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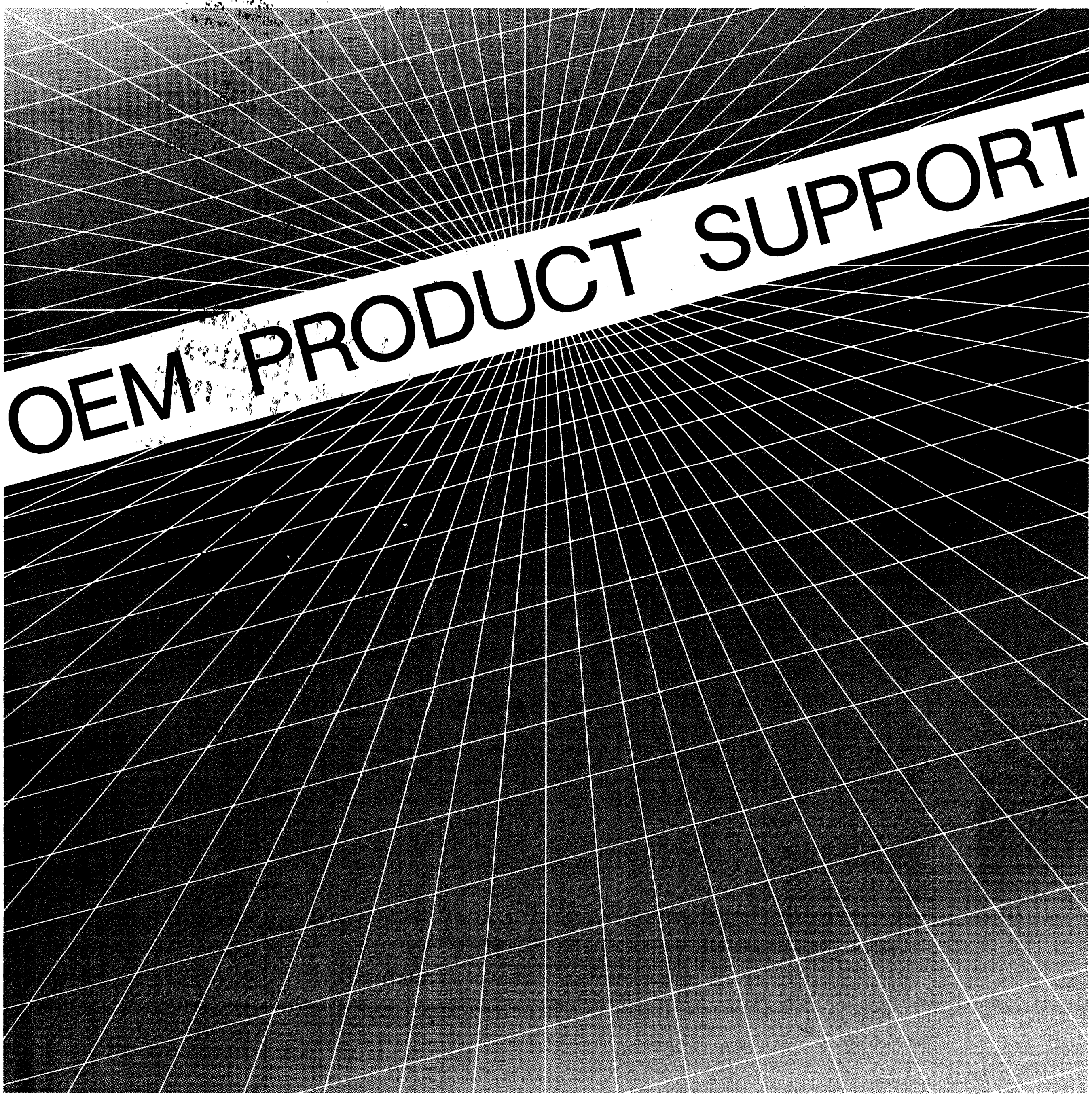
HP 9753XS/T/D SCSI Disk Drives



HEWLETT PACKARD

HP 9753XS/D/T SCSI Disk Drives OEM Product Manual

Manual part number: 5959-1412

Printed: December 1988 Edition 1, Rev 12/20/88
Printed in U.S.A. E1288

MODELS COVERED

This manual covers the following models: HP 97534S/D/T, HP 97538S/D/T.

HEWLETT PACKARD

P.O. Box 39, Boise, Idaho 83707-0039

Notice

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

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.

Edition 1, Rev 12/20/88 .... December 1988

Preface

Manual Description

This manual provides the information needed by customers to integrate the HP 9753XS (SCSI Single-Ended Interface), the HP 9753XT (SCSI High Performance), and the HP 9753XD (SCSI High Performance Differential Interface) Disk Drives into their computer-based systems. This information is intended for use by system designers, purchasing personnel, design engineers, marketing personnel, and other personnel who require knowledge of the HP 9753XS/T/D Disk Drives.

Throughout this manual, the term "head/disk assembly" or "HDA" refers to the mechanical assemblies which contain the heads, disks, actuator, spindle, and mainframe; while the terms "drive", "disk drive", or "Target" refer to the combination of the HDA and drive electronics/controller printed circuit assembly (PCA). Unless otherwise stated, "disk drive(s)" and "head/disk assembly" refer to all HP 9753XS/D/T Disk Drives.

Manual Organization

The following chapters are included in this manual:

Chapter 1. Product Information/Specifications - lists the disk mechanism specificatons and environmental requirements

Chapter 2. Unpacking and Re-Packing - provides instructions for unpacking the drive, and for re-packing it for return shipments.

Chapter 3. Installation/Operation - includes mounting instructions, power requirements, cabling information, and front panel LED indications

Chapter 4. Functional Description - provides a functional description of the major components of the product

Chapter 5. SCSI Interface - describes the implementation of the Small Computer System Interface (SCSI) in these products

Related Documentation

The following documentation provides information related to the operation of the HP 9753XS/D/T Disk Drives:

- *Small Computer System Interface: ANSI X3T9.2/82-2 (REV 17B) and ANSI X3.131.86*
- *Common Command Set (CCS) of the Small Computer System Interface (SCSI): ANSI X3T9.2/85-52 (REV 4.B)*

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Product Information/Specifications 1

1-1. General Description

The HP 9753XS (SCSI Single-Ended Interface), the HP 9753XT (SCSI High Performance), and the HP 9753XD (SCSI High Performance Differential Interface) Disk Drives are reliable, low cost, high capacity, high performance, random access mass storage devices. Each product utilizes sputtered thin-film 5.25-inch disks as storage media. Each disk has 1663 tracks per surface. The total unformatted capacity of the disk drives is 136.2 megabytes for the 2-disk 97532S/T/D, 204.3 megabytes for the 4-disk 97533S/T/D, and 408.7 megabytes for the 6-disk 97536S/T/D. This translates to 107.6, 161.5, and 323.0 megabytes formatted user capacity, respectively.

Low cost, high capacity and reliability are achieved by the use of advanced electronics and by embedding the servo and data information on the same track. Embedded servo allows the same electronics to be used for both servo control and reading of user data; this results in reduced component count and lower overall drive cost. Embedded servo also greatly reduces head alignment problems and makes it possible to achieve an industry leadership position with greater than 1500 tracks per inch.

High performance (17.5 msec random average seeks) while still maintaining relatively low power is achieved by using a state-of-the-art Hewlett-Packard designed actuator. This sophisticated actuator design combines the performance benefits of a linear actuator with the reliability and cost benefits of the traditional rotary actuator.

The disk drive electrical interface is compatible with the industry standard Small Computer System Interface (SCSI). The drive is identical to the 5.25-inch minifloppy in size and voltage requirements. Figure 1-1 shows the major components of the disk drive. Mounting instructions are in chapter 3.

Key features of the HP 9753XS/T/D Disk Drives include:

- High reliability (40,000 hours MTBF)
- High performance embedded SCSI controller
- 136-, 204-, and 408-megabyte unformatted capacity (107-, 161-, and 323-megabytes formatted)
- Extensive use of HP's state-of-the-art VLSI processes
- Fourth generation of Hewlett-Packard designed embedded servo mechanisms
- High performance Hewlett-Packard designed actuator
- Industry standard 5.25-inch form factor and voltage requirements
- Synchronous burst data transfer rate of 4.0 Mbytes/second (HP 9753X/T and D)

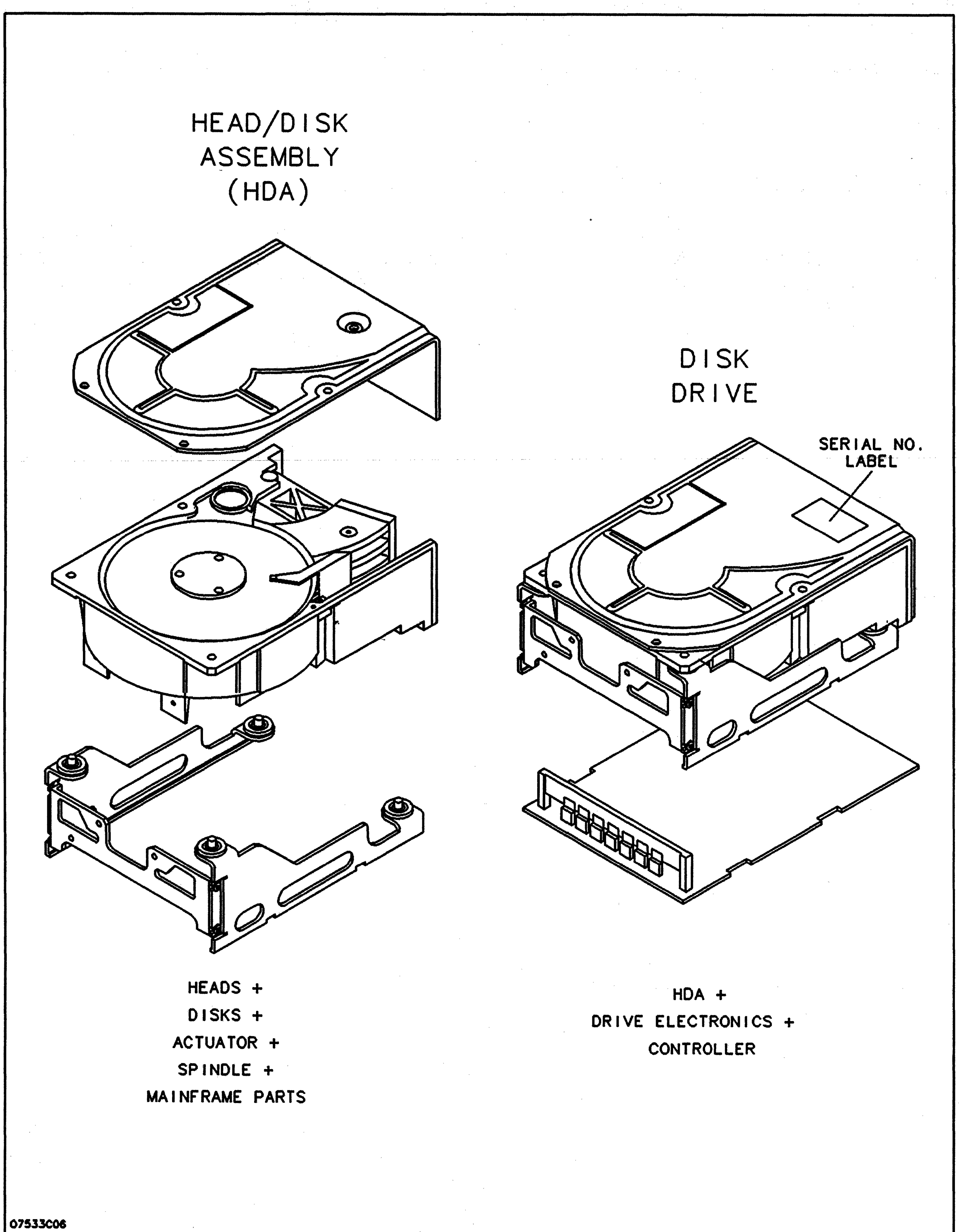


Figure 1-1. Disk Mechanism Major Components

1-2. Options

The following options are available:

- Orderable with or without a front bezel.
- Orderable with or without a bottom cover.
- Orderable with or without terminator resistor packs.
- Orderable with or without a front panel LED indicator.
- Three terminator options:
  - The drive supplies +5V to the on-board terminators only
  - The drive supplies +5V to the on-board terminators, and to pin 26 of the SCSI Connector (J1).
  - The host or initiator supplies +5V to pin 26 of the SCSI Connector (J1) for the on-board terminators.

