the record. If this positioning is not possible the position unrecovered bit in the Status (bit 4, register #3) will be set. The Host can, therefore, perform additional recovery if desired.

The read retry algorithm is as follows:

```
BEGIN
  read record (or detect block for space type cmd.);
  n := 1
  WHILE (soft error AND n<8) DO
    BEGIN
      reposition tape to beginning of record;
      read record (or detect block) ;
      n := n+1
    END
  IF (hard error OR soft error) THEN
    position tape at end of record; (if possible)
END
```

The write retry algorithm is as follows:

```
BEGIN
  write record;
  n := 0;
  WHILE (soft error AND n<3) DO
    BEGIN
      reposition tape to beginning of record;
      write record;
      n := n+1
    END;
  WHILE (soft error AND n<18) DO
    BEGIN
      reposition tape to beginning of record;
      write gap;
      write record;
      n := n+1
    END
  IF (hard error OR soft error) THEN
    position tape at end of record; (if possible)
END
```

7-2. CRC ERROR RECOVERY

Upon detecting a CRC error on a write or read transfer the host should attempt a recovery sequence.

The recovery sequence for a CRC error during a write record data transfer is straight forward. After the report for the write record is received, a backspace record is initiated (to position the tape prior to the bad record), and then the write record is retransmitted.

The recovery sequence for a CRC error during a read record transfer is similar. After the report phase of the read record is completed a backspace record is initiated, and then the read record command reissued.

7-3. POWER FAIL RECOVERY

The following cases of power fail / recovery describe combinations that must be accounted for:

```
Case 1; CPU cycles power - Device not active
          No loss of Data
          Recovery Action I.

Case 2; CPU cycles power - Device active
          Loss of Data possible
          Recovery Action I.

Case 3; CPU cycles power - Device cycles power
          If device active, Loss of data possible
          Recovery Action I & II.

Case 4; CPU normal       - Device cycles power, but not active
          No loss of Data
          Recovery Action II.

Case 5; CPU normal       - Device cycles power while active
          Loss of data possible
          Recovery Action II.
```

*** Recovery Action I;**

If CPU cycles power - and no carry-over power supply (batteries, MG flywheel, etc) is installed, a Device Clear sequence should be issued to reset the device and any commands outstanding. The CPU warm start will not have sufficient control retained to allow continuation of I/O at the device. Following is the protocol for the message sequence:

```
DEVICE CLEAR
Service Request by tape drive
READ DSJ
READ STATUS (optional)
END "COMPLETE"
```

*** Recovery Action II;**

If device cycles power - normal power-up sequence causes a parallel poll assertion to the CPU. The CPU will read the DSJ. The device controller will set the DSJ=1 with status register reflecting 'power-up'. Following is the protocol for the message sequence:

```
Service Request by tape drive
READ DSJ
READ STATUS
READ SELF TEST STATUS (optional)
END "IDLE" - (optional)
```

7-4. DOOR OPEN RECOVERY

When 7978A/B detects a door open condition such that it cannot complete a host command until the door is closed, a transparent status message will be sent to the host. The host is encouraged to send a message to the operator as appropriate.

The 7974A, 7979A, and 7980 do not provide capability to recover gracefully from a door open condition due to constraints in the drive mechanism Therefore any time the door is opened during any tape operation the operation will be aborted. In order to recover from this condition, the tape must be rewound to BOT, and then the tape rewritten. In the event of a door open, an unrecoverable data error will be set and a position unrecovered will be returned in status. The tape drives will stay on line in the event of this error.

7-5. PROTOCOL ERRORS

When it detects a protocol error, the drive will immediately assert a Parallel Poll Response. To resynchronize communications, the Host must issue the following command sequence over the HP-IB:

```
READ DSJ (=1)
READ STATUS (indicates protocol error, Status must be read
             to resync protocol with the drive)
END "COMPLETE"
```

Upon detecting a protocol error the drive will purge all pending commands in the command queue, and all reports from previous commands in the report queue. The data buffer will also be cleared. Tape position, tape status, and the online status will not be affected.

7-6. HP-IB TIMEOUT PROCEDURE

If a timeout occurs during operations such as DSJ, Data byte handshake or any other operation which may cause the HP-IB to time out due to system restrictions, the following procedure (by the host) will return the drive to a known state avoiding future protocol errors.

