FOXTROT
External Reference Specification

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First Edition
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Printing History

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new edition or a new update is published. No information is incorporated into a reprinting unless it appears as a prior update; the edition does not change when an update is incorporated.

A software code may be printed before the date; this indicates the version level of the software product at the time the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

First Draft ..... APRIL 1988
First Edition ..... May 1988

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Introduction 1

1.1 Changes History

This is a preliminary draft of the Foxtrot ERS to provide a discussion document for the Foxtrot/Silverfox series of meetings on April 25th to April 29th 1988.

1.2 Cross Reference

The following documents provide additional relevant information:

- DDS Digital Data Storage Format Specification
- Quickstep ERS
- Various GNU documents (to be advised)

The following documents are to be created:

- CE Service Handbook
- Foxtrot Integration Manual

1.3 Foxtrot Overview

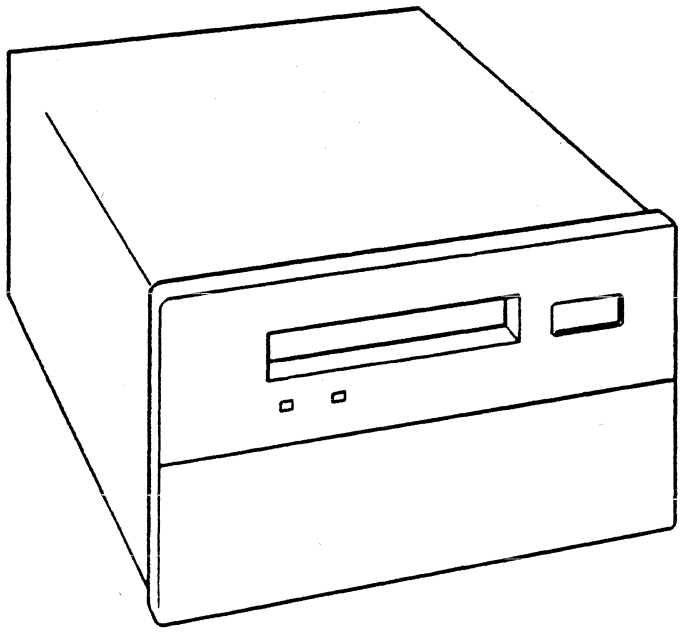


Figure 1-1. The tape drive.

1.3.1 The Foxtrot Concept

Foxtrot is a cartridge tape drive using digital audio tape (DAT) cartridges aimed at the Silverfox program, using the HP-IB interface.

1.3.2 Product Features

Foxtrot has taken the helical-scan technology used in the latest offering to the audio HI-FI market and adapted this for data storage. Foxtrot is a high capacity, medium transfer-rate tape backup device. It can store 1.3 GigaBytes of data on a standard audio DAT cartridge, measuring only 73 X 54 X 10.5 mm. A fast-search capability typically allows data to be accessed within twenty seconds on a standard 1.3 GigaByte tape.

The DAT technology allows a product which has low operator intervention, low-cost and convenient media and low cost of ownership. High data reliability is achieved through read-while-write and additional third-level error detection and correction circuitry.

1.3.3 Compatibility

There is currently no structured format for data storage on DAT cartridges. Foxtrot stores data on tape in a proprietry format, discussed in chapter 5.

Hewlett-Packard aims to have this format accepted as a de facto standard. Any manufacturers who license the format from Hewlett-Packard will be able to manufacture drives that are compatible with Foxtrot.

1.3.4 Cartridge Availability

Foxtrot stores data on a standard audio DAT cartridge. It can use cartridges from several manufacturers, but since their quality varies from one make to another, Hewlett-Packard will recommend only those which are suitable. This will help to ensure data reliability and interchange.

In addition, Hewlett-Packard will supply qualified cartridges.

1.3.5 The Project Team

This section is included for reference and will lengthen as the project develops.

DAT Program

Bert Vermeulen	Program Manager
Manuel Escuder	R&D Section Manager

Foxtrot R&D

Dave Webster	Program Manager
John McCarthy	CS/EE
Steve Langford	EE
Duane Harman	EE
Steve Dimond	ME/ID (Oct 1988)
Chris Herbert	CS/EE

Quickstep R&D Team:

Eng Tan	Project Manager
Pete Bramhall	Project Manager
Jon Buckingham	Data Reliability
David Tuckett	Front Panel & Test Equipment
Brian Johnston	NINJA Firmware & ERS
Toby Ferguson	SAMURAI Firmware
Brian Milthorp	Prototype Development/Sony Drive liaison/CCL
Pete Walsh	SCSI Hardware - NINJA/KIWI
Alastair Atkinson	Buffer Hardware - SAMURAI
Peter Steven	Mechanical Engineering
Simon Southwell	Electronic Engineering
James Harrison	Buffer ASICS - JITTERBUG
Henry Higgins	Data Reliability
John Waters	Test Coordination

Product Marketing:

Jay Young	Product Marketing Manager
Peter Messer	Captive Product Manager

Celia Watts	Marcom Specialist

Product Support:

David Gill	Documentation
Simon Ball	Product Support Engineer

Manufacturing:

TBH	Manu. Engineering Section Manager.
????????????????	Manu. Engineer (Mech).
????????????????	Manu. Engineer (Elect).
Ian Russell	Materials Engineer
Roy Bradford	Procurement Engineer
Neil Johnson	Purchasing Co-ordinator
????????????????	Line Manager
Derek Wong	Media Qualification
Geoff Metselaar	PCA Test Engineering

Quality:

Neil McCoubrey	Product Verification
John Allen	Product Regulations
Joanne Dodsworth	Warranty

Local Operation 2

NOTE

The information in this chapter is based on the Quickstep product and will need to be scrutinized to check if it is appropriate for Foxtrot.

2.1 Local Operation

Local operation of Foxtrot is achieved via the Front Panel. There are three basic areas of functionality: display of drive and cartridge status, display of diagnostic information, and cartridge insertion and removal.

The Front Panel hardware consists of two bi-colour (green/yellow) LEDs and an Unload button. Green LEDs are used for normal status display, and yellow LEDs for fault.

2.1.1 Status Display

For status display, the two LEDs represent DRIVE status and CARTRIDGE status repectively. Each LED can be off, displaying a constant GREEN, flashing GREEN at a variable rate or pulsing GREEN, on for 0.25 seconds off for 0.25 seconds. The full functionality is best represented by a matrix.

STATUS	DRIVE LED	CARTRIDGE LED
No cartridge present	Off	Off
Loading/Unloading	Pulse green	Pulse green
Cartridge loaded	Off	Green
HP-IB/DAT activity and cartridge present	Flash green	Green
HP-IB/DAT activity and no cartridge present	Flash green	Off

If during normal operation of Foxtrot, an excessive number of read- after-write (RAW) or third level error correction (ECC3) errors are detected, a media warning will be displayed. The CARTRIDGE status LED display of constant GREEN will be replaced by alternating GREEN for 4.5 seconds and OFF for 0.5 seconds. This status will be cleared by unloading the cartridge.

A head/media test is performed after power-up when a cartridge is present, and as part of the load cycle after a cartridge has been inserted. Failure of the test results in the same media warning being displayed. Again, the display will be cleared when the cartridge is unloaded.

2.1.2 Diagnostic Display

During power up, Foxtrot will run self test diagnostics. If any of these diagnostics fail, the most suspect field replaceable unit (MSFRU) will be identified and displayed on the Front Panel, as shown below.

MSFRU	DRIVE LED	CARTRIDGE LED
Interface board	Yellow	One yellow pulse
Buffer board	Yellow	Two yellow pulses
DAT mechanism & boards	Yellow	Three yellow pulses

Each pulse is ON for 0.25 seconds, OFF for 0.25 seconds. The sequence of pulses is repeated after 1.5 seconds.

To clear failures on the other MSFRU, Foxtrot must be power cycled.

Host initiated diagnostics are displayed as HP-IB and DAT mechanism activity. Failures of these diagnostics are not displayed on the front panel displays.

2.1.3 Cartridge Insertion and Removal

When a cartridge is inserted into Foxtrot, it is loaded automatically. Once the cartridge is loaded, Foxtrot automatically comes on line.

The cartridge can be removed from Foxtrot in one of two ways. Either, in response to an HP-IB Unload command, or as a result of the Unload button being pressed.

2.1.4 Head Cleaning

To be evaluated by reliability testing.

2.1.5 Online/Offline Implementation

When the device is powered-up and the operator loads a cartridge, the device is automatically put on-line once the tape is threaded.

When the device is powered-up and a cartridge is in the drive, the cartridge will be loaded to BOT, but will NOT be put online.

What if the tape is unthreaded upon power-up?... J. McCarthy.

The only way an operator can put the drive online is to insert a cartridge. Inserting a cartridge may mean ejecting the cartridge and re-inserting it if the console directs the operator to put the device online when it is offline with a tape in the drive.

The device can be pot online and offline remotely by host commands.

Interface Implementation 3

The Foxtrot tape drive will use an HP-IB interface to connect to the host system.

This chapter is based on the information provided in the document:

HP 7974A, HP 7978A/B, HP 7979A and HP 7980A

HP-IB INTERFACE PROTOCOL AND SPECIFICATIONS

This chapter is intended as a starting point, from which we shall develop a definition of the Interface Implementation for Foxtrot.

Information in a **Bold** font is to be deleted.

Information in an *Italic* font needs to be discussed and possibly changed.

3.1 Product Differences

The following table lists the major differences in the products which determine their date capacity, performance, and any other additional features.

	PRODUCT		
SPECIFICATION	FOXTROT	HP 7979A	HP 7980A
R/W Density	DDS Density Format looks like 1600 PE to the Host	1600 PE	(DC option) 6250 GCR 1600 PE
Operating mode	Streaming	Streaming	Streaming
R/W Speed		125 IPS	125 IPS
Rewind Speed		up to 400 IPS	up to 400 IPS
Reposition time		1300 MS	1300 MS
Data Buffer	512 Kbytes	512 Kbytes	512 Kbytes
Queue size		250 blocks	250 blocks
Max record size	64 Kbytes	32 Kbytes	60 Kbytes
DIAGNOSTIC SUPPORT	7979/7980 Compatible	7980 compatible	7980 compatible

3.2 Tape Command Differences

The following tables list the differences in tape command support. Tape commands which operate identically on ALL products are NOT shown in these tables.