1-3. Specials

For customer needs that differ from the products described in this manual, Hewlett-Packard can provide specially modified products. These modifications are ordered, defined, engineered, and manufactured under "special" contract negotiations.

If you have ordered a "special" product, the changes required to adapt this manual to your product are contained inside the back cover of this manual.

1-4. Product Specifications

The operating specifications for the HP 9753XS/T/D Disk Mechanism are listed in table 1-1, and the Disk Mechanism Environmental Requirements are listed in table 1-2.

CAUTION

The HP 9753XS/T/D must be operated within the environmental limits specified in table 1-2 in order for it to function properly.

Table 1-1. Disk Mechanism Specifications (1 of 5)

Disk Mechanism Specifications

This table lists the operating specifications for the HP 9753XS/T/D Disk mechanism.

Interface

Industry standard SCSI. Controller features include the following:

Controller Overhead Time:	450 microseconds typical
Controller Buffer Size:	16 kbytes (full track)
Controller Buffer Type:	Dual-ported
Interleave:	1:1

Seek Time

	Typical
Track to track seek:	3.5 ms
Random average seek:	17.5 ms
Maximum seek (1663 cylinders):	32.0 ms

Seek time is defined as the time from when the last byte of the seek command is transferred over the interface until the time when the arbitration for the status phase begins. It does not include any initiator overhead time.

Track to track seek time is mean value of seek time measured by performing all possible single track seeks.

Random average seek time is defined as the time to do all possible seeks divided by the number of possible seeks.

"Typical" seek time represents the mean value on a representative sample of drives measured under normal conditions of temperature, voltage, and horizontal orientation.

Table 1-1. Disk Mechanism Specifications (2 of 5)

Rotational Latency Time

Average: 8.96 ms ±1%

Data Transfer Rate

Internal (Controller/Disk):
Burst: 1.25 Mbytes (10 Megabits) per second for a single sector transfer
Sustained: >700 kbytes per second for a continuous transfer

External (Burst, Host/Controller):

	9753XS	9753XT/D
Asynchronous:	1.5 Mbytes/sec	1.5 Mbytes/sec
Synchronous:	2.0 Mbytes/sec	4.0 Mbytes/sec

Unformatted Capacity

The unformatted capacities listed below are for comparison purposes only. The numbers are derived from calculations based on comparisons to equivalent drives that use a single dedicated servo surface. Refer to chapters 4 and 5 for additional formatting details.

	Data Bytes per	Sectors per	Tracks per	Surfaces per
Sector	320			
Track	20,480	64		
Surface	34,058,240	106,432	1,663	
97532S	136,232,960	425,728	6,652	4
97533S	204,349,440	638,592	9,978	6
97536S	408,698,880	1,277,184	19,956	12

Formatted Capacity

	Data Bytes per	Sectors per	Tracks per	Surfaces per
Sector	256			
Track	16,384	64		
Surface	26,918,912	105,152	1,643*	
97532S/T/D	107,675,648	420,608	6,572	4
97533S/T/D	161,513,472	630,912	9,858	6
97536S/T/D	323,026,944	1,261,824	19,716	12

* There are 1663 physical tracks/surface, 19 are reserved for use as spares, and 1 is used as a maintenance track, leaving 1643 user accessable tracks.

Table 1-1. Disk Mechanism Specifications (3 of 5)

Recoverable Data Error Rate

Less than one (1) error in 10^{10} bits transferred when the disk drive is operated within the specified environmental limits.

Unrecoverable Data Error Rate

Less than one (1) error in 10^{12} bits transferred when the disk drive is operated within the specified environmental limits.

Seek Error Rate

Less than one (1) seek error in 10^{6} seeks when the drive is operated within the specified environmental limits.

Disk Speed

3348.2 rpm ±1%

Recording Density

Innermost Track: 544.3 flux reversals/mm (13,830 per in.)

Track Density

62.6 tracks/mm (1590 tracks/in.)

Coding System

2-7 Run Length Limited Code (RLL)

Code Algorithm

Data Pattern	Transition Pattern
00	1000
01	0100
100	001000
101	100100
111	000100
1101	00100100
1100	00001000

Table 1-1. Disk Mechanism Specifications (4 of 5)

DC Power:

Note: All values assume input voltages are within limits specified in table 1-2.

	+5Vdc		+12Vdc Ave. (Note 1)	+12Vdc Peak (Note 1)	Power	
	Single Ended	Diff.		(Note 2)	Single Ended	Diff.
START UP						
- Typ.	1.4A	1.8A	4.5A	4.6A		
- Max.	1.6A	2.0A	4.7A	4.8A		
RUNNING[3]						
- Typ.	1.4A	1.8A	1.0A		19W	21W
- Max.	1.6A	2.0A	1.4A		22W	24W
SEEKING[4]						
- Typ.	1.4A	1.8A	1.8A	3.0A	29W	31W
- Max.	1.6A	2.0A	2.0A	3.8A	32W	34W

1. Typical +12V currents are for sustained drive operation at 25 deg C ambient temperature. Maximum +12V currents are for initial drive turn on at 0 deg C ambient temperature.
2. Peak values shown are for occurrences greater than 5 msec duration.
3. Spindle up to speed and actuator is track following.
4. Assuming random seeks with an average latency between seeks.

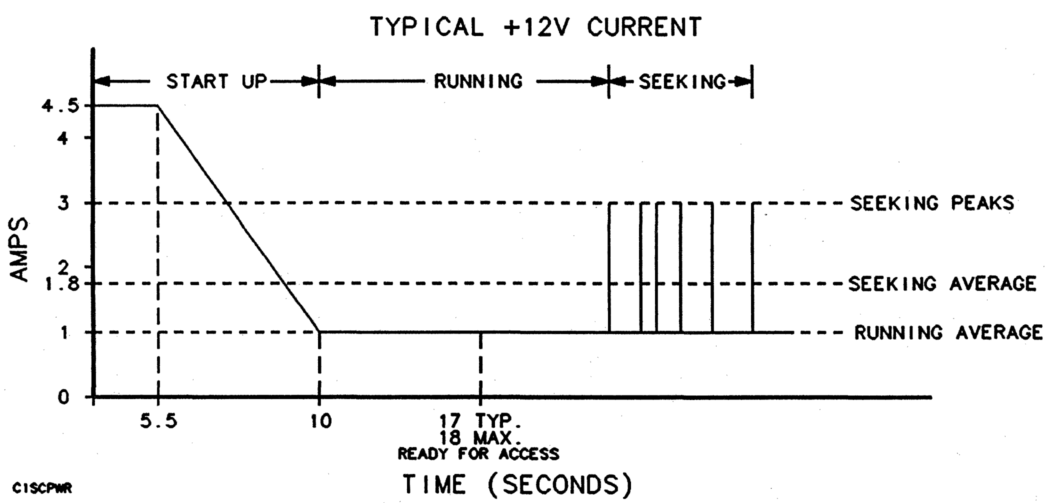


Table 1-1. Disk Mechanism Specifications (5 of 5)

Electromagnetic Emissions

Radiated and conducted interference: HP 97534S/T/D, and HP97536S/T/D

These products have been characterized from 10kHz to 1GHz as individual "components" (incomplete in nature). Data is available upon request.
(Note: FTZ and FCC regulations do not require "components" to meet emission specifications as free standing devices.

End user system emissions are highly dependent upon the characteristics of the system in which the product is installed. A complete test and evaluation program should be performed on the end use application.

Acoustical Noise

Less than 50 dbA sound pressure level while performing random address seeks

Safety

This product will be evaluated as a component (incomplete in nature) to:

- IEC: 380 and 435
- UL: 114 and 478
- CSA: C22.2 No. 220
- TUV: DIN IEC 380/VDE 0806/8.81

A complete test and evaluation program should be performed on the end use application.

Physical Characteristics

Unit Weight: 3.2 kg (7 lbs)

Shipping Weight:	Single-Unit Package	4.5 kg (10 lbs)
	Four-Unit Package	14.8 kg (33 lbs)

Dimensions (excludes front bezel):
(Additional information provided in Chapter 3)
146 mm (5.75 in.) wide
83 mm (3.25 in.) high
204 mm (8.00 in.) long

Table 1-2. Disk Mechanism Environmental Requirements (1 of 3)

Disk Mechanism Environmental Requirements

This table lists the environmental conditions required for proper operation of the HP 9753XS/T/D Disk Mechanism.

Input Power Requirements

Voltage:	+5V	+12V
Regulation:	+/- 5%	+/- 5%[1]
Ripple and Noise:	< 100 mV p-p	< 150 mV p-p

1. +/- 10% tolerance allowed during startup.

Ambient Air Temperature

Operating:	0 to 50°C (32 to 122°F)
Nonoperating:	-40 to 70°C (-40 to 158°F)

Maximum rate of change shall not exceed 20°C (36°F) per hour.

Relative Humidity*

Operating:	8% to 80%
Nonoperating:	5% to 80%

* Excludes all conditions which can cause condensation in or on the disk drive.

Altitude

Operating:
305 m (1,000 ft) below sea level to
4 572 m (15,000 ft) above sea level

Nonoperating (packaged):
305 m (1,000 ft) below sea level to
15 240 m (50,000 ft) above sea level

Sway Space

The drive requires at least 3 mm (0.12 in.) around the physical limits of the drive for shock and vibration clearance. This space may have to be adjusted for airflow to maintain temperature specifications.

Table 1-2. Disk Mechanism Environmental Requirements (2 of 3)

Shock

Operating:

11 ms, half wave sine shock with a peak amplitude of 2.0 g's without change in performance
11 ms, half wave sine shock with a peak amplitude of 5.0 g's without loss of data

Nonoperating:

11 ms, half sine shock with peak amplitude of 30 g
26 ms, trapezoidal shock with peak amplitude of 25 g

Swept Sine Vibration

Operating: 0.25 g (peak), 5 to 500 Hz with no loss in performance or data.
0.5 g (peak), 5 to 500 Hz with no loss of data.
Nonoperating: 0.5 g (peak), 5 to 500 Hz

Random Vibration

Operating: Power spectral density of 0.0001 g^2/Hz from 5 to 350 Hz, decreasing by 6 dB/octave from 350 Hz to 500 Hz (approximately 0.21 g rms) in any translational direction.

Nonoperating: Power spectral density of 0.015 g^2/Hz from 5 to 100 Hz, decreasing by 6 dB/octave from 100 to 150 Hz then constant from 150 Hz to 350 HZ, and decreasing by 6 dB/octave from 350 to 500 Hz (approximately 2.09 g rms) in any translational direction.

Random vibration is excellent as a test technique to excite product resonances simultaneously. This is especially necessary with products whose performance characteristics are statistical in nature and can only be measured over a period of time, such as disk and tape drives. It is impractical to do a long duration single frequency test at every frequency. In addition, a sweep through the frequency range does not give adequate statistics for problem frequencies. Only random vibration offers both thoroughness and timeliness.

Random vibration testing has been used extensively in military and aerospace applications but does not have widespread use in commercial markets due to the high cost of test equipment. Random vibration has a magnitude that is not specified for any given instant of time. The instantaneous magnitude of a random vibration is specified only by probability distribution functions giving probable fraction of the total time that the magnitude lies within a specified frequency range. Random vibration contains no periodic nor quasi-periodic constituents.

The magnitude of this distribution is measured in power spectral density, or PSD, which is the limiting mean square acceleration per unit bandwidth. It is measured in g^2/Hz and reveals how much energy is applied at a particular frequency. The g rms value listed is an rms average over time of the specified power spectral density and is equal to one σ (sigma) of the amplitude distribution.