The HP-IB message sequence is:

```
Device clear sequence ( previously described )
```

8-1. AMIGO IDS

The following table shows the Amigo identification numbers for the tape drives. The first byte indicates the peripheral class (where 1 indicates a storage device), and the second byte is the subclass.

	product	Identify byte #1	Identify byte #2
	HP 7974A	01H	74H
	HP 7978A	01H	78H
	HP 7978B	01H	78H
	HP 7979A	01H	79H
*	" "	"	74H
	HP 7980	01H	80H
**	" "	"	78H
***	" "	"	81H
****	HP 7970E	01H	83H
****	HP 7976A	01H	76H

* = the HP 7979A may be configured to identify as an HP 7974A for driver compatibility.

** = the HP 7980A may be configured to identify as an HP 7978B for driver compatibility.

*** = the HP 7980XC (extra capacity) may be configured to identify with an unique id to differentiate it from a non XC drive.

**** = shown for informational purposes only

FIGURE 8-1

8-2. LISTEN SECONDARY COMMANDS

MSA (bin)	Secondary (dec)	Description
11100000	0	WRITE EXECUTE Data byte(s) to follow represent data to be written to tape.
01100001	1	TAPE COMMAND TO FOLLOW. Data byte to follow represents the actual command to be performed by the tape unit (See Figure 8-4).
01100100	4	DOWNLOAD DIAGNOSTIC Data bytes to follow represent the downloaded diagnostic test routine to be executed.
1100110	6	WRITE FIRMWARE UPDATE Data bytes to follow represent the firmware update record to be stored in EEPROM.
01100111	7	END COMMAND Data byte to follow represents an "End command" (See Figure 8-5).
01110000	16	AMIGO DEVICE CLEAR
11110001	17	CLEAR CRC Clear CRC generator.
01111101	29	RUN HP 7979A / 7980A SELF TEST Five bytes of test information must follow.
11111110	30	WRITE INTERFACE LOOPBACK HP-IB loopback data (256 bytes) follow.
01111111	31	RUN SELF TEST One byte of test information must follow.

Note: The low order 5 bits of the secondary address (MSA) represents the Amigo Command Instruction Modifiers. The high order bit represents the Command Parity Bit.

FIGURE 8-2

8-3. TALK SECONDARY COMMANDS

MSA (bin)	Secondary (dec)	Description
11100000	0	READ EXECUTE Data byte(s) represent data read from tape.
01100001	1	READ STATUS The six data bytes returned represent the status registers registers from the tape drive, (See Figure 8-6).
01100010	2	READ BYTE COUNT Two bytes of count are returned representing the number of bytes read/written for the last record. The first byte is the most significant half of the count.
11100011	3	READ DIAGNOSTIC RESULTS The results of a downloaded diagnostic are returned.
01100100	4	READ FIRMWARE REVISIONS (HP7980XC) The firmware revisions are returned.
11100101	5	READ LOG The diagnostic log information is returned.
11100110	6	READ FIRMWARE UPDATE The firmware update code in EEPROM is returned.
11110111	15	READ EXTENDED STATUS (HP7979A / 7980A) The 16 byte extended status message is returned as six bytes of HP-IB status followed by a 10 byte CCL report.
01110000	16	READ DSJ One byte of Device Specified Jump is returned.
11110001	17	READ CRC Read CRC generator.
11111101	29	READ EXTENDED SELF TEST STATUS (7979/7980) Five bytes of diagnostic status are returned.
11111110	30	READ INTERFACE LOOPBACK The HP-IB loopback data (256 bytes) is returned.
01111111	31	READ SELF TEST STATUS Two bytes of diagnostic status are returned.

See also Notes for Figure 8-2.

FIGURE 8-3

8-4. TAPE COMMANDS

Value (Decimal)

0 = Select Unit 0 (native protocol)
1 = Select Unit 0 (7970 type Cold Load Select)

2,3,4= Reserved

5 = Write Record
6 = Write File Mark (EOF)
7 = Write Gap

8 = Read Record

9 = Forward space record
10 = Backspace record
11 = Forward space File
12 = Backspace file

13 = Rewind
14 = Rewind and go offline

15 = Set data compressed GCR (6250 BPI) format
16 = Set GCR (6250 BPI) format
17 = Set PE (1600 BPI) format
18 = Set NRZI (800 BPI) format
19 = Set non-compressed GCR (6250 BPI) format

20 = Start/Stop Mode only
21 = Enable Streaming mode

22 = Disable Immediate report mode
23 = Enable Immediate report mode

24 = Request status

25 = Remote load
26 = Remote unload
28 = Remote online

30 = Disable data compression
31 = Enable data compression

FIGURE 8-4

8-5. END COMMAND

DIO Line	meaning
8	= Reserved
7	= Reserved
6	= Reserved
5	= Clear DSJ Register (Cold Load only).
4	= End-Complete
3	= Enable Parallel Poll Response for going online.
2	= Stop transferring read data.
1	= Clear Parallel Poll Response (Cold Load only).