TAPE COMMAND	COMMAND SUPPORT BY PRODUCT: FOXTROT	HP 7979A	HP 7980A
#14 Rewind-offline	YES note (a)	YES note (a)	YES note (a)
#15 Set Data Compressed density	note (c)	note (c)	YES note(d,e)
#16 Set 6250 GCR density	note (c)	note (c)	YES note (e)
#17 Set 1600 PE density	YES note (c,h)	YES note (e)	YES note (e)
#18 Set 800 NRZI	note (c)	note (c)	note (c)
#19 Set 6250 GCR no-compress dens.	note (c)	note (c)	YES

NOTES

(a) - Does not unload the tape.

(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 the above mentioned command is received and completed.

(h) - The Density written specifies the DDS density.

TAPE COMMAND	COMMAND SUPPORT BY PRODUCT: FOXTROT	HP 7979A	HP 7980A
#20 Set Start/stop mode	YES note (f)	YES note (f)	YES note (f)
#21 Enable streaming mode	YES note (f)	YES note (f)	YES note (f)
#25 Remote load	YES	YES	YES
#26 Remote unload	YES	YES	YES
#28 Remote online	YES	YES	YES
#30 Disable data compression	YES note (g)	YES note (g)	YES note (g)
#31 Enable data compression	YES note (g)	YES note (g)	YES note (g)

NOTES

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

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

(g) - 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.

3.3 Status Differences

The following table lists the differences in status conditions returned by the drive:

STATUS OR CONDITION	PRODUCT: FOXTROT	HP 7979A	HP 7980A
HP-IB Amigo ID (configurable) (configurable)		0179H (0174H)	0180H (0178H) (0181H)
Long record support bit (status byte #2)	SET	SET	SET
Density bits (status bytes #2 and #3)	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)		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	Not applicable	Aborts command, sets door open bit and door open error code #55	Aborts command, sets door open bit and door open error code #55

3.4 Diagnostic Support Differences

The following table lists the differences in diagnostic function support. Diagnostic functions which are common to all products are NOT shown in this table.

DIAGNOSTIC FUNCTION	PRODUCT: FOXTROT	HP 7979A	HP 7980A
RUN SELF TEST	LISTEN SECONDARY and 5 bytes of params		
RETURN SELF-TEST RESULTS	TALK SECONDARY returns 5 bytes		
WRITE FIRMWARE UPDATE	NOT SUPPORTED		
READ FIRMWARE UPDATE	NOT SUPPORTED		

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

Chapter 4 of this ERS

3.5 Protocol Differences, HP 7979 v. Foxtrot

No Protocol Differences have been identified to date.

3.6 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.

3.7 HP-IB Functions

3.7.1 Parallel Poll (Service Request)

The tape drive interface assumes a dedicated fundamental address of 0 through 7 (selected through the front panel) and asserts the corresponding request-for-service line DIO 8 through 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 write record, write file mark and write gap commands while in immediate response mode.
- Completion of any tape command (except for rewind-offline and immediate responsed write commands mentioned above).
- Transparent status message available. This includes soft or hard error status on immediate response write commands.
- Completion of a Run Selftest command.
- Completion of the write phase of the HP-IB Loopback sequence.
- Completion of a Downloaded Diagnostic Test.
- Any condition requiring a parallel poll response within the HP 7970E cold load sequence.
- Error conditions that occur during the command processing. This includes protocol errors.
- Device Clear command from the interface.

3.7.2 Serial Poll (SQR)

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

3.7.3 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. Sections 3.13.2 and 3.13.3 list 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.

3.7.4 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).

3.7.5 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.

3.7.6 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 section 3.12.1). 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 section 3.12.1) To be defined.
MTA [host]

3.7.7 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] (section 3.12.2)
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] (section 3.12.3)
DAB (CRC - MSB)
DAB tagged with EOI (CRC - LSB)
UNT/IFC

3.8 Device Support Requirements

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

3.8.1 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] (section 3.12.2)
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 3.12.2)
READ STATUS (optional) (see section 3.12.3)
END "IDLE" (optional - enables online parallel poll) (see section 3.12.5)

3.8.2 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 (power-on parallel poll)

Identify (optional)
READ DSJ (= 1) (see section 3.12.2)
READ STATUS (not optional) (see section 3.12.3)
READ SELF TEST RESULTS (optional)
END "IDLE" (optional - enables online parallel poll) (see section 3.12.5)

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.

3.8.3 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 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 3.12.2)
READ STATUS (optional) (see section 3.12.3)
END "IDLE" (optional - re-enables the online parallel poll) (see section 3.12.5)

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

3.8.4 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.

3.8.5 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 section 3.12.2) specifying a tape command message. This is followed by a byte representing the actual tape command for the device (section 3.12.4), 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] (section 3.12.2)
DAB (tape command) tagged with EOI if no parameter is specified (section 3.12.4)
DAB (parameter) tagged with EOI (this byte is optional)
UNL/IFC

3.8.6 Read DSJ

To read the DSJ, the interface must be placed in talk mode then the proper secondary is issued (see section 3.12.3). 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] (section 3.12.3)
DAB tagged with EOI (DSJ sent by device, section 3.12.7)
UNT

3.8.7 Read Status

To read the status, the interface must be placed in the talk mode and then the proper secondary issued (see section 3.12.3). The drive will return with 6 status bytes (see section 3.12.6 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] (section 3.12.3)
DAB .
DAB (Status bytes .
DAB sent by drive). (section 3.12.6)
DAB

DAB
DAB tagged with EOI
UNT/IFC

3.8.8 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 section 3.12.3) 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] (section 3.12.3)
DAB (MSB of byte count)
DAB tagged with EOI (LSB of byte count)
UNT

3.8.9 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 (section 3.12.2), then a data byte indicating the type of end (see section 3.12.5).

The HP-IB message sequence is as follows:

UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
MSA [END COMMAND] (section 3.12.2)
DAB tagged with EOI (section 3.12.5)
UNL

3.8.10 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, HP-IB command parity error, position unrecovered, formatter error, servo error, controller error, or non-zero 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 3.12.4)

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]       (section 3.12.3)
DAB (Data Record
 :   read from
DAB  Tape,tagged with EOI)
UNT
END "DATA" - optional
READ CRC - optional
READ DSJ
          tatus should be read if the DSJ = 1.
READ STATUS - optional
READ BYTE COUNT - optional
END "COMPLETE" or "COMPLETE-IDLE"
```

3.8.11 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 64K in DDS 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, HP-IB command parity error, position unrecovered, formatter error, servo error, controller error, or non-zero 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 3.12.4)

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".
     here with an END "COMPLETE".

CLEAR CRC - optional
MLA [drive's address]
MSA [WRITE EXECUTE]      (section 3.12.2)
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 DSJ
READ STATUS - optional

READ BYTE COUNT - optional
END "COMPLETE" or "COMPLETE-IDLE"
```

3.8.12 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), HP-IB 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 non-zero 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 PE 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 3.12.4)

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"
```

3.8.13 Cold Load Sequence

7978 Protocol?

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

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

```
UNT/IFC (if the drive was previously a talker)
MLA [drive's address]
MSA  [TAPE COMMAND]                        (section 3.12.2)
DAB tagged with EOI, 7970 Unit Select
UNL
```

Service Request by tape drive

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

After HP 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]        (section 3.12.3)
|   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.

3.9 Diagnostic Support Requirements

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

3.9.1 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] (section 3.12.2)
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] (section 3.12.3)
DAB (256 bytes returned to user.
 :   Byte 256 is tagged with EOI)
DAB
UNT
```

3.9.2 Self Test

There are two ways in which self tests are initiated:

1) The Host program can initiate selective self tests with the run self test command. (See section 3.12.12 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]      (section 3.12.2)
DAB tagged with EOI (section 3.12.12)
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] (section 3.12.3)
DAB
DAB tagged with EOI (test results, section 3.12.1)
UNT
```

2) 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 be displayed on the front panel LED's.**

3.9.3 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]  (section 3.12.2)
|     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]  (section 3.12.3)
|     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.

3.9.4 Read Log

For diagnostic purposes a host can access the drive's 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 section 3.12.3). 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]     (section 3.12.3)
DAB
DAB ( tape drive's diagnostic log )
DAB
 :
 :
DAB   tagged with EOI
UNT/IFC
```

3.9.5 Write Firmware Update

This command is not supported on Foxtrot.

3.9.6 Read Firmware Update

This command is not supported on Foxtrot.

3.10 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.

3.10.1 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.

3.10.2 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.

3.11 Function and Status Definitions

The functions performed and status returned for the computer, as implemented within the drive, are described here. See sections 3.12.1 and 3.12.2 for a complete summary of available command functions. See section 3.11.3 for available status information.

3.11.1 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 write an amble of 22 frames to the tape.

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

Foxtrot will reject this command and return an error code 7.

16 = Set GCR (6250 bpi) format

Foxtrot will reject this command and return an error code 7.

17 = Set PE (1600 bpi/DDS) format **Foxtrot to accept this command**

This command sets the density of tape to be written as 1600 PE/DDS Format.

18 = Set NRZI (800 bpi) format

Foxtrot will reject this command and return an error code 7.

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

Foxtrot will reject this command and return an error code 7.

20 = Start/Stop mode

Foxtrot will return a "good status" message and do nothing.

21 = Enable streaming

Foxtrot will return a "good status" message and do nothing.

22 = Disable immediate response mode **Check this for Foxtrot**

This command disables immediate reporting of write operations. The report for a write operation will not 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 through 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

Foxtrot will return an error message which is still to be defined.

26 = Remote unload

This command will cause the tape to be unloaded and ejected. If the tape is already unloaded, Foxtrot will return a "Good Status" message.

28 = Remote online

This command will cause the tape to go online. The tape must be loaded before this command will succeed.

30 = Disable data compression

Foxtrot will return a "Good Status" message.

31 = Enable data compression

Foxtrot will return a "Good Status" message.

3.11.2 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 online. 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).

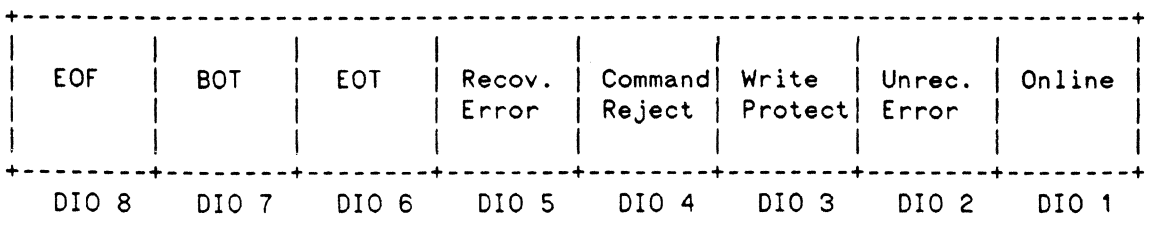
DIO 5 : 1 = Reset DSJ register to 0
0 = No action

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

3.11.3 Status Request Registers

Status Register #1



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.