Table 1-2. Disk Mechanism Environmental Requirements (3 of 3)

Electromagnetic Susceptibility

Radiated: > 3V/m from 14 kHz to 200 MHz

Conducted:
+ 5V; > 200 mV p-p from 100 kHz to 250 MHz
+12V; > 400 mV p-p from 100 kHz to 250 MHz

Magnetic: > 4 gauss from 47.5 to 198 Hz

Electrostatic Discharge:
These products have been characterized as individual "components" (incomplete in nature) with a company-imposed set of operational and non-operational standardized tests. Data is available upon request.
Note: Current regulations do not specify or require Electrostatic Discharge (ESD) testing.

ESD susceptibility is highly dependent upon the characteristics of the system in which the product is installed. A complete test and evaluation program should be performed on the end use application. Avoid ESD damage by using proper grounding procedures whenever the drive is handled.

Tilt

The disk drive will meet all performance specifications when within 15° of horizontal on any of the major mounting axes. Refer to chapter three for mounting instructions.

Unpacking and Re-Packing 2

CAUTION

Handle the drive with care. Until secured in a chassis, it is susceptible to excessive mechanical shock, vibration, and Electrostatic Discharge (ESD). Never set the drive upside-down. Also, handle the printed circuit assembly (PCA) by the edges only. Follow approved grounding procedures. Improper handling may cause damage to the equipment which is not covered under your warranty.

2-1. Unpacking the Drive

The drive is shipped in a reusable shipping container. Retain the shipping container and all packing material for re-shipment. When your shipment arrives, ensure that it is complete as specified by the carrier's bill of lading. Inspect the shipping container immediately upon receipt for evidence of mishandling during transit. If the container is damaged or water stained, request that the carrier's agent be present when the container is unpacked.

Remove the drive from the shipping container and inspect it for any mechanical damage that may have occurred during shipment. If any damage is observed, immediately notify Hewlett-Packard and file a claim with any carrier involved.

2-2. Serial Number

Each drive carries an individual serial number. Keep a record of all serial numbers. If your drive is lost or stolen, the serial number is often necessary for tracing and recovery, as well as for any insurance claims.

2-3. Re-Packing For Shipment

Use the original container and packaging material supplied with the drive for any shipments. If the original container is not available, you can order new packaging kits from Hewlett-Packard: HP 19518A for the single-unit kit, or HP 19519A for the four-unit kit. In addition, the part numbers for the individual pieces are listed in figures 2-1 and 2-2. Consult your authorized distributor or Hewlett-Packard Sales Representative for ordering instructions. Hewlett-Packard recommends that all shipments be insured.

CAUTION

Never ship less than four drives in the four-unit package. The drives may be damaged in shipment if the four-unit package is not completely loaded. Use the single-unit package for shipments of less than four.

Preparation: Note the serial number, date, and reason for the return (i.e. loaner return, failure symptom, repair needed, etc.) on the adhesive return label provided by Hewlett-Packard. Attach the completed label to the inner carton. For the four-unit package, complete a separate label for each drive. See figures 2-1 and 2-2.

Packaging: Pack the drive(s) as shown in figure 2-1 (for the single-unit package), or figure 2-2 (for the four-unit package). Seal each static shielded bag with the ATTENTION label in the kit, or with adhesive tape. Seal both the inner and outer cartons securely with adhesive tape. To ensure special handling at the factory, attach a single blank shipping label to the outer carton as shown in figures 2-1 and 2-2.

Return Shipping Address:

```
Hewlett-Packard
          Disk Memory Division
          11413 Chinden Blvd
          Boise, Idaho    83714
```

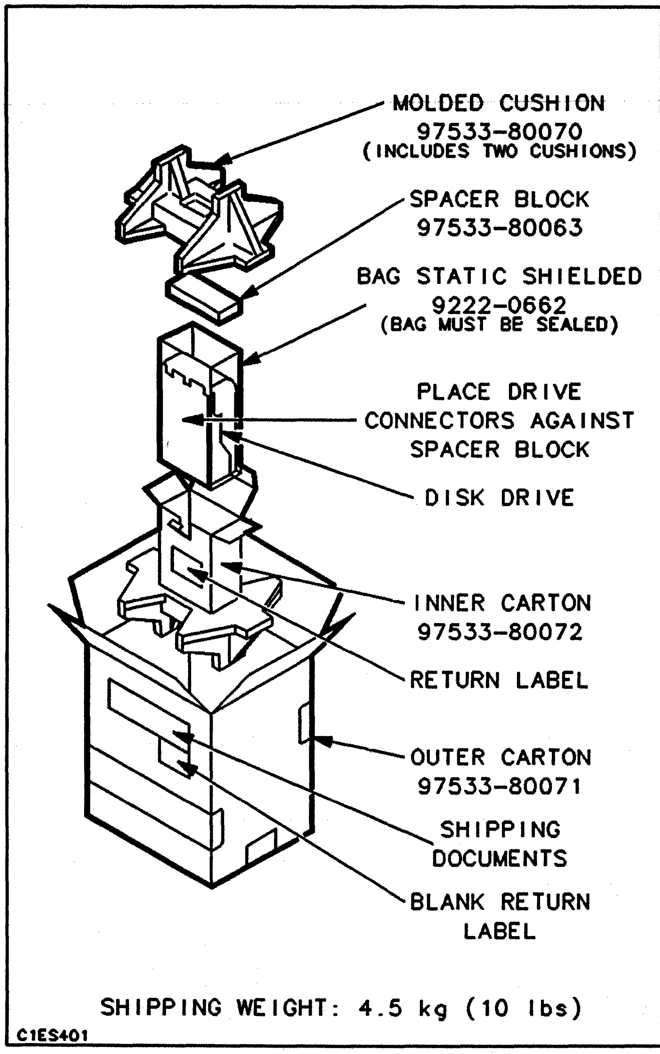


Figure 2-1. Single-Unit Packaging Kit, HP 19518A

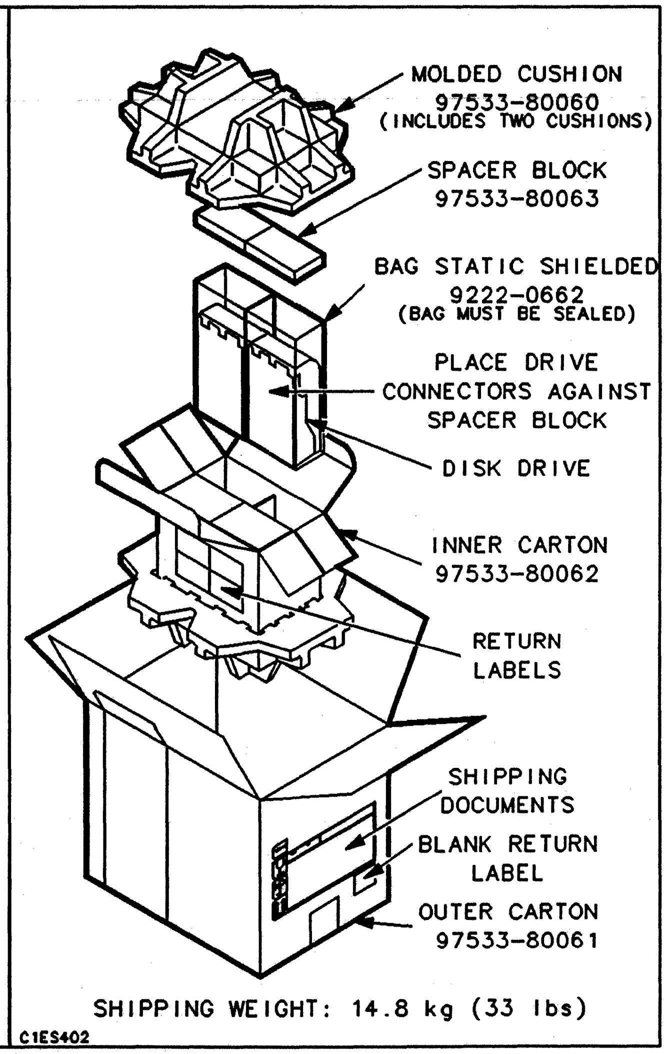


Figure 2-2. Four-Unit Packaging kit, HP 19519A

Installation/Operation 3

3-1. Introduction

This chapter provides information needed for the mechanical and electrical installation of the disk drive. For your reference, the diagrams are included at the end of the chapter.

NOTE

For Standard information refer to the Physical Characteristics chapter of the ANSI SCSI specifications.

The purpose of a correct installation is to provide an optimum environment for the disk drive. Continually subjecting the disk drive to the extremes of the environmental specifications results in stress on the product and can result in early failure or less reliable operation. All possible combinations of stresses have not been tested and the results of simultaneously applying worst case extremes of several environment parameters are unpredictable.

It is Hewlett-Packard's goal that our customers be highly successful in the use of our products. We therefore highly recommend that the time, energy and effort be made to provide a benign environment and installation for our products. It will be to the long term benefit of our customers.

3-2. Safety/Regulatory Considerations

When installing an HP 9753XS/T/D Disk Drive into an end use product, safety and regulatory conditions of acceptability should be considered.

If the front bezel option has been installed, it should be evaluated in the intended end use application.

3-3. Mounting Instructions

CAUTION

Do not mount the disk drive in a front down or back down position.

Since each design installation of the product can be unique, the following information should be taken into consideration when mounting the product. The disk drive can be mounted on either side, or the bottom.

3-4. Chassis Dimensions and Mounting Screw Locations

The physical dimensions and mounting screw locations for the disk drive chassis are shown in figure 3-1. The length dimensions shown are for the chassis only and do not include clearances for power and interface connectors.

3-5. Connector Dimensions and Locations

The physical locations and dimensions of the disk drive connectors are shown in figure 3-2.

3-6. Physical Mounting

Typically the disk drive is fastened directly to a chassis with 6/32 screws. Use the following mounting information.

NOTE

There are eight (8) threaded mounting holes (for 6/32 threads) on the disk drive: two on each side, and four on the bottom (see figure 3-1).

- When mounted, the hardware must not protrude more than 3 mm (0.12 in.) beyond the disk drive frame.
- Use 6/32 screws that are torqued to 10 inch pounds.
- The bottom of the disk drive has exposed voltages. Allow at least 3 mm (0.12 in.) between the bottom of the disk drive and any electrical conducting surface.

3-7. Shock and Vibration Sway Space

To meet the Shock and Vibration Specifications (refer to table 3-1), allow at least 3 mm (0.12 in.) around the physical limits of the disk drive. This space may have to be adjusted for air flow to maintain temperature specifications.

3-8. Airflow Requirements

The disk drive must be installed such that the ambient air temperature is maintained within the limits specified in table 1-2.

Airflow is required to improve disc drive reliability. Better reliability will be achieved with lower operating temperatures. The disk drive can be cooled by either forced air or natural cooling. Forced air may be necessary if the disk drive is located within a cabinet or other enclosure. If forced air cooling is not used, the disk drive must be located such that internal heat is conducted away from the drive and no outside heat sources raise the operating temperature above that specified in table 1-2.

As a guideline, the estimated front to back airflow to prevent exceeding the maximum operating temperature at a 50°C ambient temperature is 225 linear feet per minute. This is a function of the specific airflow pattern inside the cabinet where the disk drive is installed. This airflow estimate is to serve as a guideline.

As an additional guideline, the airflow should be adjusted to prevent the temperature of the critical components listed below from exceeding the maximum temperatures specified.

- U102, large custom VLSI package maximum case temperature is 80°C (see figure 3-3).
- U409, TO220 package maximum case temperature is 100°C (see figure 3-3).
- Head disk assembly (HDA) casting, left side maximum casting temperature is 60°C (see figure 3-4).

3-9. Disk Drive Interface Connectors

Figure 3-5 shows the locations of the interface connectors and the terminator resistor packs. In addition, figure 3-5 provides pin-out information for the power connector, J2, and the settings for the Options/Address connector, J4.

3-10. Option/Address Connector (J4)

The Option/Address connector (J4) located on the drive electronics/controller PCA-A2 (see figure 3-5) is a 7 pin-set connector used to establish the options and select the SCSI address. The disk drive is shipped from the factory with a shorting jumper across all seven pin-sets. This sets up a SCSI address of 7, enables drive initiation of a Synchronous Data Transfer Request message, enables parity check, and activates auto spin up. If you remove any of the shorting jumpers, save them for future use. If lost, DO NOT remove any shorting jumpers from the factory test connector on the side of the PCA. See figure 3-6.