FIGURE 8-5

8-6. STATUS REGISTERS

- - - - - - - - Status Register #1 - - - - - - - -

DIO Lines
- 8 = End-of-file (EOF).
- 7 = Load point (LP) / Beginning-of-Tape (BOT).
- 6 = Beyond end-of-tape (EOT).
- 5 = Recovered error check.
- 4 = Command rejected.
- 3 = Write protected (not write enabled; no write ring).
- 2 = Unrecovered error.
- 1 = Online.

- - - - - - - - Status Register #2 - - - - - - - -

DIO Lines
- 8 = GCR (6250 BPI) format.
- 7 = Unknown density on tape.
- 6 = Data parity error.
- 5 = Data timing error.
- 4 = Tape runaway.
- 3 = Door open.
- 2 = Long records supported.
- 1 = Immediate response mode.

- - - - - - - - Status Register #3 - - - - - - - -

DIO Lines
- 8 = PE (1600) format
- 7 = NRZI (800) format (with NRZI option only).
- 6 = Power has been restored.
- 5 = HP-IB command parity error.
- 4 = Position unrecovered.
- 3 = Formatter error.
- 2 = Servo error.
- 1 = Controller error.

FIGURE 8-6A

8-9. 7979A/7980A ERROR CROSS REFERENCE

Figures 8-9A and 8-9B list the HP-IB reported error codes and their corresponding HP7979A / 7980A internal (CCL) error codes which could have occurred. For descriptions of the HP-IB error codes see section 6-3, status register #5. For descriptions of the CCL error codes see Figure 8-10.

HB-IB ERROR	POSSIBLE 7979A / 7980A INTERNAL (CCL) ERROR CODES (all errors in decimal)
0	0
5	4
6	1
7	22
9	10
10	11
11	02
16	12
19	13
24	16, 17, 240
31	24
33	241
45	34, 35, 36, 66, 67
47	81, 82, 83, 84, 85, 86, 87, 88, 89, 90
48	49, 91
49	44, 50, 76
50	119
51	33, 45, 65, 77
53	37, 38, 39, 69, 70, 71
55	118
59	68
60	32
61	43, 47, 75
63	51
82	98
83	96, 116
88	46, 48, 78, 79
90	120
91	97
94	52, 53, 125, 126, 127
95	110, 111, 112, 113, 114, 115

FIGURE 8-9A

HB-IB ERROR	POSSIBLE 7979A / 7980A INTERNAL (CCL) ERROR CODES (DECIMAL)
102	42, 74
104	80
105	93
123	166
125	165
129	92, 160, 161, 220
130	64
131	162
140	25, 26, 163, 164
141	128
150	168
151	169, 170, 171, 172, 173, 174, 175
152	176, 177, 178, 179, 180, 181, 182
162	192
167	197
168	198
170	200
174	204
175	205
176	206
178	208
180	210
181	211
184	214
185	215
188	218
189	219
254	All reserved CCL error codes
"	94,95 *** revision 3.40 and earlier firmware return these errors here. They should be mapped to HPIB error #47, and will be fixed in the future.
255	3, 5, 7, 8, 9, 14, 18, 19, 20, 21, 23, 28, 29, 30, 31, 117

FIGURE 8-9B

8-10. 7979A / 7980A CCL ERRORS

The following table lists the Internal CCL error code definitions of the HP 7979A and 7980A. These errors are NOT the error codes returned to the host within the 6-byte status report. The HP-IB error codes are described in section 6-3, status register #5. This table is provided to describe the CCL error codes which are obtained from the HP-IB to CCL cross reference table (Figure 8-9).