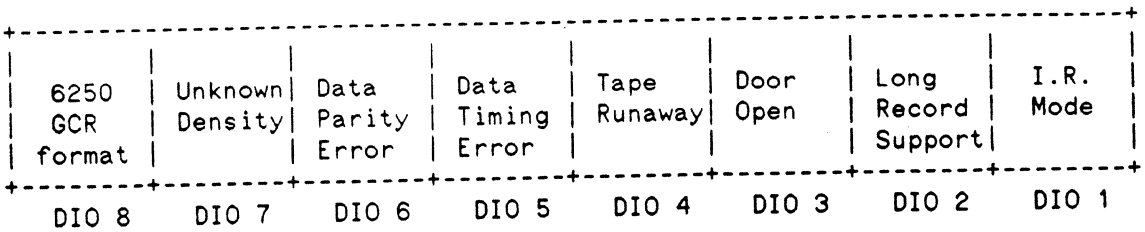
Corrective action for this condition is to inform the user's program.

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 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 is always set to 64K in the DDS format.

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

This bit is always set to zero in Foxtrot.

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

This bit indicates that the drive has read the EOD group. 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 DDS Format 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 DDS with a valid wrote mode command while at load point.

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

This bit will not be set.

Status Register #3

1600 PE/ DDS 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 through 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.

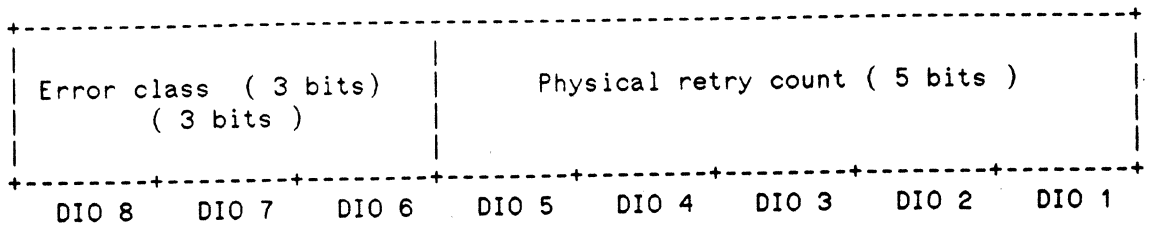
DIO 7: 1 = NRZI (800 bpi) format
0 = Not NRZI format

This bit will always be set to zero.

DIO 8: 1 = PE/DDS (1600 bpi) format
0 = Not PE format

This bit is set upon the identification of a PE/DDS tape or the setting of the tape drive into the PE/DDS format at load point. When this bit is cleared, no tape is loaded or the tape loaded is 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.

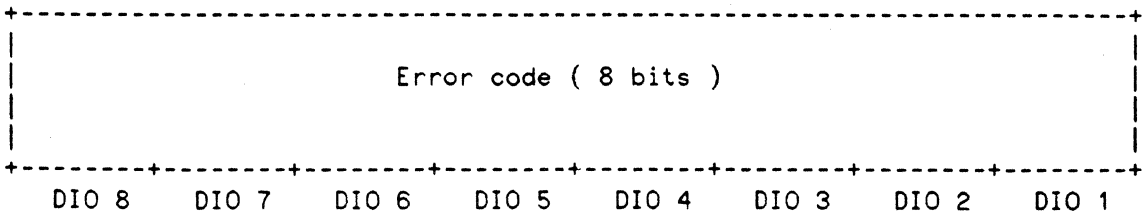
0 = Successful operation complete on first try.
1 = Correctable error detected on first try.
>1 = Number of tries to finally complete the operation, where the success or failure is indicated elsewhere.

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 are 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. This will not occur on the DDS Tape Drive.

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

37 = Tape positioning failure while removing readaheads. *What does this mean?—J. McCarthy.*

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. This will not occur on the DDS Tape Drive.

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 density ID just written.

48 = Noise on detect. Unreadable block of data.

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

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. This will not occur on the DDS Tape Drive.

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

53 = Redundancy check error. The read formatter detected either a CRC, ACRC, LRC, or residual error while reading or verifying a data block. This will not occur on the DDS Tape Drive.

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. (HP 7978B, 7979A, 7980A only). This will not occur on the DDS Tape Drive.

55 = Abnormal command abort, door opened (HP 7974A only). This will not occur on the DDS Tape Drive.

57 = Maximum skew exceeded (HP 7974A only). This will not occur on the DDS Tape Drive.

58 = False preamble or postamble detected (HP 7974A only). This will not occur on the DDS Tape Drive.

59 = Corrected data error on write (HP 7974A only). This will not occur on the DDS Tape Drive.

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. Unreadable block of data.

62 = Tape mark dropout. A full tape width dropout was detected within a tape mark. This will not occur on the DDS Tape Drive.

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. This will not occur on the DDS Tape Drive.

64 = Tape mark timeout. Could not detect the gap following a detected tape mark. This will not occur on the DDS Tape Drive.

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. This will not occur on the DDS Tape Drive.

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 = HP 7978 Read Formatter unresponsive. The read formatter did not respond with end of record status after a data block was detected. This will not occur on the DDS Tape Drive.

102 = HP 7978 Read Formatter hardware error.

103 = Bad block type detected on a write operation. This will not occur on the DDS Tape Drive.

104 = Erase failure. Flux transitions were detected in a portion of tape currently being erased. This will not occur on the DDS Tape Drive.

105 = No data detected after write.

106 = Tracks out of sync on write verify.

107 = HP 7974A formatter hardware error. This will not occur on the DDS Tape Drive.

108 = HP 7974A formatter unresponsive. This will not occur on the DDS Tape Drive.

109 = No gap timeout. The gap timer did not count down, or was never started. This will not occur on the DDS Tape Drive.

110 = Formatter byte count mismatch with data buffer. This will not occur on the DDS Tape Drive.

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. This will not occur on the DDS Tape Drive.

122 = No pending command found for report received from Device program. This will not occur on the DDS Tape Drive.

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. This will not occur on the DDS Tape Drive.

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.

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.

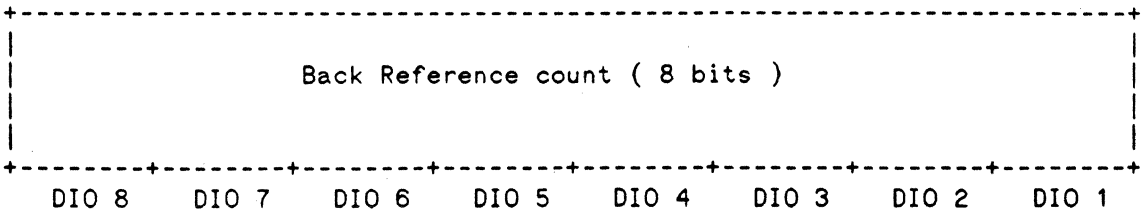
185 = Run self test protocol error.

188 = HP-IB command parity error.

189 = Reset by operator during a protocol sequence. This will not occur on the DDS Tape Drive.

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.

3.11.4 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, section 3.12.8. The exact causes of the DSJ being set to 1 are different than for the HP 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.

3.11.5 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 HP 7978, 7979A, and 7980A. Read record, write record and write file mark commands will use recovery on the HP 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.

Refer to the DDS Format Specification for the retry algorithms.

3.11.6 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 re-transmitted.

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.

3.11.7 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)

3.11.8 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.

3.11.9 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)

3.12 Additional Information

3.12.1 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 7980A	01H	80H
**	" "	"	78H
***	" "	"	81H
****	HP 7970E	01H	83H
****	HP 7976A	01H	76H
	FOXTROT	01H	?????

* = 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 7980A with data compression may be configured to to identify with an unique ID to differentiate it from a non compressed drive.

**** = shown for informational purposes only

3.12.2 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 section 3.12.4).
01100100	4	DOWNLOAD DIAGNOSTIC Data bytes to follow represent the downloaded diagnostic test routine to be executed.
01100110	6	WRITE FIRMWARE UPDATE Data bytes to follow represent the firmware update record to be stored in EEPROM. (not supported)
01100111	7	END COMMAND Data byte to follow represents an "End command" (see section 3.12.5).
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.

3.12.3 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 section 3.12.6).
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.
11100101	5	READ LOG The diagnostic log information is returned.
11100110	6	READ FIRMWARE UPDATE The firmware update code in EEPROM is returned. (not supported>
11110111	15	READ EXTENDED STATUS (HP 7979A/7980A) The 16 byte extended status message is returned. The format is the 6 bytes of HP-IB status followed by a ten 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 the notes in section 3.12.2.

3.12.4 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

3.12.5 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).

3.12.6 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/DDS (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.

```
        - - - - - - - Status Register #4 - - - - - - -

DIO Lines
   1-5      = Retry count.
   6-8      = Command rejected error class (decimal).
              0 - No command reject
              1 - Reserved.
              2 - Device Reject.
              3 - Protocol Reject.
              4 - Reserved.
              5 - Reserved.
              6 - Reserved.
              7 - Self Test Failure.

- - - - - - - Status Register #5 - - - - - - -
```

This byte contains binary coded information regarding the specific error encountered.

```
- - - - - - - Status Register #6 - - - - - - -
```

This byte is used only with transparent status messages of soft and hard errors in immediate response mode. It contains the number of commands pending at the time of the error.

See section 3.11 for a complete description of the status registers.

3.12.7 DSJ Register

Device Specified Jump Definitions

Value	meaning
0	No special action required
1	Unexpected status, read status should be performed.
2	Transparent status message, read status should be performed.