CAUTION

**Do not remove any shorting jumpers
from the factory test connector.
See figure 3-6.**

3-11. Synchronous Data Transfer Request (SDTR)

When pin-set 2 is shorted (1 position) the drive will initiate an SDTR message at power on and RESET. When open (0 position) the drive will not initiate an SDTR message. The drive will respond to a host-initiated SDTR message whether this pin-set is open or shorted.

3-12. Parity Option Setting

When pin-set 3 is shorted (1 position), the disk drive checks parity on commands and data. When open (0 position), the disk drive does not check for parity. Parity bits are generated whether this pin-set is open or shorted.

3-13. Auto Spin Up Option

When pin-set 4 is shorted (1 position), the disk drive will automatically spin up at power on. If open (0 position), the drive will not spin up until the Intiatior sends a START UNIT command. When not in the auto spin up mode the drive will return "Not Ready" to all commands except REQUEST SENSE, INQUIRY, RESERVE, RELEASE, and START UNIT until the drive is ready for access.

3-14. Address Setting
Pin-sets 5, 6, and 7 select the disk drive SCSI address. The selection patterns are shown in figure 3-5.

3-15. SCSI Connector (J1)

An unshielded 50-pin SCSI connector (J1) is located on the rear of drive electronics/controller PCA-A2 (see figure 3-5). The physical construction and pin assignments for this connector conform to the SCSI specification for single-ended driver and differential driver configurations. The connector pin assignments are listed in tables 3-1 and 3-2.

3-16. DC Power Connector (J2)

Power requirements for the disk drive are listed in table 2-1. The power connector (J2) on the rear of drive electronics/controller PCA-A2 provides connection for dc power used by the drive. The pin assignments for J2 are shown in figure 3-5.

3-17. Frame Ground Connector (J3)

The frame ground connector (J3) provides the ground contact to the drive chassis (see figure 3-5). This is a Faston® type connector.

3-18. Terminator Resistor Packs

The drive is shipped with three terminator resistor packs installed. The packs are located on the bottom of the drive electronics/controller PCA-A2 (see figure 3-5). When installing multiple drives on an SCSI channel, the packs must be removed from all but the last drive in the chain. The drives can be ordered from the factory with the packs removed. (When re-installing the packs, ensure that they are properly keyed into their connectors. See figure 3-5.)

3-19. Termination Power Source
There are three orderable options for the +5V terminator power source:

- The drive supplies the +5V to the on-board terminators only.
- The drive supplies the +5V to the on-board terminators and to pin 26 of the SCSI connector.
- The host or initiator supplies the +5V to pin 26 of the SCSI connector for the on-board terminators.

3-20. Mating Connector Requirements

The nonshielded SCSI device connector shall be a 50-conductor connector consisting of two rows of 25 male pins with adjacent pins 2.54 mm (0.1 in.) apart. A shroud and header body should be used.

The nonshielded cable connector shall be a 50-conductor connector consisting of two rows of 25 female contacts with adjacent contacts 2.54 mm (0.1 in.) apart. It is recommended that keyed connectors be used.

The nonshielded connector pin assignments are as shown in table 3-1 for single-ended drivers and as shown in table 3-2 for differential drivers.

The recommended mating connector manufacturer's part numbers are as follows:

Disk Drive Connector/Function	Recommended Mating Connector
J1-SCSI Connector (single-ended and differential)	3M® 3425-6600
J2-DC Power	AMP® 1-480424-0
J3-Frame Ground	AMP® 62187-1
J4-Options Connector (shorting jumper)	AMP® 531220-3 (7 supplied with the disk drive) (Manufacturer supplies rail of 10)

3-21. Cabling Requirements

The disk drive adheres to the cabling requirements and limitations set forth in the ANSI SCSI specifications. Figure 3-2 shows the physical location and dimensions of the connectors.

Refer to the SCSI specifications for details.

- Cables with a characteristic impedance of 100 ohms ±10% are recommended for unshielded flat or twisted-pair ribbon cable.
- Cables with a characteristic impedance of 90 ohms ±10% are preferred for shielded cables.
- To minimize discontinuities and signal reflections, do not use cables with different impedances on the same bus.
- A minimum cable size of 28 AWG should be used to minimize noise effects and ensure proper distribution of termination power.
- Cables should be properly terminated.

3-22. Single-ended Cable

For disk drives with single-end output, use the following cable information.

- A 50-conductor flat cable or 25-signal twisted-pair cable should be used. Cable length shall be equal to or less than 6.0 metres. This refers to internal and external cable length (except stubs).
- A stub length of no more than 0.1 metre is allowed off the main line interconnection within any connected device.

3-23. Differential Cable

For disk drives with differential output, use the following cable information.

- A 50-conductor flat cable or 25-signal twisted-pair cable should be used. Cable length shall be equal to or less than 25 metres. This refers to internal and external cable length (except stubs).
- A stub length of no more than 0.2 metre is allowed off the main line interconnection within any connected device.

3-24. Front Panel LED Indicator

The light emitting diode (LED) indicator on the front of the disk drive displays the status of the power-on diagnostics. As the disk drive progresses through the diagnostics, the LED will present the following displays:

1) LED ON. When power is first applied, the power-on reset from the drive hardware illuminates the LED. The LED remains lit until extinguished by the microprocessor on the drive electronics/controller PCA-A2. If the LED remains on, a catastrophic failure has occurred. The most probable cause is a failure of the drive electronics/controller PCA-A2.

2) LED OFF. Once the servo processor has tested itself and its internal RAM, the LED is extinguished. The LED remains off for approximately 1 second, during which time the processor performs additional hardware tests and establishes various operating parameters.

3) LED ON. The LED illuminates indicating that the spindle motor is being started. The LED remains lit until the spindle is up to speed.

4) LED FLASHES. This indicates that the controller is performing its internal diagnostic tests. Because of the duration of these tests, this LED pattern may not even be seen. If the LED continues to blink at a rate of 1 Hz, the controller has failed some portion of these tests.

Once the power-on diagnostics have completed, the LED functions as an activity light. The LED will be illuminated any time the disk drive is executing a command, reading, or writing. If the LED is extinguished, the drive is idle.