COMMAND REJECT ERROR CODES (1..31)

1 (01H) = No tape is loaded.
2 (02H) = Drive is not online.
3 (03H) = Drive is not offline.
4 (04H) = Drive is write protected.
5 (05H) = Tape loaded prevents access to test.
6 (06H) = Front door or top cover is open.
7 (07H) = Controller is currently in diagnostic/options mode.
8 (08H) = Controller is not in diagnostic mode.
9 (09H) = Drive not streaming (when streaming command was received).
10 (0AH) = Cannot read tape with unidentified or unsupported format.
11 (0BH) = Cannot write tape with unidentified or unsupported format.
12 (0CH) = Tape not positioned at BOT for write density ID command.
13 (0DH) = Tape already at BOT when backspace command was issued.
14 (0EH) = Tape past EOT.
15 (0FH) = Tape ten feet past EOT, cannot write to tape.
16 (10H) = Unknown or unsupported command received.
17 (11H) = Invalid parameter for requested command.
18 (12H) = Invalid test/info number.
19 (13H) = Test not remotely accessable.
20 (14H) = Test aborted by reset.
21 (15H) = User defined sequence is full, can't add test to sequence.
22 (16H) = Requested density is not available.
23 (17H) = Invalid target id for command.
24 (18H) = Requested write record length exceeded maximum supported.
25 (19H) = Write record request did not precede write record transfer
26 (1AH) = Write record transfer did not follow write record request.
27 (1BH) = Command rejected due to poweron selftest failure.
28 (1CH) = Buffer is empty, cannot retrieve record from buffer.
29 (1DH) = Buffer is full, cannot place record in buffer.
30 (1EH) = Invalid header on non-volatile memory load.
31 (1FH) = Record length or checksum error on non-volatile memory load.

FIGURE 8-10A

TAPE READ ERRORS (32..63)

32 (20H) = Buffer overrun.
33 (21H) = Gap detected before end of data on read.
34 (22H) = Two or more tracks in error on read.
35 (23H) = Two tracks in error on read.
36 (24H) = Single track in error on read (NRZI only).
37 (25H) = CRC error on read.
38 (26H) = ACRC error on read.
39 (27H) = residual error on read.
40 (28H) = syndrome detected single track in error on read.
41 (29H) = formatter CRC error on read.
42 (2AH) = Unknown formatter error on read.
43 (2BH) = Data block timeout.
44 (2CH) = Block detect error.
45 (2DH) = End block detect error.
46 (2EH) = Bad gap after ID.
47 (2FH) = Gap check timeout.
48 (30H) = Short gap after block.
50 (32H) = False ID block detected.
51 (33H) = Bad tape mark read.
58 (3AH) = Tracks with gain too low during autocal.
59 (3BH) = Tracks with gain too high during autocal.
60 (3CH) = Tracks with gain too low and too high during autocal.

FIGURE 8-10B

TAPE WRITE ERRORS (64..95)

64 (40H) = Buffer underrun.
65 (41H) = Gap detected before end of data on write.
66 (42H) = Two or more tracks in error on write.
67 (43H) = Two tracks in error on write.
68 (44H) = One track in error on write.
69 (45H) = CRC error on write.
70 (46H) = ACRC error on write.
71 (47H) = residual error on write.
72 (48H) = syndrome detected single track in error on write.
73 (49H) = formatter CRC error on write.
74 (4AH) = Unknown formatter error on write.
75 (4BH) = Data block timeout.
76 (4CH) = Data block detect error.
77 (4DH) = End data block detect error.
78 (4EH) = Bad gap after ID.
79 (4FH) = Gap check timeout.
80 (50H) = Erase verify error.
81 (51H) = PE density ID detect error.
82 (52H) = PE density ID verify error.
83 (53H) = GCR density ID detect error.
84 (54H) = GCR density ID verify error.
85 (55H) = GCR ARA burst detect error.
86 (56H) = GCR ARA burst verify error.
87 (57H) = GCR ARA ID detect error.
88 (58H) = GCR ARA ID verify error.
89 (59H) = tape mark detect error.
90 (5AH) = tape mark verify error.
91 (5BH) = Bad pregap on write.
92 (5CH) = Buffer data parity error during write record.
93 (5DH) = No block detected during write record verify.
94 (5EH) = No block detected during write tape mark verify.
95 (5FH) = No block detected during write ID verify.

FIGURE 8-10C

TAPE POSITIONING/SERVO ERRORS (96..127)

96 (60H) = Tension shutdown.
97 (61H) = Tape speed out of specifications.
98 (62H) = Tape ramping error.
110 (6EH) = No reel found.
111 (6FH) = Hub lock failure.
112 (70H) = Reel will not seat.
113 (71H) = Reel inverted.
114 (72H) = Tape stuck to reel.
115 (73H) = Tape stuck in path.
116 (74H) = Unable to establish tension.
118 (76H) = Door open abort.
119 (77H) = Failure to reidentify tape on a rewind.
120 (78H) = No BOT marker detected.
121 (79H) = Operator reset abort.
122 (7AH) = Host reset abort.
125 (7DH) = Last block not found.
126 (7EH) = Gap recapture position error.
127 (7FH) = Block recapture position error.