3.12.8 DSJ Table

STATUS CONDITIONS	write record	write file mark	write gap	read record	forward space record	backspace record	forward space file	backspace file	rewind-identify	rewind-offline	write GCR mode	write PE mode	write NRZI mode	start/stop or streaming	disable or enable immediate response
Not Online (Offline)	c	c	c	c	c	c	c	c	c	c	c	c	c	c	c
Unrecovered error	1	1	1	1	-	-	-	-	-	-	-	1	1	1	-
Write protected	c	c	c	0	0	0	0	0	0	0	c	c	c	0	0
Command rejected	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Recovered error check	s	-	-	s	-	-	-	-	-	-	-	-	-	-	-
Beyond End of Tape (EOT)	s	1	1	s	1	1	1	1	-	-	-	-	-	0	0
Load Point (BOT)	-	-	-	-	-	1	-	1	0	0	0	0	0	0	0
End Of File (EOF)	-	0	-	1	1	1	0	0	-	-	-	-	-	0	0
Rewinding	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
Tape runaway	-	-	-	1	1	1	1	1	-	-	-	-	-	-	-
Data timing error	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Data parity error	s	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Unknown density	c	c	c	c	c	c	c	c	-	-	1	1	1	-	-
GCR mode	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Controller error	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Servo error	s	1	1	1	1	1	1	1	1	1	1	1	1	1	-
Formatter error	s	1	-	1	-	-	-	-	-	-	1	1	1	1	-
Position unrecovered	s	1	1	1	1	1	1	1	1	1	1	1	1	1	-
HP-IB cmd. parity error	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Power just restored	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
NRZI mode	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PE/DDS mode	0	0	0	0	0	0	0	0	0	0	0	-	0	-	-
Non zero retry count	1	1	1	1	1	1	-	-	-	-	1	1	1	-	-

0 : Condition will not cause a DSJ of one.
1 : DSJ of one.
s : DSJ following data transfer set to one.
c : DSJ of one due to command reject.
- : This condition should never occur.

3.12.9 7979A/7980A Error Cross Reference

The following tables list the HP-IB reported error codes and their corresponding HP 7979A/7980A internal (CCL) error codes which could have occurred. For descriptions of the HP-IB error codes see section 3.11.3, status register #5. For descriptions of the CCL error codes see section 3.12.10.

HB-IB ERROR	POSSIBLE 7979A/7980A INTERNAL (CCL) ERROR CODES
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
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

Subject to change

HB-IB ERROR	POSSIBLE 7979A/7980A INTERNAL (CCL) ERROR CODES
102	42, 74
104	80
105	93
129	92, 160, 161, 220
130	64
131	162
140	25, 26, 163, 164
141	128
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
255	3, 5, 7, 8, 9, 14, 18, 19, 20, 21, 23, 28, 29, 30, 31, 117

Subject to change

3.12.10 7979A/7980A CCL Errors

Subject to change. Possibility of modifications and additions.

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 3.11.3, 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 (section 3.12.9).

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.
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 accessible.
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 power-on 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 read.

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.
49 (31H) = Block overrun.
50 (32H) = False ID block detected.
51 (33H) = Bad tape mark read.
52 (34H) = Hitch into a block failed.
53 (35H) = Hitch into a gap failed.
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.

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.

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.
117 (75H) = Tape eject timeout.
118 (76H) = Door open abort.
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.

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) = Interface data parity error.
161 (A1H) = Drive data parity error.
162 (A2H) = Byte count mismatch.
163 (A3H) = Prior error reject.
164 (A4H) = Write stopped at EOT.
165 (A5H) = Zero byte count record read or requested.
166 (A6H) = Final report not valid.
167 (A7H) = Tape runaway during manual commands.

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.

3.12.11 Diagnostic Self Tests

Refer to Chapter 4.

3.12.12 Self Test Results

Refer to Chapter 4.

Diagnostics 4

This chapter is based on the information taken from the following document:

HP 7979A, HP 7980A and HP 88780A Diagnostic ERS.

4.1 Diagnostic Test Function

Due to the lack of front panel selection of these tests, the tests can only be run via host commands (with the exception of those tests which run at power-on).

4.1.1 Initiating a Test

The host sends a "RUN HP 7979A / 7980A SELF TEST" command (1DH), with five (5) bytes of test information to follow. The five bytes are specified as follows:

Byte	Description
1	Test number to be run
2	Loop count for test
3 - 5	Any parameters needed for the test

4.1.2 Obtaining Results of a Test

Results are obtained by issuing a "READ EXTENDED SELF TEST STATUS" command (1DH), which is followed by five (5) bytes of the results of the self-test command. The five bytes are specified as follows:

Byte	Description
1	Power-on error (B7) Time resync (B6) Error set (B3-B0)
2	Error code
3	FRU 1
4	FRU 2
5	Test number ran

4.1.3 Test Descriptions

Diagnostic tests will inherently exercise some portion of the drive. There are three classes of diagnostic tests.

EXERCISERS	- These tests cause the drive to perform some specific function allowing it to be observed or monitored in operation. They do not inherently return an error unless an invalid setup prevents the test from operating.
TESTS	- These tests are written such that the drive can detect when a failure has occurred. They are self contained and return either a passed or failed response at the completion of the test.

Sequences may combine both exercisers and tests, but will typically not include checks because of their interactive nature.

All three forms of tests are listed with any additional parameters, or special requirements, and with a description of the test. The format of each test listed is as follows:

```
-------------------------------------------------------------------
TEST #  -  TEST NAME       (Additional Parameters) (special requirements)

          Description of the test
-------------------------------------------------------------------
```

4.1.3.1 Sequence Tests (0 - 14)

0 - HOST CONTROLLED SELF-TEST

Checks out all digital data paths and normal machine operation. Th sequence runs tests that are similar to those normally run at power The tests for each controller are run serially here rather than in parallel as in actual power-up.

Sequence Order:

```
0D - Drive Controller Power-on sequence
0E - Buffer Controller Power-on sequence
0F - Interface Power-on sequence
09 - Multi-processor Sequence
```

1 - GENERAL CHECKOUT (scratch tape required)

This test performs a complete machine checkout. It runs all power-on tests, then loads a tape and checks out all sensors. It then runs the tests in the multi-processor, sensor, and wellness sequences.

Sequence Order:

```
00 - Power On
A5 - Load Tape
02 - Wellness Test
```

2 - WELLNESS TEST (scratch tape required)

This test needs to be redefined for Foxtrot

This test checks out the general read/write capability of the HP 7979A or 7980A. The sequence includes the tests necessary to write a GCR tape, rewind and read the tape, rewind, write the tape in PE, rewind and read the PE tape, then rewind.

During the write process, the enter key causes the write to end early so that the entire tape is not written. The subsequent read pass will only read as far as the write pass had written.

Sequence Order:

```
A5 - Load Tape
AE - Clear Data Buffer
AB - Create Record in Buffer    (A = 1, all zeros)
                                (B =  4K)
AB - Create Record in Buffer    (A = 2, all ones)
                                (B =  16K)
AB - Create Record in Buffer    (A = 3, rotating)
                                (B =  32K)
96 - Write Density ID           (A = 6250/DDS)
AC - Write Buffer to Tape       (A = 1)
                                (loop)
AE - Clear Data Buffer
AA - Write Tape Mark to Buffer
AC - Write Buffer to Tape       (A = 3)
AC - Write Buffer to Tape       (A = 3)
A6 - Rewind
AD - Read From Tape to Buffer   (A =  0)
                                (loop)
A6 - Rewind
AE - Clear Data Buffer
```

3 - INITIALIZE ERROR RATE SEQUENCE

Sequence 3 initializes the cumulative logs in preparation to running error rate.

Sequence Order:

AF - Initialize cumulative logs

4 - ERROR RATE SEQUENCE (scratch tape required)

This test needs to be redefined for Foxtrot

Sequence 4 writes a tape in GCR, rewinds and reads it, then perform the same operations in PE. While the sequence runs, read/write errors are recorded in the cumulative error rate log. The error rate results are viewed in the cumulative error rate logs from INFO 3,4,and 5. Error rate results are accumulated until sequence 3 is used to initialize the log.

The error rate sequence operates very similar to the wellness test but differs in that hard read and write error do not terminate the error rate test. Only Hard Errors are logged.

Sequence Order:

```
A5 - Load Tape
AE - Clear Data Buffer
AB - Create Record in Buffer    (A = 1, all zeros)
                                (B =  4K)
AB - Create Record in Buffer    (A = 2, all ones)
                                (B =  16K)
AB - Create Record in Buffer    (A = 3, rotating)
                                (B =  32K)
96 - Write Density ID           (A = DDS)
AC - Write Buffer to Tape       (A = 5)
                                (loop)
AE - Clear Data Buffer
AA - Write Tape Mark to Buffer
AC - Write Buffer to Tape       (A = 7)
AC - Write Buffer to Tape       (A = 7)
A6 - Rewind
AD - Read From Tape to Buffer   (A =  4)
                                (loop)
A6 - Rewind
AE - Clear Data Buffer
```

9 - MULTI-PROCESSOR SEQUENCE

This sequence will execute all multi-processor tests to check out the communication between processors, the message bus, and data transfer paths. It will normally be called after each processor has executed its individual power-on sequence and established communications at power-up.

Sequence Order:

```
0B - Dual-Port RAM Test Sequence
3D - Buffer Initiated Loopback Test  (param B = 3)
3C - Interface Initiated Loopback Test
```

0B - DUAL-PORT RAM SEQUENCE

This sequence will perform all tests on the dual-port ram between all target processors.

Sequence Order:

```
32 - DPR On Board Test  (A =  3, DC)
33 - DPR Off Board Test (A =  4, BC)
32 - DPR On Board Test  (A =  4, BC)
33 - DPR Off Board Test (A =  6, IF)
35 - DPR Interrupt Test (A =  4, DC to BC)
36 - DPR Interrupt Test (A =  3, BC to DC)
36 - DPR Interrupt Test (A =  4, IF to BC)
34 - DPR Interrupt Test (A =  3, BC to DC)
34 - DPR Interrupt Test (A =  4, IF to BC)
```

0C - LOOPBACK ISOLATION SEQUENCE

This sequence will execute all Interface, Buffer initiated, and Formatter initiated loopback isolation sequences. All hardware areas used by loopbacks will be checked out. Each loopback test is stepped through and a loopback problem should be isolated. Each test will be executed with a loopback check number (param A) of zero and will run all loopback checks.

Sequence Order:

```
19 - Buffer Hardware Sequence
3D - Buffer Initiated Loopback test (param B  3, rotating)
14 - Interface Specific Hardware Sequence
3C - Interface Loopback Test
```

OD - DRIVE CONTROLLER POWER-ON TEST SEQUENCE

This sequence will be executed by the drive controller at power-up to check out all paths and operation of the servo and motor drive circuitry.

Sequence Order:

29 - Checksum
28 - Processor Test
2B - Non-Destructive Ram Test
2D - Connectivity Test (may be deleted)
31 - Timer Circuitry Test
46 - Front panel check
11 - Servo/Motor Drive Electronics Sequence
(Needs to be redefined for Foxtrot)

OE - BUFFER CONTROLLER POWER-ON TEST SEQUENCE

This sequence will be executed by the buffer controller at power-up and will check out all paths and operation of the buffer circuitry.