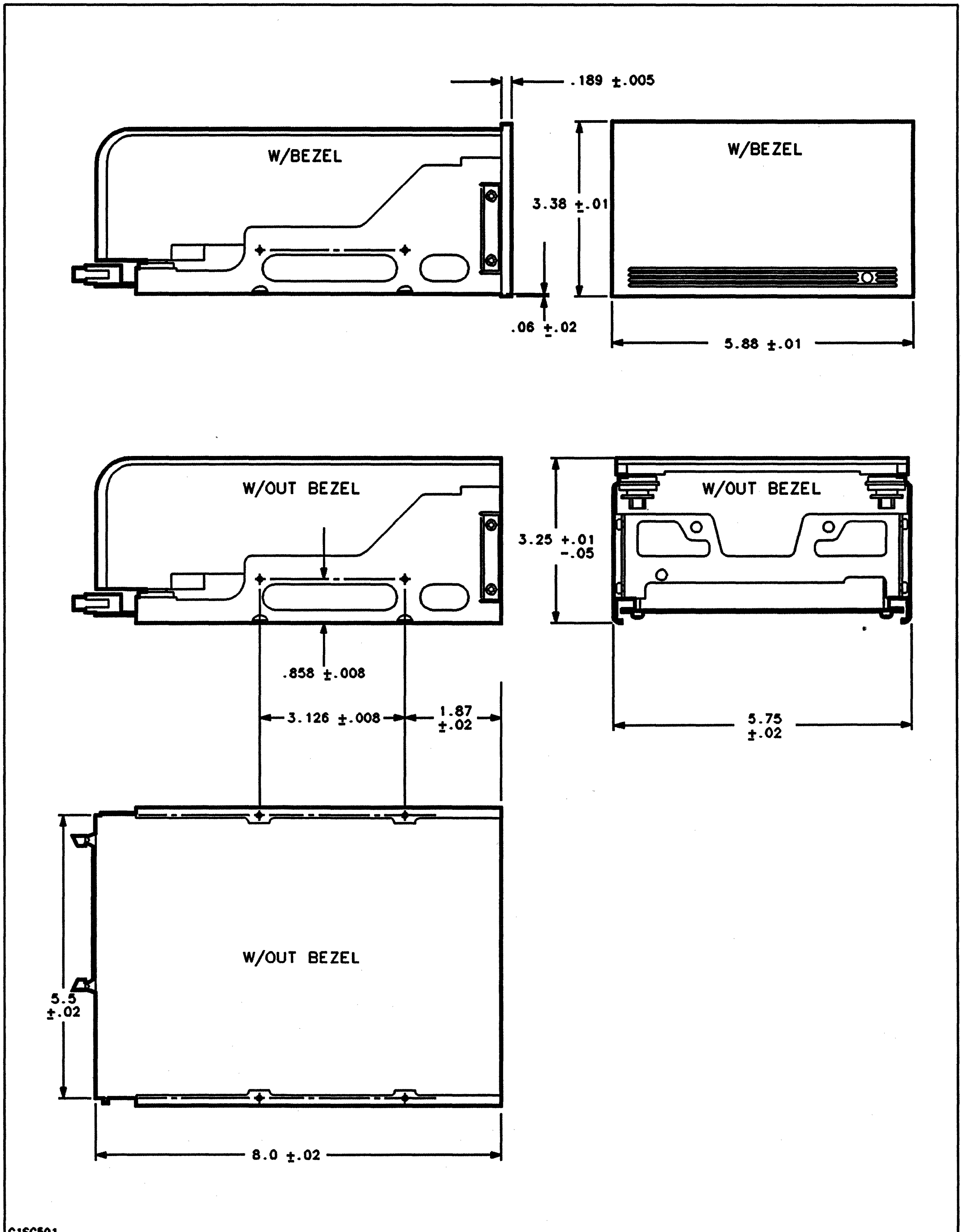


Figure 3-1. Disk Mechanism Dimensions

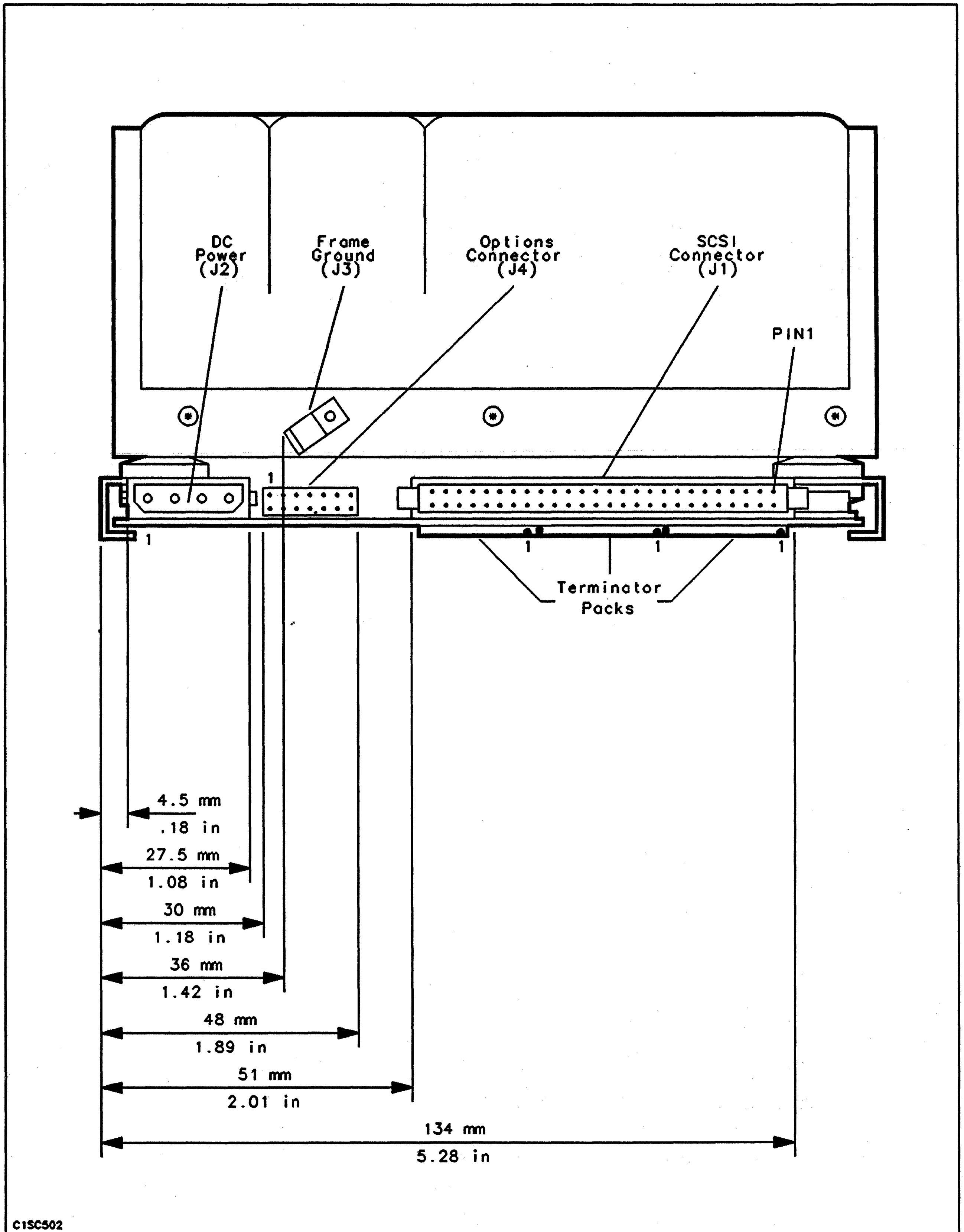


Figure 3-2. Connector Physical Dimensions

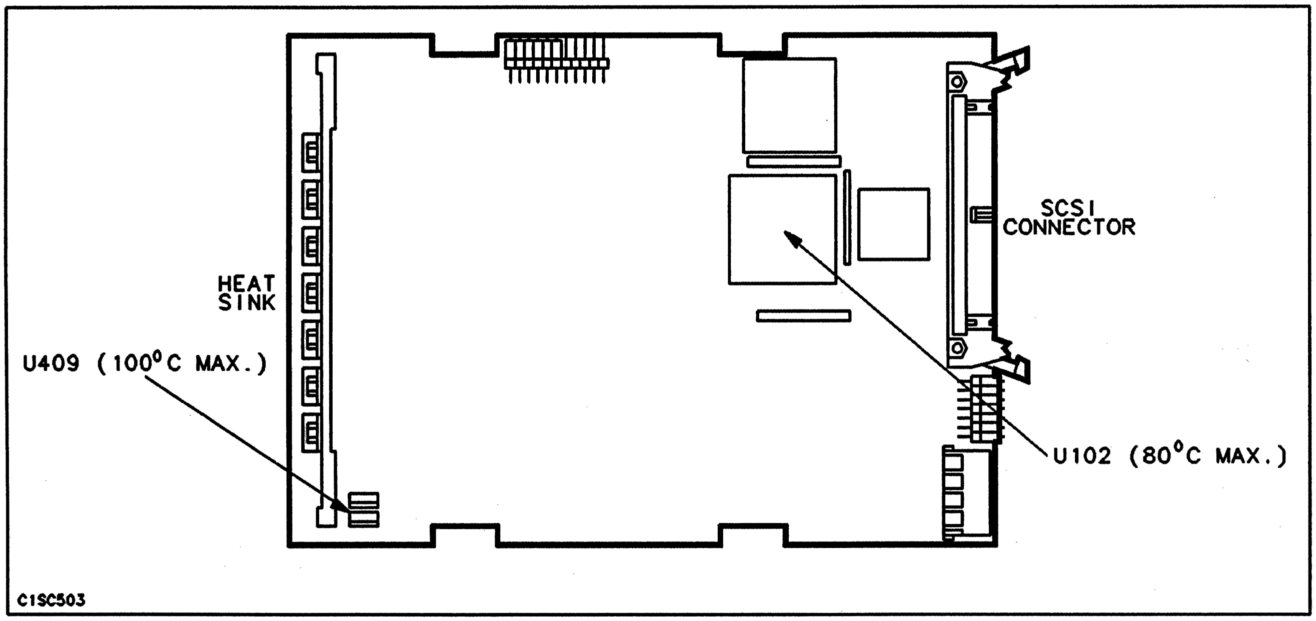


Figure 3-3. PCA Temperature Measuring Points

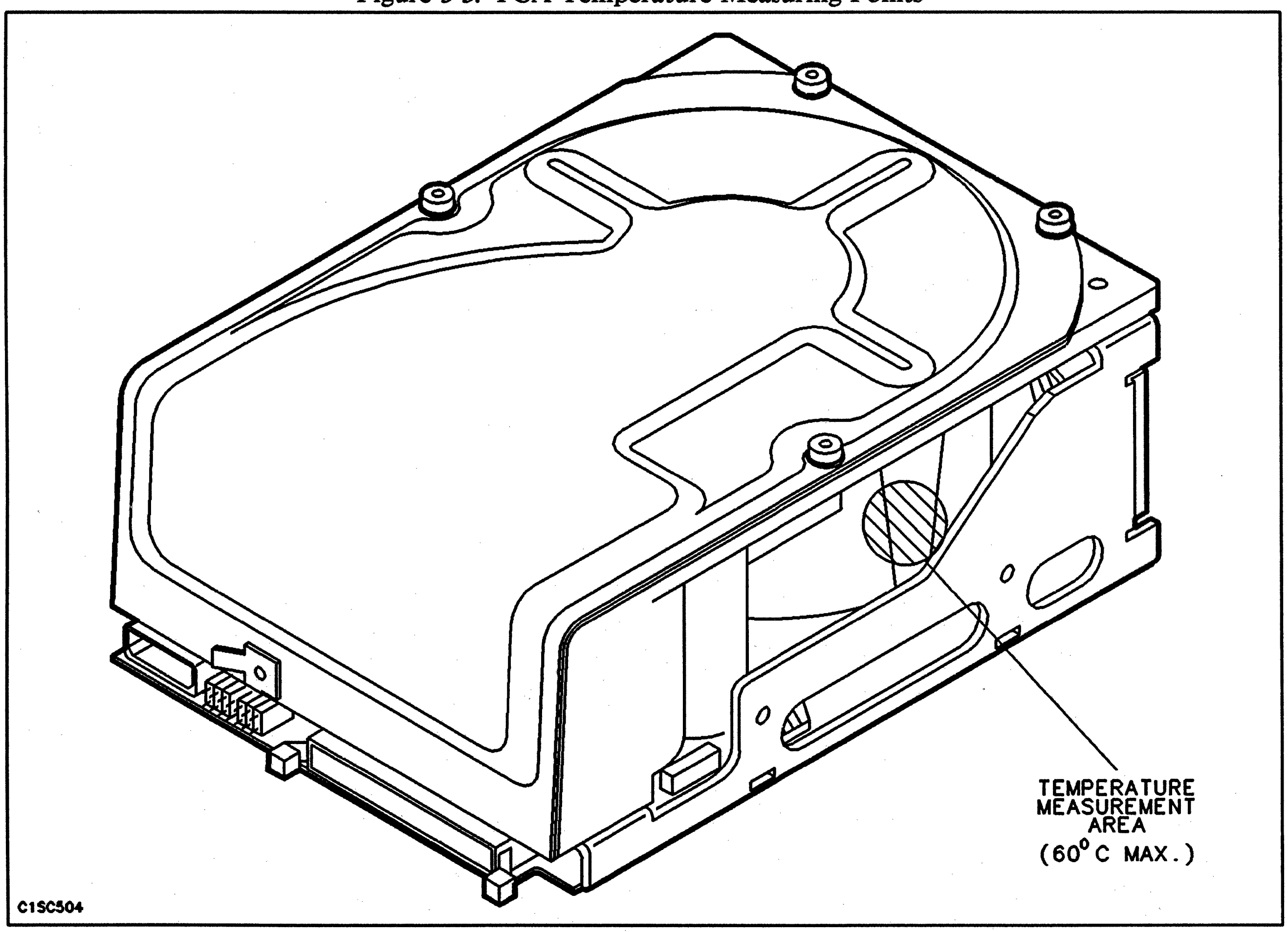
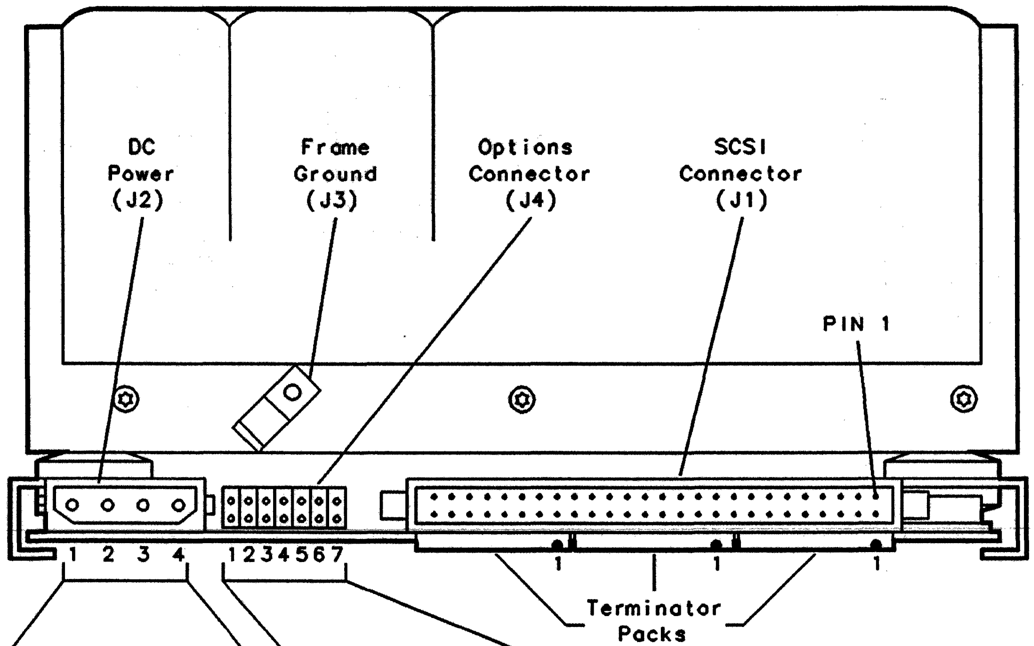


Figure 3-4. HDA Temperature Measuring Point



POWER CONNECTOR PIN	VOLTAGE
1	12V DC ±5%
2	12V RETURN
3	5V RETURN
4	5V DC ±5%

OPTION SETTINGS
0 = Open, 1 = Short

PIN 1: Reserved (Normally shorted)

PIN 2: Drive initiation of SDTR message
0 = Inhibit initiation of SDTR message
1 = Enable initiation at Power On and RESET

PIN 3: Parity
0 – Parity checking is disabled
1 – Parity checking is enabled

PIN 4: Auto spin up
0 – Drive will not spin up until host sends start unit command
1 – Drive will automatically spin up on power on

PINS 5–7: SCSI address

PINS			DRIVE ADDRESS
5	6	7	
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

C1SC505

Figure 3-5. Interface Connectors, and Settings

Table 3-1. SCSI Connector (J1) Single-Ended Pin Assignments

PIN	SIGNAL	PIN	SIGNAL	PIN	SIGNAL
2	-DATA BIT 0	20	GROUND	36	-BSY
4	-DATA BIT 1	22	GROUND	38	-ACK
6	-DATA BIT 2	24	GROUND	40	-RST
8	-DATA BIT 3	26	TERMPWR	42	-MSG
10	-DATA BIT 4	28	GROUND	44	-SEL
12	-DATA BIT 5	30	GROUND	46	-C/D
14	-DATA BIT 6	32	-ATN	48	-REQ
16	-DATA BIT 7	34	GROUND	50	-I/O
18	-DATA BIT P				

NOTES: 1) All odd numbered pins, except pin 25, must be connected to ground. Pin 25 should be left open.
2) Pin 26 is reserved for terminator resistor power source.