FIGURE 8-10D

DRIVE CONTROLLER ERRORS (128..159)

128 (80H) = Reel size detector failure.
131 (83H) = Unable to thread tape into tape path.
132 (84H) = Open loop motor control error.
133 (85H) = Gap timer circuitry check failed.

BUFFER CONTROLLER ERRORS (160..191)

160 (A0H) = Pop parity error.
161 (A1H) = Push parity error.
162 (A2H) = Byte count mismatch on write or read.
163 (A3H) = Prior error reject.
164 (A4H) = Write stopped at EOT.
165 (A5H) = Zero byte record read, or requested.
166 (A6H) = Final report message was not valid.
167 (A7H) = Tape runaway during manual diagnostic commands.
168 (A8H) = Tape position syncronization mismatch.
169 (A9H) = Physical data record too small to deblock
170 (AAH) = Invalid pointer found during deblocking of physical record
171 (ABH) = Access table contents were invalid
172 (ACH) = Access table contents were incomplete
173 (ADH) = Improper byte count sum of access table entries
176 (B0H) = Hardware error detected in data compression (XC) circuitry
177 (B1H) = Bad parity detected from Data compression circuitry
178 (B2H) = Data compression circuitry not properly flushed of data
179 (B3H) = Bad parity detected from interface into data compresssion hardware
180 (B4H) = Bad parity detected from buffer into data compression hardware
181 (B5H) = Data compression-to-interface byte count mismatch
182 (B6H) = Data compression-to-buffer byte count mismatch
191 (BFH) = Fatal error detected by the firmware.

HP-IB DETECTED ERRORS (192..255)

192 (C0H) = Request DSJ expected
196 (C4H) = Tape command secondary expected.
197 (C5H) = Data byte expected.
198 (C6H) = Missing EOI on tape command data byte, self test number, or END command data byte.
200 (C8H) = Command phase protocol error for write record.
204 (CCH) = Cold load sequence protocol error.
205 (CDH) = HP-IB protocol sequence error.
206 (CEH) = END "COMPLETE" or "COMPLETE-IDLE" expected.
208 (D0H) = END "DATA" expected.
210 (D2H) = Unknown interface secondary command.
211 (D3H) = Misplaced data byte.
214 (D6H) = Interface loopback protocol error.
215 (D7H) = Run self test protocol error.
218 (DAH) = HP-IB command parity error.
219 (DBH) = Reset by operator during a protocol sequence.

FIGURE 8-10E

8-11. DIAGNOSTIC SELF TESTS

Data bytes for selecting diagnostic self tests can be found 7978B DIAGNOSTIC E.R.S., the 7974A DIAGNOSTIC E.R.S., or the HP 7979A / 7980A DIAGNOSTIC E.R.S. as appropriate.

8-12. SELF TEST RESULTS

The results of diagnostic self tests are product specific.

The format of the diagnostic error code can be found in the 7978B DIAGNOSTIC E.R.S., the 7974A DIAGNOSTIC E.R.S., or the HP 7979A / 7980A DIAGNOSTIC E.R.S. as appropriate.

8-13. DATA COMPRESSION TAPE HEADER

The HP 7980A with the data compression option has the ability to write tape in a data compressed format. Data compressed tapes are automatically recognized and decoded by the HP 7980A with data compression. On an HP 7980A without data compression, or any other non data compressed drive, the compressed format will not be recognized or decoded.

Data compressed tapes start with 3 identification records (which are all the same). These records are used by the data compressed HP 7980A to allow it to interpret the tape with the data compressed format. These will not be sent to the host.

When reading a data compressed tape on a non-compressed drive the identification records will be sent to the host. A host program can detect these identification records and take appropriate action (such as displaying a warning message on the system console).

Data compressed identification records

```
Record length = 256 bytes

  Bytes 1 - 48      = ASCII identification string :

                        "** Hewlett-Packard Precision Tape Compression **"


  Bytes 49 -254     = Reserved

  Bytes 255 - 256   =  Modulo 65536 checksum of bytes 1 thru 254.
                       Byte 255 is the most significant portion of
                       the checksum, and byte 256 is the least significant.
```

** END OF FORMATTING **
TDP/V (A.04.04) HP36578 Formatter
MON, MAY 8, 1989, 2:30 PM
NO ERRORS
INPUT = HPIB655.DAVE.GNU
OUTPUT = *LASER