Sequence Order:

29 - Rom Checksum
28 - Processor Test
30 - Non-volatile Ram Checksum
2B - Non-destructive Ram Test
2D - Connectivity Test (may be deleted)
13 - Buffer Hardware Sequence

OF - INTERFACE POWER-ON TEST SEQUENCE

This sequence will be executed by the interface controller at power-on and will check out all paths and operation of the specific interface

Sequence Order:

29 - Rom Checksum
28 - Processor Test
2B - Non-Destructive Ram Test
2D - Connectivity Test (may be deleted)
14 - Interface Specific Hardware Sequence

11 - SERVO/MOTOR DRIVE ELECTRONICS SEQUENCE (no scratch tape)

This sequence needs to be redefined for Foxtrot).

This sequence will check out the operation of the servo and motor drive circuitry. These sequence tests are non-interactive.

Sequence Order:

4E - ADC Test ? Drum test
4C - DAC Test ? Thread/Unthread with cartridge
52 - QDC Test ? Write data Exerciser
4D - Tachometer Test ? Reel Test
51 - 48 Volt PSU Test
50 - Motor Drive Loopback ? Capstan Test

12 - SERVO/MOTOR DRIVE CHECKOUT SEQUENCE (scratch tape required)

This sequence needs to be redefined for Foxtrot).

Sequence Order:

A5 - Load Tape
5F - Servo Performance Test
60 - Servo Repositioning Test
A6 - Rewind Tape
A7 - Unload Tape

13 - BUFFER HARDWARE SEQUENCE

This sequence will checkout the data path and operation of the data buffer registers and ram. It will isolate any problems specific to the data buffer.

Sequence Order:

78 - Buffer Register Test
79 - Buffer Function Test
7A - Buffer Ram Test

14 - INTERFACE SPECIFIC HARDWARE SEQUENCE

This sequence will run through all of the interface specific hardware tests.

Sequence Order:

8C - Interface Specific Test 1

4.1.3.2 Kernal Tests (28-31)

Note: all kernel tests and certain multi-processor tests require a Target processor parameter. These tests are common to more than one processor and as such the processor must be specified. The possibilities are as follows:

```
TARGET PROCESSOR

    All Processors          0
I - Interface Controller    6
B - Buffer Controller       4
D - Drive Controller        3
```

The default processor is "All processors" With all processors set each processor which has the test defined, will execute the test, beginning with the interface controller, and ending with the drive controller.

28 - MICROPROCESSOR OPERATION TEST param A = processor (I,B,D)

A functional check of the microprocessor subsystem is performed

29 - ROM CHECKSUM param A = processor (I,B,D)

A checksum verification of the ROM is performed

2A - DESTRUCTIVE RAM TEST Interface Only

Volatile ram is tested, checking for data acceptance and retention. The test insures that writing to one location has no affect on other locations. This test is destructive and as such will only run at power-on.

2B - NON-DESTRUCTIVE RAM TEST param A = processor (I,B,D)

Ram is tested, checking for data acceptance and retention. The test is non-destructive. This test is used at power-on for non-volatile ram and while running the power-on test sequence for all ram areas.

2C - COMPLETE RAM TEST param A = processor (I,B,D)

Ram is fully tested for data acceptance and retention. The test also insures that no memory cells affect other cells within the ram. This test is non destructive and may be used without power-cycling the drive, but does require extended times to run.

```
Drive_controller   -   17 minutes
Buffer controller  -   72 minutes
Interface controller - 04 minutes
```

2D - CONNECTIVITY TEST param A = processor (I,B,D)

All connectors are checked for proper connectivity.

2E - DESTRUCTIVE DUAL-PORT RAM TEST (B,D)

The dual-port ram is tested using the destructive ram test. This test is destructive and is only run at power-on. This test cannot be run from the Host.

30 - NON-VOLATILE RAM CHECKOUT (B)

A ram test and checksum verification of the controlled portion of non volatile ram is performed.

31 - TIMER CIRCUITRY TEST ,D)

This sequence needs to be redefined for Foxtrot.

The PTM is checked for proper counting. The oscillator is used to verify the STS has the proper period.

4.1.3.3 Processor Communication Tests (32 - 36)

32 - ONBOARD DPR TEST param A = processor B,D

This test allows the DPR to be checked out from the subordinate side The test performs a walking ones and zeros test in a non-destructive manner. All of the ram may be accessed for checking with the exception of the master interrupt location.

33 - OFFBOARD DPR TEST param A = processor I(B),B(D)

This test allows the DPR to be checked out from the master side. The test performs a walking ones and zeros test in a non-destructive manner. All of the ram may be accessed for checking with the exception of the subordinate interrupt location.

34 - DPR COLLISION TEST param A = processor I(B),B(D)

This test checks DPR arbitration by creating read/write collisions at the DPR. The two processors then pass incrementing information back and forth through the diag message area (DPR location 084H).

35 - SUBORDINATE DPR INTERRUPT TEST param A = processor I(B),B(D)

This test verifies the ability of the master to interrupted by the subordinate through the DPR. The test is initiated by the target processor sending a multi-processor command with the parameter set to "subordinate interrupt". The receiving processor will write the interrupt test value to the interrupt location of the DPR then report on the command.

36 - MASTER DPR INTERRUPT TEST param A = processor B(I),D(B)

This test verifies the ability of the subordinate to be interrupted by master through the DPR. The test is initiated by the target processor sending a multi-processor command with the parameter set to "master interrupt". The receiving processor will write the interrupt test value to the interrupt location of the DPR then report on the command.

4.1.3.4 Loopback Tests (3C - 41)

```
3C - INTERFACE LOOPBACK TESTS        param A = Loopback check number  I
```

The interface uses manual CCL commands to communicate with the data buffer. Parameter 3 indicates the extent of the test:

```
param A       loopback check                    expected result

  0 - run all loopback checks from 1 through 3

  1 - loopback correct data                    = no error

  2 - data to buffer with a parity error       = data parity error
      (NOTE: This test option not available on HP-IB interface)

  3 - data from buffer with a parity error     = data parity error
```

```
3D - BUFFER INITIATED LOOPBACK TESTS   (param A - loopback type)
                                       (param B - data pattern)
```

Data is generated within the buffer then looped through the formatter using the multi-processor loopback command. Parameter A indicates the extent of the test:

```
Parameters to be defined
```

4.1.3.5 Drive Controller Tests (46 - 77)

46 - FRONT PANEL CHECK SHOW F

48 - 6.6V SUPPLY TEST Checks that the 6.6V supply is within upper/lower limits.

4B - THREAD/UNTHREAD with no cartridge

The thread mechanism is exercised to check the rotary sensor and limit switch. The reel FG is checked to make sure a cartridge is not present during the the test (which may indicate a recognition switch failure).

- Unthread Timeout
- Position Sensor Error
- Reel FG detected
- Thread Timeout

Checks the thread mechanism during unthreading

-Unthread Timeout
- S-Reel circuit failure
- position sensor error
- no reel FG
- S-Reel FG too high

4C - THREAD/UNTHREAD with cartridge

Checks the thread mechanism during loading

- Thread Timeout
- Position Sensor Error
- No Reel FG
- Thread Circuit Failure

4D - REEL TEST (no cartridge) D

Checks the reel motor drive circuits (D/A and A/D) and the reel FG and speed control circuits.

- Drive voltage loopback failure (too high)
- S-Reel FG loopback failure (too high)
- S-Reel FG loopback failure (too low)
- T-Reel FG loopback failure (too high)
- T-Reel FG loopback failure (too low)
- Reel Brake Failure

4E - Drum Test

Tests the correct operation of the drum servo and control circuitry. The drum speed ramps are checked as well as the phase lock time.

- *drum PG loopback failure (too high)*
- *drum loopback failure (too low)*
- *drum phase-lock timeout*
- *drum speed ramp too slow*
- *drum speed ramp too fast*

50 - CAPSTAN TEST

Checks correct operation of the capstan servo and control circuitry, the ability to drive the capstan at all forward and reverse speeds within the tolerance limits is tested. The reverse-enable detector is checked.

- *capstan speed ramp too slow*
- *capstan FG loopback failure (too high)*
- *capstan FG loopback failure (too low)*
- *abnormal ATF error signal*
- *capstan speed-change timeout*
- *reverse-enable not detected*

52 - POSITION COUNTER TEST (tape must be unloaded)

CHAN_A and CHAN_B bits are toggled on the QDC. Proper counts are checke for.

52 - WRITE DATA EXERCISER (this test is run by the drive)

54 - READ DATA EXERCISER D

55 - WRITE DDS DATA EXERCISER (this test is run by the drive)

56 - REPOSITION EXERCISER D
Use this test with caution as it wears the tape heads.

57 - LOAD/SEMI-LOAD EXERCISER D

58 - SEARCH EXERCISER D
Use this test with caution, it wears the head.

59 - BOM/EOM EXERCISER D

BUFFER CONTROLLER TESTS (120 - 129)

78 - BUFFER REGISTER TEST

Write to and read values from all of the buffer registers to verify their data acceptance and retention.

79 - BUFFER FUNCTION TEST

Perform push and pop operations from the buffer controller, verifying counter and address operation, parity circuitry, and prefetch latch

7A - BUFFER RAM TEST

Buffer ram is tested for data acceptance and retention. The test is destructive to data in the data buffer.

80 - DUMP NV RAM TO TAPE (scratch tape required)

The non-volatile ram of the data buffer is dumped written onto the tape as the first record, and with the appropriate header. This test should be run prior to replacing the battery.

81 - LOAD NV RAM FROM TAPE (pre-written dump tape required)

The non-volatile ram of the data buffer is loaded from the tape. The record must be the first record on the tape and have the appropriate header as is described in appendix ??. This test is used to reload non-volatile ram information following the changing of the battery.

4.1.3.6 HP-IB Interface Controller Tests (8C - 91)

8C - HP-IB CONTROLLER TEST

Checks out operations of the HP-IB controller chip.

4.1.3.7 Drive Command Execution (96 - C8)

All of these commands with the exception of host to buffer commands require that a scratch tape be loaded.

96 - WRITE LEAD-IN AREA

98 - WRITE END-OF-DATA

99 - WRITE AMBLE

A0 - FAST SEARCH

A1 - SPACE GROUP FORWARD

Single groups are spaced over without verifying any data in the groups.

A2 - SPACE GROUP REVERSE

Single groups are spaced over without verifying any data in the groups.

A5 - LOAD TAPE

A6 - REWIND

A7 - UNLOAD TAPE (param A door control)

param A	door control
0 -	Unload but do not eject
1 -	Unload and eject

Test AA-B2 are run by the buffer controller and will perform retries.