Table 3-2. SCSI Connector (J1) Differential Pin Assignments

PIN	SIGNAL	PIN	SIGNAL	PIN	SIGNAL
1	SHIELD GND	19	+DB(P)	37	+RST
2	GROUND	20	-DB(P)	38	-RST
3	+DB(0)	21	DIFFSENS	39	+MSG
4	-DB(0)	22	GROUND	40	-MSG
5	+DB(1)	23	GROUND	41	+SEL
6	-DB(1)	24	GROUND	42	-SEL
7	+DB(2)	25	TERMPWR	43	+C/D
8	-DB(2)	26	TERMPWR	44	-C/D
9	+DB(3)	27	GROUND	45	+REQ
10	-DB(3)	28	GROUND	46	-REQ
11	+DB(4)	29	+ATN	47	+I/O
12	-DB(4)	30	-ATN	48	-I/O
13	+DB(5)	31	GROUND	49	GROUND
14	-DB(5)	32	GROUND	50	GROUND
15	+DB(6)	33	+BSY		
16	-DB(6)	34	-BSY		
17	+DB(7)	35	+ACK		
18	-DB(7)	36	-ACK		

NOTE: SHIELD GROUND is optional on some cables. (Implementors note: Some shielded flat ribbon cables use pin 1 as a connection to the shield.)

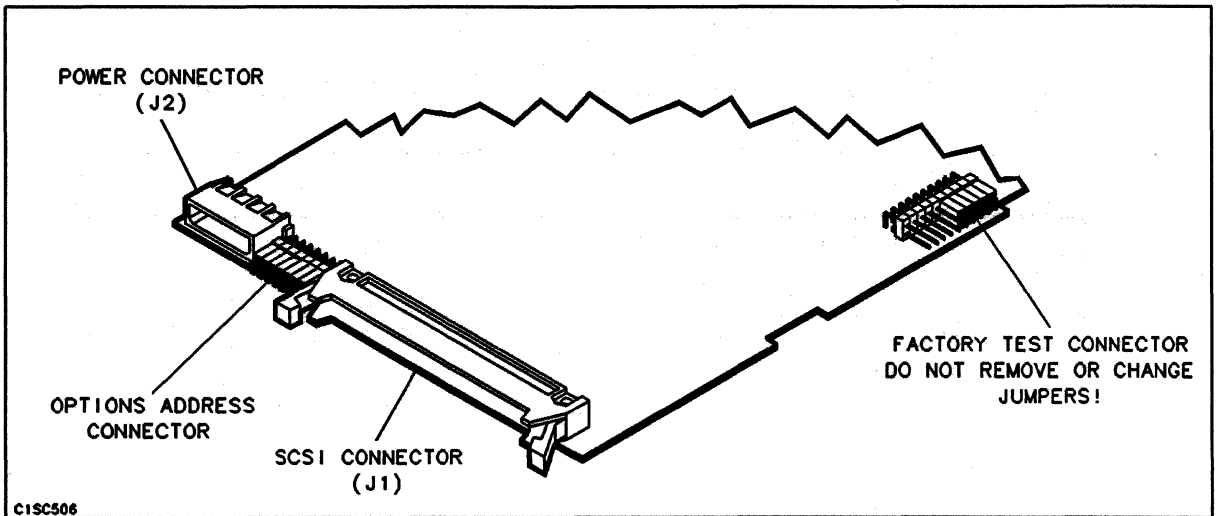


Figure 3-6. Factory Test Connector Location

Functional Description 4

4-1. Disk Format

The head/disk assembly (HDA) contains two, three, or six disks (see figure 4-1). Each disk provides two data surfaces with a single read/write head accessing each surface.

Each data surface contains 1663 physical tracks. Nineteen of these tracks are reserved for use as spares and one additional track is used for maintenance. This leaves a total of 1643 tracks available for user data. Figure 4-2 displays how the tracks on the media are physically allocated. Each track is divided into 64 sectors. Embedded in each sector is servo information used for head positioning and sector timing. Each physical sector can store 256 bytes of user data.

4-2. Sector Format

The smallest directly addressable storage area on a data surface is a sector (see figure 4-3). Accessing a sector is accomplished when the controller specifies the address of the cylinder, head, and sector. Each sector contains a 44-byte intersector gap and 306 user bytes. The formatted sector bytes are allocated as shown in figure 4-3.

4-3. Addressing Structure

All addressing between the disk drive and the host is logical. The drive's embedded controller converts the logical block address into the appropriate physical address (i.e., head, track, sector), allowing for any sparing operations that have been performed. To support multiple block sizes (refer to chapter 5), the drive automatically blocks and deblocks the physical sectors into the currently specified logical block size.

4-4. Buffer Management

The controller implements a full-track 16-Kbyte buffer to provide performance enhancements with the "Split Read" capability.

Assume a host-issued READ command that requests data residing in sectors 5 through 40 on a specific track. If, after seeking, the head settles on the track over sector 12, almost an entire latency would occur before sector 5 again reaches the head and the READ operation could begin. With Split Reads, the controller can immediately begin reading sectors 12 through 40 into the buffer and then add sectors 5 through 11 when they reach the head. The data is then transferred to the host in the proper order. In this example, the Split Read capability saved the time required for 28 sectors to go by the head, or more than 7 milliseconds.