AA - WRITE TAPE MARK TO BUFFER

A tape mark entry is generated in the buffer without writing it to tape.

AB - CREATE RECORD IN BUFFER (param A pattern)
(param B record size)

A record is created in the buffer without writing it to tape. The pattern parameter indicates the type of data to be generated.

param A	pattern
0 -	all zeros
1 -	all ones
2 -	alternating all zeros, all ones
3 -	rotating data bytes (0 .. 255)

```
        4 -   pseudo random data
        5 -   use existing data in buffer ram
        6 -   rotating data with parity error on the last byte

    param B     record size

        0 -     1 byte
        1 -   256 bytes
        2 -     1K
        3 -     4K
        4 -    16K
        5 -    32K
        6 -    64K
        7 -   128K
        8 -   256K
```

AC - WRITE BUFFER TO TAPE (param A retain_data / next write control)

Write the group which is the next entry in the queue to tape. The following parameters affect the write.

```
    remove      - remove group from buffer following the write
                  Note that if the test is looped more times than there
                  are buffer entries, the test will fail with an empty
                  buffer.
    retain      - retain group in buffer following the write
    stream      - attempt to stream by starting to write the next group
                  in the buffer.  If no write is received, the startup is
                  aborted and the tape repositioned.
    single      - do not startup the next write.  Streaming will not occur
    err normal  - fail on all errors.
    err bypass  - fail on all errors except write errors.
                  write errors will be logged in the error and
                  error rate logs and can can be displayed using INFO

    param A

        0 - remove / stream / err normal
        1 - retain / stream / err normal
        2 - remove / single / err normal
        3 - retain / single / err normal
        4 - remove / stream / err bypass
        5 - retain / stream / err bypass
        6 - remove / single / err bypass
        7 - retain / single / err bypass
```

AD - READ FROM TAPE TO BUFFER (param A retain data / readahead control)

A group is read from the tape into the data buffer. The following parameters affect the read.

```
remove      - remove group from buffer following the read
retain      - retain group in buffer following the write
              Note that if the test is looped more times than there
              is room left in the buffer, the test will fail with a
              full buffer.
stream      - attempt to stream by starting to read the next group
              from the tape.  If no read command is received, the
              startup is aborted and the tape repositioned.
single      - do not startup the next read.  Streaming will not occur
err normal  - fail on all errors.
err bypass  - fail on all errors except read errors.
              read errors will be logged in the error and
              error rate logs and can can be displayed using INFO

param A

    0 - remove / stream / err normal
    1 - retain / stream / err normal
    2 - remove / single / err normal
    3 - retain / single / err normal
    4 - remove / stream / err bypass
    5 - retain / stream / err bypass
    6 - remove / single / err bypass
    7 - retain / single / err bypass
```

AE - CLEAR DATA BUFFER

All entries in the data buffer are removed.

AF - INITIALIZE CUMULATIVE LOG

The cumulative logs are cleared.

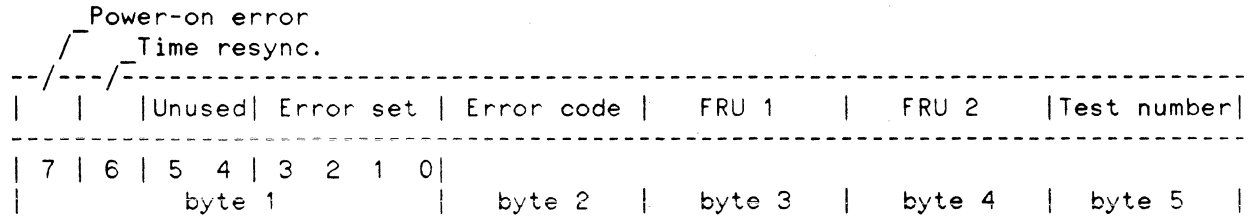
BO - READ VENDOR GROUP

The information in the following section is subject to change.

4.1.4 Diagnostic Result Message

4.1.4.1 Result Message Structure

All error messages are of the same format. All fields within the error message may not be known or applicable. An unknown field is cleared to Zero. All zeros is used only as a diagnostic result and indicates no error detected, i.e. PASSED.



Power-on error - This bit is set when an error occurs during power-on selftest.

Time resync. - This bit indicates that the time stamp saved with the error log has no relation to that of the previous entry. It is only set by the logging routine within the data buffer as an error is logged.

Complete error -The complete error message which is displayed on the front panel consists of the Error set combined with the error code.

Error set - Various sets of error codes exist The definition of the error is dependent upon which set it is taken from as follows:

- 0 - Runtime errors
- 3 - Drive controller diagnostic errors
- 4 - Buffer controller diagnostic errors
- 6 - Interface controller diagnostic errors
- C - Multi-processor errors (loopback and DPR)
- F - Operational status (for internal use, not logged)

Error code - Error codes for each error set are defined later within this appendix.

FRU 1 and 2 - Up to two FRUs may be identified by the drive as being at fault. Two isolated FRUs may be specified if the fault has been isolated to being within the interaction of the two units. If only one FRU is being identified, the remaining FRU should be set to Zero. Both FRUs are set to Zero if an error is merely detected, or if an operational status message is being sent.

Test number - The individual test number (not sequence number) which failed is included.

4.1.4.2 Error Codes

4.1.4.2.1 RUNTIME/OPERATIONAL STATUS CODES.

0XX(hex)

000 = No error
001 = No tape is loaded
002 = Drive is not online
003 = Drive is not offline
004 = Drive is write protected
005 = Tape loaded prevents access to test
006 = Front door or top cover is open
007 = Test is currently in diagnostic mode
008 = Drive is not in diagnostic mode
009 = Not streaming error
00A = Invalid format on read
00B = Invalid format on write
00C = Not at BOT for a write ID
00D = Backspace at BOT requested
00E = Tape past EOT
010 = Invalid cmd error
011 = Invalid param error
012 = Invalid test/info number
013 = Test not remotely accessible
014 = Test aborted by reset
015 = Nested sequence error
016 = Density NA error
017 = Invalid target id
018 = Requested record length exceeded maximum supported
019 = Write record request did not precede write record transfer
01A = Write record transfer did not follow write record request
01B = Command rejected due to power-on selftest failure
01C = Buffer is empty, cannot retrieve a record from buffer
01D = Buffer is full, cannot place a record in buffer
01E = Block header invalid for a non-volatile memory load

4.1.4.2.2 READ ERRORS.

020 = Buffer overrun error
021 = Gap before EOD error
022 = 2 or more Tracks in error
023 = 2 Tracks in error
024 = 1 Track in error
025 = CRC error
026 = ACRC error
027 = Residual error
028 = Reserved1 RF error
029 = Reserved2 RF error
02A = Unknown RF error
02B = Block timeout error
02C = Block detect error
02D = End block error
02E = Bad gap after ID error
02F = Gap check error
030 = Short postgap error
031 = Block overrun error
032 = False ID block error
033 = Bad tape mark error
034 = Hitch into block error
035 = Hitch into gap error
039 = Bad NRZI tape mark read
03A = Tracks with gain too low during read channel autocalibration
03B = Tracks with gain too high during read channel autocalibration
03C = Tracks with gain too low and high during read channel autocal.

4.1.4.2.3 WRITE ERRORS.

040 = Buffer underrun error
041 = Gap before EOD error
042 = 2 or more Tracks in error
043 = 2 Tracks in error
044 = 1 Track in error
045 = CRC error
046 = ACRC error
047 = Residual error
048 = Reserved1 RF error
049 = Reserved2 RF error
04A = Unknown RF error
04B = Block timeout error
04C = Block detect error
04D = End block error
04E = Bad gap after ID error
04F = Gap check error
050 = Erase verify error
051 = PE ID detect error
052 = PE ID verify error
053 = GCR ID detect error
054 = GCR ID verify error
055 = GCR burst detect error
056 = GCR burst verify error
057 = GCR ARA detect error
058 = GCR ARA verify error
059 = Bad TM detect error
05A = Bad TM verify error
05B = Bad pregap error
05C = Buffer parity error
05D = No data detect error
05E = No TM detect error
05F = No ID detect error

4.1.4.2.4 SERVO ERRORS.

060 = Tension shutdown error
061 = Tape speed error
062 = Tape ramping error
063 = Servo unresponsive error
06E = No reel found error
06F = Hub lock error
070 = Reel not seated error
071 = Reel inverted error
072 = Tape stuck to reel error
073 = Tape stuck in path error
074 = Tape tensioning error
075 = Tape eject error
076 = Door open error
078 = No BOT detected
079 = Operator reset abort of tape operation.
07A = Host reset abort of tape operation.
07D = Block missing error
07E = Gap recapture error
07F = Block recapture error
080 = Reel encoder failure
083 = Unable to thread tape
084 = Open loop motor error
085 = Gap timer circuitry check failed

4.1.4.2.5 BUFFER ERRORS.

```
0A0   = Pop parity error
0A1   = Push parity error
0A2   = Byte count mismatch
0A3   = Prior error reject
0A4   = Write stopped at EOT
0A5   = Zero byte record read or requested
0A6   = Final report not valid
0A7   = Tape runaway during manual commands
0A8   = Tape position synchronization mismatch
0A9   = Physical data record too small to deblock
0AA   = Invalid pointer found during deblocking of physical record
0AB   = Access table contents were invalid
0AC   = Access table contents were incomplete
0AD   = Improper byte count sum of access table entries

0B0   = Hardware error detected in data compression (XC) circuitry
0B1   = Bad parity detected from Data compression circuitry
0B2   = Data compression circuitry not properly flushed of data
0B3   = Bad parity detected from interface into data compression hardware
0B4   = Bad parity detected from buffer into data compression hardware
0B5   = Data compression-to-interface byte count mismatch
0B6   = Data compression-to-buffer byte count mismatch
```

4.1.4.2.6 INTERFACE ERRORS (HP-IB interface only).

```
0C0   = Request DSJ expected Error
0C5   = Data byte expected Error
0C6   = Missing EOI error
0C8   = Command phase Error
0CC   = Cold load protocol Error
0CD   = HP-IB sequence protocol error
0CE   = End complete expected Error
0D0   = End data expected Error
0D2   = Improper secondary Error
0D3   = Misplaced data byte Error
0D6   = Loopback protocol Error
0D7   = Selftest protocol Error
0DA   = HP-IB parity error
0DB   = Reset by operator Error
0DC   = Data parity error
0F0   = Invalid tape command
0F1   = Self test failure
```

4.1.4.2.7 DRIVE CONTROLLER DIAGNOSTIC ERROR CODES.

3XX

301 = ROM checksum error
302 = Ram test error (destructive data)
303 = Ram test error (non-destructive)
304 = Complete RAM test error
307 = Connectivity test error
308 = Timer error
309 = Micro-processor test error
314 = Buffer controller not responding to DPRAM
346 = Optical sensors cable not connected
347 = Motor Drive cable not connected
348 = Speed Encoder cable not connected
349 = Tension Arm cable not connected
34A = Front Panel cable not connected
34B = Interface cable not connected
34C = Interface cable plugged into Slave connector
34D = Slave cable plugged into Interface connector
34E = 48 Volt PSU failure
34F = A to D converter failure
350 = Speed DAC failure
351 = Feed Forward circuit failure
352 = Gain/Load DAC failure
353 = Supply Motor loopback failure
354 = Take-up Motor loopback failure
355 = Quadrature Decoder failure
356 = Tachometer circuit failure
357 = Door failed to open
358 = Excess tension arm motion
359 = Servo ramps too slow
361 = Tape speed error
362 = Tape ramping error
364 = TDU inoperative
365 = TDU is slow
366 = TDU is slightly slow
36E = Track already triggered
36F = Track would not trigger
372 = Missing or unsupported revision R/W assembly

3FF = Buffer controller not responding

4.1.4.2.8 BUFFER CONTROLLER ERROR CODES.

4XX

401 = ROM checksum error
402 = Ram test error (destructive data)
403 = Ram test error (non-destructive)
404 = Complete RAM test error
405 = Error in testing controlled area of non-volatile RAM
407 = Connectivity test error
409 = Micro-processor test error
40A = Error in checksum of controlled area of non-volatile RAM
433 = Parity error in Push data
434 = Parity error in Pop data
435 = Error found in prefetch circuitry
436 = Pop data mismatch in buffer function test
437 = Push end of data status error
438 = Push interrupt circuit error
439 = Pop end of data status error
43A = Pop interrupt circuit error
43E = Error in buffer dynamic RAM test
446 = Error in Push counter extend register of buffer USM
447 = Error in Push counter upper register of buffer USM
448 = Error in Push counter lower register of buffer USM
449 = Error in Push address extend register of buffer USM
44A = Error in Push address upper register of buffer USM
44B = Error in Push address lower register of buffer USM
44C = Error in Pop counter extend register of buffer USM
44D = Error in Pop counter upper register of buffer USM
44E = Error in Pop counter lower register of buffer USM
44F = Error in Pop address extend register of buffer USM
450 = Error in Pop address upper register of buffer USM
451 = Error in Pop address lower register of buffer USM
481 = Checksum error in non-volatile RAM load from tape
482 = Byte count mismatch in non-volatile RAM load from tape
483 = Buffer header mismatch in non-volatile RAM load from tape
484 = Attempt to load data from tape into illegal address (not RAM)
490 = Hardware error detected in data compression (XC) circuitry
491 = Bad parity detected from Data compression circuitry
492 = Data compression circuitry not properly flushed of data
493 = Bad parity detected from interface into data compression hardware
494 = Bad parity detected from buffer into data compression hardware
495 = Data compression-to-interface byte count mismatch
496 = Data compression-to-buffer byte count mismatch
4A0 = XC chip status byte 0 error
4A1 = XC chip status byte 1 error
4A2 = XC input byte count error
4A3 = XC output byte count error
4A4 = XC chip interrupt circuit error
4A5 = XC chip functional error

4FF = Interface not responding

4.1.4.2.9 INTERFACE CONTROLLER ERROR CODES.

6XX

601 = ROM checksum error
602 = Ram test error (destructive data)
603 = Ram test error (non-destructive)
604 = Complete RAM test error
607 = Connectivity test error
609 = Micro-processor test error
646 = HP-IB controller loopback error
647 = EOI test error
648 = Inbound FIFO jammed
66E = Error in write loopback with good data
66F = Error in read loopback with good data
670 = Parity error in write loopback not detected
671 = Parity error in read loopback not detected
672 = Loopback compare error
6FF = Interface controller not responding

4.1.4.2.10 MULTI-PROCESSOR ERROR CODES.

CXX

C07 = Connectivity test error
C0E = On board dual-port RAM test error
C0F = Off board dual-port RAM test error
C10 = Subordinate detected dual-port RAM collision test error
C11 = Master detected dual-port RAM collision test error
C12 = Error in master DPR interrupt test
C13 = Error in subordinate DPR interrupt test
C66 = Pop count mismatch in loopback to formatter
C67 = Push count mismatch in loopback to formatter
C68 = Parity error not detected in loopback to formatter
C69 = Data mismatch in loopback to formatter (return data)
C6A = Buffer overrun not detected
C6B = Buffer underrun not detected
C6E = Error in write loopback with good data
C6F = Error in read loopback with good data
C70 = Parity error in write loopback not detected
C71 = Parity error in read loopback not detected
CC8 = Loopback timeout

4.2 Data Structures

4.2.1 Pointers to Data Structures

Data structures may be accessed in their entirety using either the memory dump or the log dump. The log dump is a subset of the memory dump, which contains only the data structures described within this appendix and identified by the pointers. Pointers are located at the start of the section of memory dump in which they reside and are included sequentially as they are listed below. Each pointer is two bytes long. Pointers are generated as relative to the start of the section of the memory dump.

4.2.2 Data Structure Definitions (FRU 14/24)

4.2.2.1 ERROR LOG (Header) (FRU 14/24)

BYTE #	LEN	DESCRIPTION
0	1	Current entry number
1	1	Number of entries in log
2	1	Currently displayed log
3	1	reserved

4.2.2.2 ERROR LOG (Entries) (FRU 14/24)

Error log Byte 4 - 303 (up to 30 entries 10 bytes each)

BYTE #	LEN	DESCRIPTION
0-4	5	Error message (see appendix C)
5	1	reserved
6-9	4	Time stamp (in 1/20 second increments)

4.2.2.3 ERROR LOG (Current Time) (FRU 14/24)

Error log Byte 304 - 307 current time stamp (in 1/20 second increments)

4.2.2.4 ERROR RATE LOG (Header) (FRU 14/24)

Error rate log Byte 0 - 23

BYTE #	LEN	DESCRIPTION
0	1	- Current entry number
1	1	- Number of entries in log
2	1	- Currently displayed log
3	1	- Density

4-5	2	- Current write hard errors
6-7	2	- Current write soft errors
8-14	6	- Current write data
14-15	2	- Current read hard errors
16-17	2	- Current read soft errors
18-23	6	- Current read data

4.2.2.5 ERROR RATE LOG (Entries) (FRU 14/24)

Error rate log Byte 24 - 343 (up to 20 entries 16 bytes each)

BYTE #	LEN	DESCRIPTION
0	1	- Density
1	1	- Write hard errors
2-3	2	- Write soft errors
4-7	4	- Write data
8	1	- (reserved)
9	1	- Read hard errors
10-11	2	- Read soft errors
12-15	4	- Read data

4.2.2.6 ERROR RATE LOG (Cumulative Error Data) (FRU 14/24)

GCR -- (Error rate log byte 344 - 363)
PE -- (Error rate log byte 364 - 383)

BYTE #	LEN	DESCRIPTION
0-1	2	Write hard errors
2-3	2	Write soft errors
4-9	6	Write data
10-11	2	Read hard errors
12-13	2	Read soft errors
14-19	6	Read data

4.2.2.7 CONTROLLED AREA OF NON-VOLATILE RAM (FRU 14/24)

BYTE #	LEN	TITLE	DESCRIPTION
0-5	6	ODOMETER	Odometer value (0.1 foot increments)
6-7	2	POWER CYCLES	Number of power cycles
8	1	CURRENT INTERFACE	Current interface ID
9	1	UNUSED	
10-49	40	NON_VOLATILE UTILITIES	
50-107	58	CONFIGURATIONS	Configuration values 40-97
108-149	42	SPECIAL CONFIGURATIONS	Internal use configurations
150-207	58	CONFIGURATION LOCKS	Locks for configs 40-97 internal use
208-291	84	INTERFACE GLOBALS	two global areas each consisting of a page length byte, a reserved byte, and 40 bytes of page data
292-585	294	DEVICE GLOBALS	seven global areas each consisting of a page length byte, a reserved byte, and 40 bytes of page data

4.2.2.8 POWER FAIL INFORMATION (FRU 14/24)

This data structure is updated at power-on to reflect the state of the drive prior to powerfail. Buffer contents included are for write data only. The amount of data physically written to the tape is the difference between logical information and buffered information.

BYTE #	LEN	DESCRIPTION
0-1	2	Number of logical (host) records in data buffer
2-5	4	Number of bytes of data in the data buffer
6-7	2	Number of File marks in the data buffer
8-11	4	Logical tape block number
12-15	4	Logical tape file number

4.2.2.9 DEVICE CONTROLLER LOGS

DRIVE LOG DUMP

BYTE	LEN	DESCRIPTION
0	1	error log in index
1	1	error log out index
2-63	62	error log: 2-byte entries of [error_code, encoded_command]
64-73	10	error report: internal CCL1 or CCL2 format report
74-102	29	tape status: internal tape position information
103-118	16	servo NVRAM: controls autoload parameters
119-128	10	gap gains GCR: 9 tracks of gain and 1 byte containing average
129-138	10	gap gains PE: 9 tracks of gain and 1 byte containing average
139-141	3	open
142	1	user sequence length
143-222	80	user sequence: user defined test sequence
223-282	60	forward slip stats
283-342	60	reverse slip stats

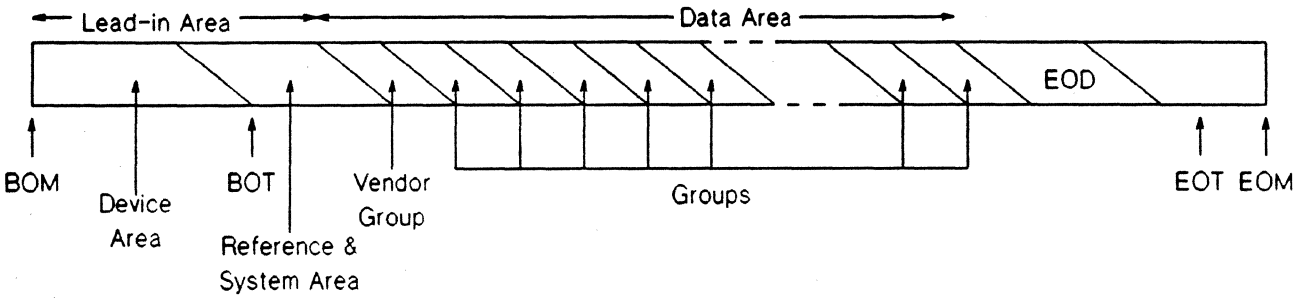
4.2.2.10 SCSI Implementation

Two types of diagnostics can be initiated by the host computer on the SCSI bus: the complete set of 88780A diagnostic test functions, and the Hewlett-Packard Extended Diagnostic functions for the 88780A.