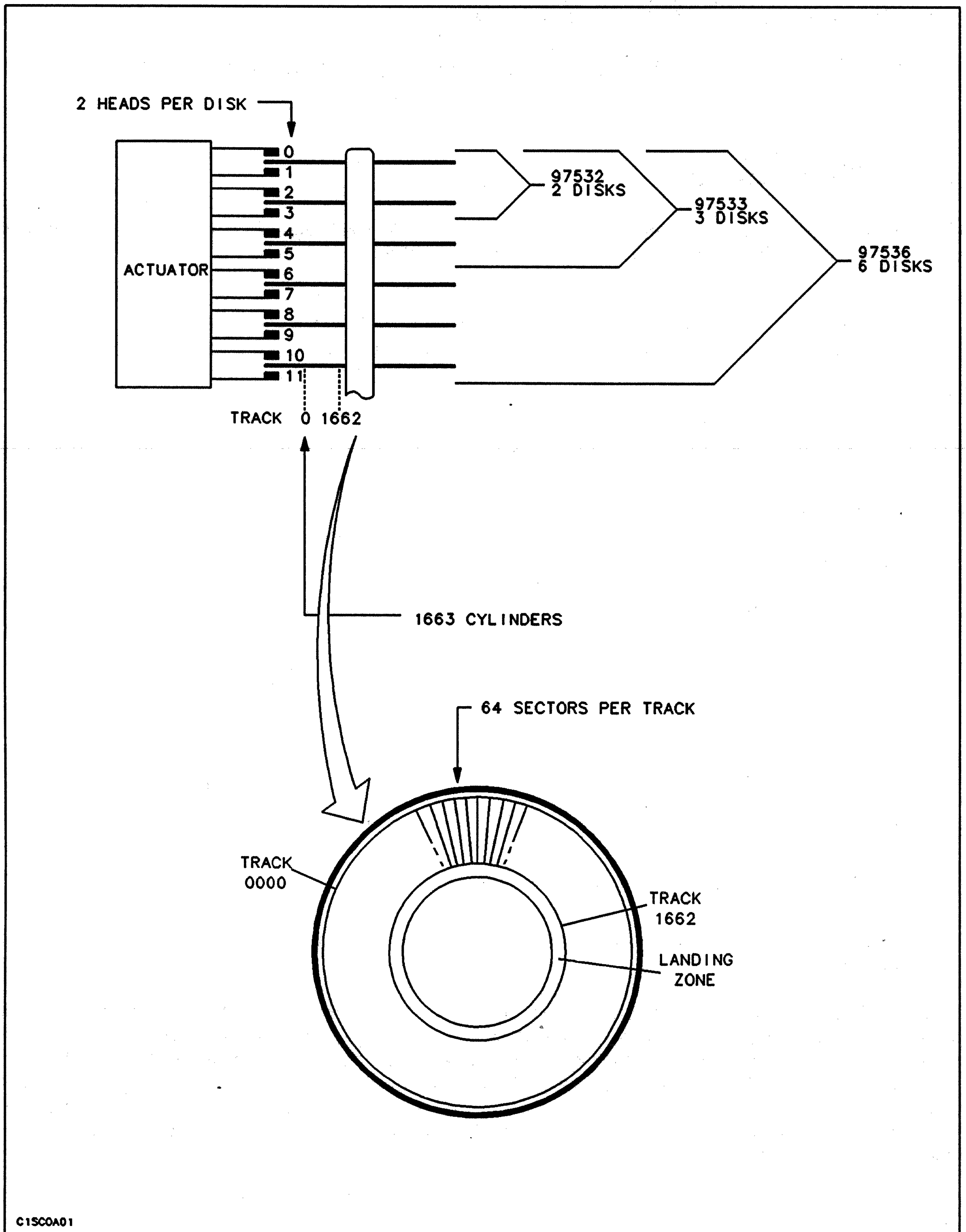


Figure 4-1. Disk Mechanism Addressing Structure

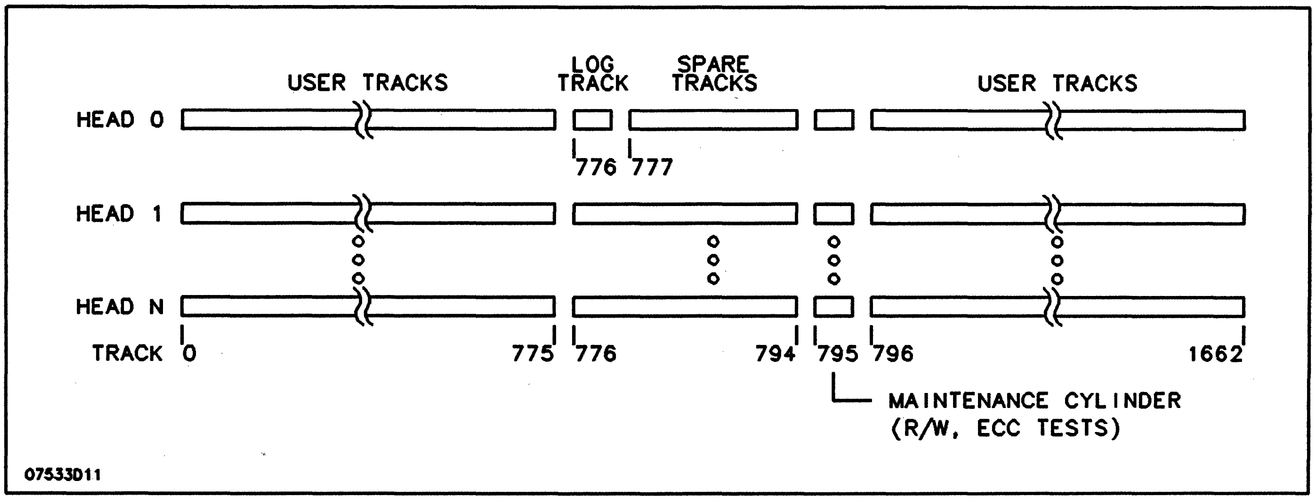


Figure 4-2. Track Allocation

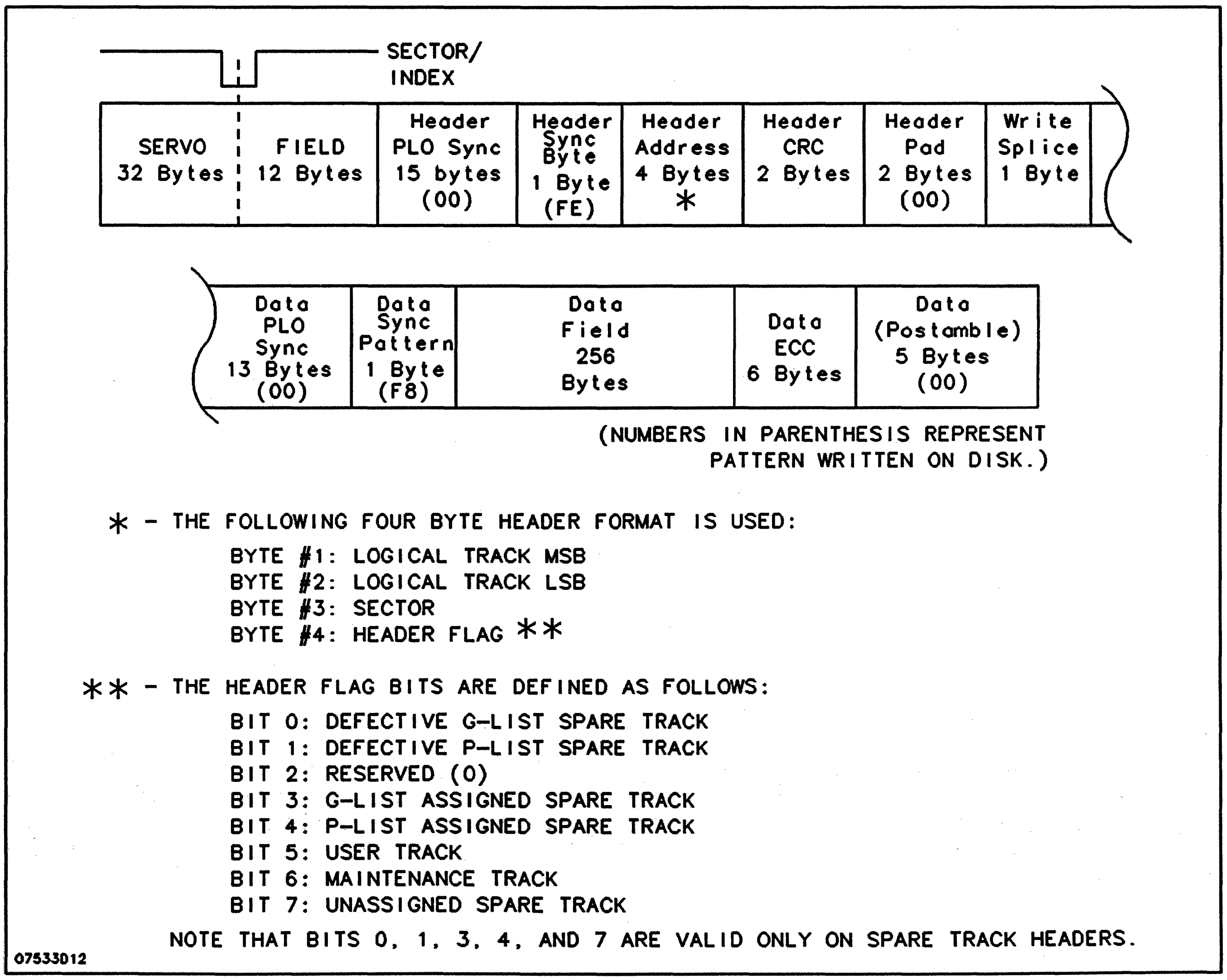


Figure 4-3. Physical Sector Format

4-5. Error Correction Code

The controller uses a 48-bit error correction code (ECC) attached to each physical sector (256 bytes) for error detection and correction. This code is a proprietary computer-generated polynomial of degree 48. The capabilities of this code (as used by this controller) are as follows:

- The controller uses a maximum correction span of 12 bits which provides optimal miscorrection margin.
- Maximum single burst detection span of 24 bits.
- Maximum double burst detection span of 7 bits.
- Probability of misdetection is $< 3.55 \times 10^{-15}$.
- Probability of miscorrection is $< 3.83 \times 10^{-9}$.

  The misdetection and miscorrection probabilities are upper bounds that assume a random distribution of all possible error cases. Under normal drive operating conditions (i.e. typical error conditions), the probabilities will be significantly lower than those stated.

4-6. Sparing

Sparing is implemented in the controller as follows:

- Track Sparing Algorithm.
- Cross head sparing to allow for one or more surfaces with an excessive number of defects.
- Spare access without seek to defective track (provided by a RAM table lookup).
- Spare tracks allocated in the center of the media to provide for access within average access time.
- Defect mapping information is kept on the media in the spare track headers to remove the requirement to keep a separate defect list.

4-7. Assembly Descriptions

The assemblies in the disk drive include the head/disk assembly (HDA) A1 and the drive electronics/controller printed-circuit assembly (PCA) A2. The sealed HDA contains the mechanical and electromechanical assemblies of the disk drive. The drive electronics/controller PCA-A2 provides the SCSI interface and all electronic control over the HDA. The following paragraphs describe the major functional components of each assembly (see figure 4-4).

4-8. Head/Disk Assembly A1

Head/disk assembly (HDA) A1 contains disks, heads, an actuator assembly, head interface circuits, atmospheric controls, vibration isolators, and a spindle assembly. An aluminum casting provides the supporting structure for these parts. The entire assembly is sealed to provide an environment free of contamination.

4-9. Disks

The disks are 130 mm (5.1 inch) diameter aluminum substrate with a sputtered thin-film surface. The disks are mounted on the spindle assembly in stacks of two (HP 97532), three (HP 97533), or six (HP 97536) disks. Data is stored on both surfaces of each disk.

4-10. Heads

Four (HP 97532), six (HP 97533), or 12 (HP 97536) data heads in the HDA write and read user data. The heads also recover the servo information embedded between sectors. One thin-film head flies over each disk surface on an air bearing.

4-11. Actuator Assembly

Mechanical positioning of the read/write heads is achieved using a Hewlett-Packard designed rotary actuator. Actuator current is supplied by the actuator driver, which amplifies position information from the servo circuits. A shipping latch captures the heads at the inside diameter of the disks (away from user data) whenever power is removed from the disk drive. This prevents the actuator from moving until power is applied to the disk drive. At power-on, the processor releases the latch, allowing normal movement of the heads.

4-12. Head Interface

The head interface circuits process the data signals transferred between the read/write heads and the drive electronics/controller PCA-A2. These ICs include write drivers which provide the necessary current to the heads during write operations. Read preamplifiers amplify data read from the disk before transferring it to the read/write circuit on the drive electronics/controller PCA-A2. Additional functions performed by the head interface include head selection and write control.

4-13. Atmospheric Controls

The atmospheric controls in the HDA consist of a breather system and a filter system. The breather system equalizes air pressure within the HDA to ambient air pressure. A breather filter prevents contaminants from entering the HDA. A particle trap maintains a low particle count within the HDA.

4-14. Vibration Isolators

The HDA is mounted on vibration isolators, chosen to have a resonant frequency of 30 to 60 Hertz. These isolators protect the HDA from external vibrations and shocks.

4-15. Spindle Assembly

The spindle assembly provides the mechanical mounting for the disks. The spindle rotates on a bearing system and is driven by a brushless dc motor attached to the HDA casting. The 3-phase drive current for the motor is supplied by the spindle driver circuit on the drive electronics/controller PCA-A2. Three Hall-effect sensors, mounted on the spindle assembly, provide feedback signals to the spindle control electronics for proper commutation.

4-16. Drive Electronics/Controller PCA-A2

The drive electronics/controller PCA-A2 controls the operation of the drive. Interface to the SCSI channel, spindle speed, head positioning, data transfer, and power distribution are all controlled by this PCA. Circuits contained on PCA-A2 include the following: SCSI interface, microprocessor, data controller, disk controller, servo, read/write, spindle driver, actuator driver, and power.

4-17. SCSI Interface

This circuit provides the interface necessary to properly transfer information over the SCSI bus. The SCSI interface handles SCSI protocol without intervention from the microprocessor, and is capable of automatically controlling the proper sequence of bus phases involved in each transaction. Full arbitration and disconnect/reselection are implemented by the SCSI interface.

The SCSI interface communicates directly with two other circuits: the microprocessor and the data controller. The processor programs the interface to perform the required operation and retrieves status from the interface. Host data is transferred between the interface and the data controller over a 16-bit internal data bus.

4-18. Microprocessor

The microprocessor manages the overall operation of the drive. The processor used on the drive electronics/controller PCA-A2 is a 68000 operating at 8 MHz. This block also contains the processor memory, which includes 16 kilowords of ROM and 8 kilowords of static RAM.

The processor directly accesses and controls three circuits: the SCSI interface, data controller, and the disk controller. By programming these circuits, the processor coordinates all drive activity. The processor also determines the operational condition of the drive by collecting status from these circuits. During seeks, the controller performs the logical-to-physical address conversion, converting variable logical block sizes into the corresponding physical sectors.

4-19. Data Controller

The data controller contains a DMA section which controls the transfer of data between the SCSI interface, the buffer RAM and the data controller. The DMA accesses a full-track (8 Kword) static RAM buffer to match the transfer speeds of the SCSI interface and the disk controller. All data transferred between the host and the disk must pass through the buffer RAM. The data controller coordinates the flow of data by interleaving RAM accesses between the SCSI interface and the disk controller. The processor is also allowed access to the buffer RAM to perform error correction.

The data controller also performs a data serializer/deserializer function. Data is transferred between the RAM buffer and the data controller in 16-bit words, and between the controller and the read/write circuit in a serial bit stream. The data controller converts the data bytes into a serial NRZ data stream, and vice versa. In addition, the controller also performs error checking on data being transferred from the disk to the RAM buffer and generates ECC on data transferred from the RAM buffer to the disk. The data controller also does header verification during read/write operations.

4-20. Disk Controller

The disk controller is responsible for managing the operation of the disk hardware. Containing its own microprocessor, this circuit synchronizes the overall operation of the hardware. The disk controller generates timing and control information for both the servo circuit and read/write circuit. The proper spindle speed is established and maintained by the controller. Head select and other control signals are transferred between this circuit and the head interface.

4-21. Servo Circuit

The servo circuitry establishes and maintains the proper position of the drive's data heads. Servo information embedded in intersector gaps is used to accomplish this task. The servo information is read from the disk, processed through the read/write circuit, and then passed to the servo circuit. Using this information, the servo circuit outputs a signal to the actuator driver, which causes the actuator to move the heads to the proper position.

The servo information is also used to generate timing signals for the disk controller. These signals are used to determine head position, provide feedback during seek operations, allow on-track/off-track detection, and establish synchronization between the servo information and all other drive operations. The disk controller generates the control and timing signals required to initiate seeks, keep heads on track, and control the overall operation of the servo circuit.

4-22. Read/Write Circuit

The read/write circuit transfers data between the disk controller and the disk media. Timing and control signals from the disk controller synchronize the operation of the read/write circuit to the rest of the drive. During write operations the read/write circuit accepts non-return to zero (NRZ) write data and its associated clock from the disk controller. The incoming NRZ data is encoded into 2-7 Run Length Limited (RLL) code, which is transferred to the head interface circuit to be written on the media.

During a read, the data is read from the disk and transferred through the head interface preamplifiers to the read/write circuit. The read/write circuit translates the data back into NRZ format, recovers the read clock, then transfers both clock and data to the disk data controller.

The read/write circuit also recovers the servo information embedded between sectors. This servo signal is output to the servo circuit for use in head positioning and drive timing.

4-23. Actuator Driver

The actuator driver provides the current necessary to operate the actuator assembly. The driver amplifies the position information provided by the servo circuit, and outputs the resultant current to the actuator.

4-24. Spindle Driver

The spindle driver provides the 3-phase current required to run the spindle motor. During spin-up, the spindle speed is controlled by the disk controller. Once the motor is up to speed, the disk controller maintains the speed of the spindle.

4-25. Power Circuits

The power circuits use +5 and +12 (±5%) voltages provided by an external dc power supply to power the spindle driver, actuator power amplifier, and digital circuitry. A negative voltage supply generates the additional operating voltages required by analog devices on the PCA. A reset output alerts the other circuits when power-on occurs and when power is lost. Each circuit responds in a predefined manner to the reset condition.