DDS Tape Block Layout 5

5.1 Overview

The overall tape layout of this format divides the tape into three areas. These areas are the lead-in area, the data area, and the EOD area. Each of these areas will be specified in further detail later. The figure below shows the different areas.



Tape Layout

5.2 General Information

5.2.1 Overall Layout of Tracks

The track layout for the whole tape is shown above.

5.2.1.1 Lead-in Area

The first section of the tape is the lead-in area. This has several functions and begins with a length of blank tape called the Device Area. The Device Area extends from Beginning-of-Media (BOM) to a logical position known as Beginning-of-Tape (BOT). Its purpose is to allow the drive mechanism to pull enough tape out of the cartridge to wrap around the head drum by 90 degrees so that the drum can spin up to speed without damaging any recorded data. Near the end of the Device Area, there is a short test area for read and write tests which check the electronics and the servo system. After this, another blank area provides a guard area between the test area and the start of recorded information.

The Reference and System Area completes the lead-in area and is used for logging tape usage and error-rate information collected during normal use. This is the first information written to the tape.

5.2.1.2 Data Area

The main section of the tape is the Data Area. Data is written in groups of fixed capacity which store the information written by the host computer. This information comprises records, file marks and save-set marks. Collections of records of stored data are separated by file marks and save-set marks so that the host can identify where logical collections of data begin and end.

The first group is called the Vendor Group and contains the name of the tape drive manufacturer, together with information about the tape drive. This information is written by the tape drive itself, not by the host computer.

After the Vendor Group is the main Data Area. This area grows as more data is written to the tape. Its length is bounded by the edge of the Vendor Group and the edge of the End-Of-Data area.

5.2.1.3 End-of-Data (EOD) Area

The End-Of-Data area is used to mark the location on the tape where the host has stopped writing data. The host does not write this area; it is written by the tape drive when it detects that the host has finished writing data.

Marking the end of the recorded data serves two purposes. One is to limit the fast-search capability only to the area of recorded data. As a result, no time is wasted searching the unrecorded area of the tape.

The other purpose of the EOD Area is to show which data is valid. When data is written to the tape it may be either appended to the tape's existing contents, by being written further along the tape, starting at the current EOD, or it may be overwritten on existing data. If no overwriting is done, the data area grows and the EOD Area moves towards the end of the tape. If existing data is overwritten and the new data is smaller in quantity, then the EOD Area will move nearer the beginning of the tape. In this case any recorded data beyond the EOD Area is no longer valid.

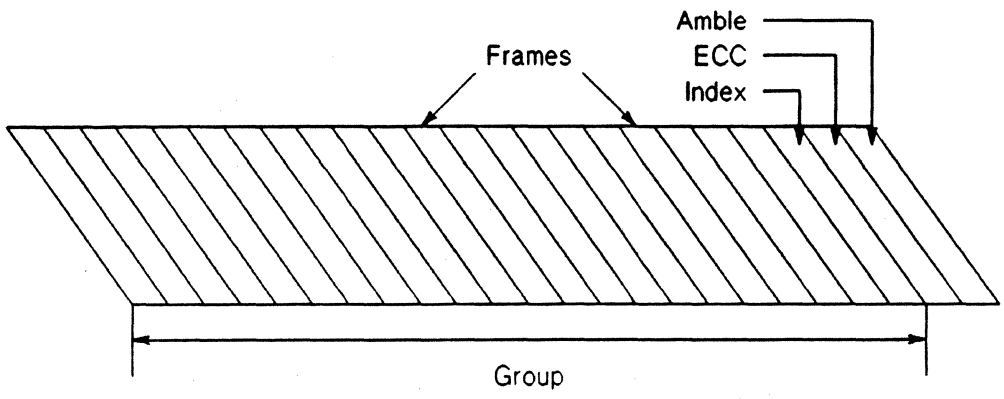
At the end of the tape are the End-of-Tape (EOT) and End-of-Media (EOM) points. The EOT point is a fixed distance from the physical end of the tape (the EOM point). When the drive detects the EOT point while writing, it indicates to the host that it should soon stop writing data to this particular tape.

5.2.2 Contents of a Group

The group is used to store the host written data, save set marks and file marks. Each group consists of a number of frames and has a fixed capacity. Having a fixed capacity group makes the error correction code generation easier and the buffering requirements simpler. This does not mean that each group contains the same number of frames, however. Some of the frames may be rewritten by the read-after-write process. However, the logical capacity of the group remains fixed. If a host record is larger than the space left in the group, that space is filled and any remaining bytes are put into the next group. A complete group is always read or written to the tape. No partial groups are written. If a group does not contain enough data to fill it but it needs to be written, the index should reflect this fact. (See the indexing section for further information on this technique).

5.2.2.1 Overall Structure

A group consists of 22 data frames. Each group is separated by an optional ECC frame and zero or more amble frames. There is no limit to the number of amble frames between groups. The 22 data frames contain host written data and one index.



Group Layout

5.2.2.2 Data Frames

Each group contains the capacity to store 22 frames worth of data or 126632 bytes. A group can consist of more than 22 frames if any have been rewritten using the read-after-write technique. However, these groups can still only store 126632 bytes of data.

5.2.2.3 Index

A specific frame is not reserved for the index. The index is actually part of the data area. The size of the index grows as necessary to describe the contents of the group. The index is stored at the end of the group and grows towards the front. Records are split as needed to completely fill a group with data and index. Partially full groups will have an index that specifies the group is not full of user data, but the group still contains 126632 bytes.

5.2.2.4 ECC Frames

This is primarily intended for drives which do not use read-after-write. The ECC frame contains a third level of error correction. (The first two levels of error correction are contained in the frame itself and are identical to that used in the audio format). Each frame of the group has the same error correction capability as specified by the audio format. However, the audio ECC only covers the data on a per frame basis. If a frame becomes completely unreadable, the normal audio ECC is not sufficient. The third level of ECC was added to provide recovery across frames. Only the frames in the group are covered by this ECC

assuring each group exists independently of all other groups. The contents of the main data area of the ECC frame contains the actual error correction bits.

Power-Fail Handling 6

NOTE

The information in this chapter is based on the Quickstep product and needs to be checked as to its suitability for Foxtrot.

After successfully completing power on self test, Foxtrot will position the tape at BOT and set the UNIT ATTENTION Condition, such that after the next host command Foxtrot will return CHECK CONDITION Status. The host should then send a REQUEST SENSE Command, in response to which, Foxtrot will return the UNIT ATTENTION Sense Key.

It is then up to the host to carry out whatever recovery strategy it implements within the constraints of Foxtrot's implementation of the HP-IB command set.

Performance Specifications 7

7.1 Data Capacity

1300 MB

7.2 Data Transfer Rate

11 MB/min

7.3 Load/Unload Times

To be specified

7.4 Recording Parameters

Encoding Technique NRZI

Recording Density 114 Mbits/sq. inch

7.5 Error Rate

Less than 1 in 10^{15}

Environmental Specifications 8

Foxtrot is designed to meet the Class B2 requirements of the HP Corporate Environmental Specification A-6950-5344-1.

Exceptions to this specification will be given below. THEY ARE LIABLE TO CHANGE IF THE DAT CARTRIDGE SPECIFICATIONS ARE CHANGED.

8.1 Temperature

Media limited to between 5 to 40 degrees centigrade (operating). Drive limited to between -40 to 70 degrees centigrade (non-operating with no media present).

The media is further limited to between -40 to 40 degrees centigrade and to within a rate of change of temperature specified by ISO 8462 spec and ANSI std X3.55-1977.

NOTE - Hardware must still be designed to meet Class B2 spec of 0 to 50 degrees centigrade (operating).

8.2 Humidity

20% to 80% with maximum wet-bulb temperature (non-condensing) not to exceed 26 degrees centigrade (media limited).

8.3 Altitude

Class B2: Operating 4.64 km @ 10°C, Non-operating 15 km @ -40°C.

8.4 Shock

Class B2: Non-operating 100g < 3ms minimum.

8.5 Vibration

Full Class B2 specifications, random and sine.

8.6 RF Emissions

To meet FCC Class B limits, and VDE Class B.

8.7 RF Susceptibility

Full Class B2 HP Environmental Specifications.

8.8 Electrostatic Discharge Susceptibility

Up to 25 kv with no damage.

Up to 15 kv with no failure.

8.9 Noise Level

Less than 55 dBA sound power.

8.10 Mains Power Surge/Sag

Foxtrot uses the Silverfox power supply.

Reliability and Maintainability 9

9.1 Average Use Estimates

For testing purposes, an estimate has been made for the typical amount of use that a Foxtrot drive would have over 10 years. This is:

- Two hours per day
- Six days per week
- Fifty weeks per year
- Ten continuous years

This adds up to (2 X 6 X 50 X 10) 6000 Hours running. A margin of X 1.5 is now applied to give an expected lifetime's use of 9000 Hours.

9.2 Failure Rate

We expect the Annualized Failure Rate (AFR) to be less than 8% at introduction and less than 4% within two years.

9.3 Service

The only servicing rquired by Foxtrot is head cleaning.

9.4 Repair Time

Half an hour, after removal from customer's enclosure.

9.5 Field Replaceable Units

The propsed list of FRUs for Foxtrot is as follows:

- Sony Mechanism
- Front Panel Assembly
- HP-IB Board
- Samuri (Buffer) Board
- Interface Cable

- Interface Cable Driver PCA

Physical Specifications 10

10.1 Power Requirements

Presently unknown. The following are taken from the Quickstep ERS.

5v @ 5.0A

12v @ 1.35A

10.2 Dimensions

Similar to the HP 9144S.

Height: 82.6mm
Depth: 203.2mm Excluding Front Panel.
Width: 146mm

10.3 Cooling

Forced-air cooling is required. The air flow rate is yet to be determined.

Diagnostics Appendix A

Here is a list of Foxtrot diagnostics.

Manual Part Number: ?????-?????
Printed in U.K., MAY 1988
First Edition
E0588

HEWLETT PACKARD