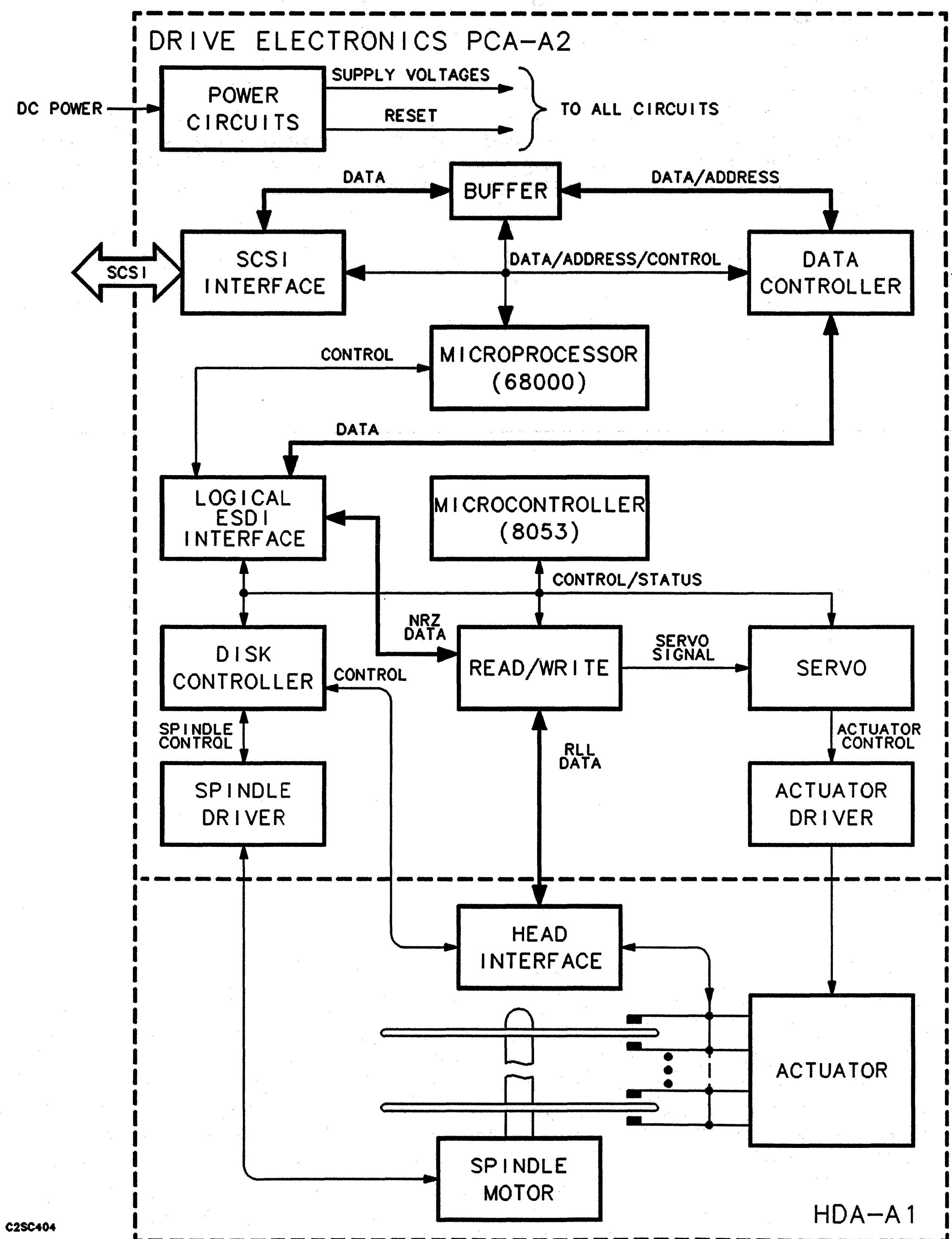


Figure 4-4. Disk Drive Block Diagram

SCSI Commands 5

5-1. Introduction

This chapter describes the implementation of the Small Computer Systems Interface (SCSI) on the HP 9753XS/T/D Disk Drives. The information includes all the SCSI features, options, and commands supported by these products. Any operating characteristics relevant to SCSI implementation are also discussed.

The information contained in this chapter allows a user familiar with SCSI to communicate successfully with the disk mechanism. In this chapter the term Target refers to the HP 9753XS/T/D Disk Drives.

5-2. SCSI Commands

Table 5-1 lists the features and options supported by the Target. Any relevant device-specific information is also provided.

Table 5-2 lists all SCSI commands executed by the Target. Any product-specific information regarding any command is also provided. A detailed explanation of each SCSI command is provided later in this chapter.

Table 5-1. Supported Features And Options (1 of 2)

FEATURE/ OPTION	COMMENTS
Drivers: Single-Ended	The standard product supports single-ended drivers. Differential drivers are available, as an option.
Connectors: Unshielded	The Target is equipped with a 50-pin unshielded connector.
Arbitration	Full arbitration is supported.
Disconnect	If allowed, the Target may disconnect after a command is received, and for any significant delay occurring during a data transfer operation.
Linked Commands	Command linking is supported.
Single-Byte Messages	The following single-byte messages are supported:

CODE (HEX)	MESSAGE	Direction*
00	Command Complete	In
02	Save Data Pointers	In
04	Disconnect	In
05	Initiator Detected Error	Out
06	Abort	Out
07	Message Reject	In/Out
08	No Operation	Out
09	Message Parity	Out
0A	Linked Command Complete	In
0B	Linked Command Complete With Flag	In
0C	Bus Device Reset	Out
80	Identify	In/Out

*In=Target to Initiator; Out=Initiator to Target

Table 5-1. Supported Features And Options (2 of 2)

FEATURE/ OPTION	COMMENTS
Status Codes	The following status codes are supported: CODE (HEX) — STATUS 00 — Good 02 — Check Condition 08 — Busy 10 — Intermediate Good 18 — Reservation Conflict
Power-On/ Hard Reset	In response to a Power-on condition, the Target performs a hard reset which includes the following: - Microprocessor Self Test - ROM Checksum - Buffer RAM Test - Microprocessor RAM Test - SCSI Interface Test - Internal Data Path Test - Data Controller Test - ECC Verification Test - Initialize Spare Table - Initialize Log - Initialize Saved Pages Information - R/W Access Test (each head)
Bus Reset	In response to a SCSI bus reset or Bus Device Reset message, the Target will perform a hard reset; this includes the following: - Abort Any Command in Progress - Controller Initialization - Initialize Spare Table - Initialize Log - Initialize Saved Pages Information

Table 5-2. Supported Commands (1 of 4)

COMMAND	OPCODE	DETAILS
ACCESS LOG	F2H	A vendor-unique command used to retrieve information from the Target's maintenance log.
EXECUTE DATA	FEH	A vendor-unique command used to execute special code downloaded using the WRITE DATA BUFFER command.
FORMAT UNIT	04H	The defect sources include P, D, and G lists (no C list). When formatting it is recommended that the Initiator not include a D list (FMTDAT=0). If the Initiator does supply a D list, it must be in the physical sector or bytes from index format. The Target uses an interleave of 1 regardless of value in Interleave field.
INQUIRY	12H	Target returns a maximum of 36 bytes in CCS format.
INTERFACE CONTROL	EFH	This vendor-unique command allows the ESDI commands to be sent to the disk drive processor.
MANAGE PRIMARY	FDH	A vendor-unique command used to manage the primary defect list (P list).
MEDIA TEST	F1H	A vendor-unique command used to test the integrity of the disk media.

Table 5-2. Supported Commands (2 of 4)

COMMAND	OPCODE	DETAILS
MODE SELECT	15H	The following values are supported: Medium Type: 0 Density Code: 0 Number Of Blocks: 0 Block Length: 256, 512, 1024, 2048, 4096 Page Code: 01 (Error Recovery Page) Page Codes: 03, 04 will be accepted as returned by Mode Sense Use of the following fields is supported: Disable Correction (DCR) Data Termination on Error (DTE) Post Error (PER) Transfer Block (TB) Retry Count Recovery Limit (converts to retry count)
MODE SENSE	1AH	The Target returns up to 38 bytes of MODE SENSE data. The following CDB values are supported: Page Control Field: 00 (Current values) 01 (Changeable values) 10 (default values) 11 (saved values) Page Code (hex): 01, 03, 04, 3F The Target default block size is 512 bytes. Default page parameters are listed in table 5-21.
READ (6-byte) READ (10-byte)	08H 28H	Both 6-byte and 10-byte (Extended) command formats are supported. Relative Addressing not supported in extended format (REL=0).
READ CAPACITY	25H	Use of PMI bit supported. Relative Addressing not supported (REL=0).
READ DATA BUFFER	3CH	Used in conjunction with WRITE DATA BUFFER command to test the Target's 16 Kbyte data buffer. Recommend executing RESERVE command to guarantee data integrity.
READ DEFECT DATA	37H	Target returns P, G, or P+G lists in physical sector or bytes from index format.

Table 5-2. Supported Commands (3 of 4)

COMMAND	OPCODE	DETAILS
READ HEADERS	EEH	This vendor-unique command reads all the headers on the addressed track and returns the requested number of bytes of this information.
READ FULL	F0H	A vendor-unique command that returns header, data field and ECC bytes of one physical sector.
REASSIGN BLOCKS	07H	Recommend that the defect list contain only one defect location per command.
REFORMAT TRACK	EDH	A vendor-unique command to format a single track. If HS bit is 0, then it uses normal default header information. If the HS bit is 1, the supplied header information is used for the track logical address and flag bytes.
RELEASE	17H	Unit and Third-Party Release supported. Extent Release not supported.
REQUEST SENSE	03H	Only the Extended Sense Data format is supported. The Target will return up to 22 bytes of sense data including: Sense Key (0-6,B,E) Additional Sense Code Device Errors (DERRORS) The Bit Pointer and Field Pointer fields are not used.
RESERVE	16H	Unit and Third-Party Reservations are supported. Extent Reservations are not supported.
REZERO UNIT	01H	Target does a recalibrate and then seeks to logical address 0.

Table 5-2. Supported Commands (4 of 4)

COMMAND	OPCODE	DETAILS
SEEK (6-byte) SEEK (10-byte)	0BH 2BH	Both 6- and 10-byte (Extended) formats are supported. Target returns GOOD status when seek is complete.
SEND DIAGNOSTIC	1DH	The only diagnostic supported is selftest (power-on) diagnostic. CHECK CONDITION status indicates that results are available using REQUEST SENSE command.
SPECIAL SEEK	ECH	Vendor-unique command. Leaves the disk drive selected after execution of the seek to allow for special testing at that address location/
START/STOP UNIT	1BH	START UNIT is fully supported. STOP UNIT will not cause the drive to spin down.
TEST UNIT READY	00H	Target returns GOOD status if drive is up to speed.
VERIFY	2FH	Target performs an ECC check only (REL=0, BYTCK=0). No data compare is performed.
WRITE (6-byte) WRITE (10-byte)	0AH 2AH	Both 6- and 10-byte (Extended) formats are supported. Relative Addressing not supported in extended format (REL=0).
WRITE DATA BUFFER	3BH	May be used to test Target's 16-kbyte data buffer or download code. To avoid possible data corruption, it is recommended that a RESERVE command be executed prior to the WRITE DATA BUFFER command.
WRITE FULL	FCH	A vendor-unique command that allows the Initiator to write one complete physical sector, including header, data, and ECC fields.

5-3. Status

A status byte shall be sent from the Target to the Initiator during the STATUS phase at the termination of each command as specified, unless the command is cleared by an ABORT message, by a BUS DEVICE RESET message, or by a "hard" RESET condition. The format of the status byte is shown in table 5-3.

Table 5-3. Status Codes

STATUS BYTE FORMAT

BYTE	BIT 7	6	5	4	3	2	1	0
00	RESRVD	VEND UNQ = 0		STATUS BYTE CODE				VU=0

STATUS BYTE CODE VALUES

4	3	2	1	STATUS
0	0	0	0	GOOD
0	0	0	1	CHECK CONDITION
0	1	0	0	BUSY
1	0	0	0	INTERMEDIATE/GOOD
1	1	0	0	RESERVATION CONFLICT

A description of the status byte codes is given below:

- GOOD. This status indicates that the Target has successfully completed the command.
- CHECK CONDITION. Any error, exception, or abnormal condition that causes sense data to be set, shall cause a CHECK CONDITION status. The REQUEST SENSE command should be issued following a CHECK CONDITION status to determine the nature of the condition.
- BUSY. The Target is busy. This status shall be returned whenever a Target is unable to accept a command from an Initiator. The normal Initiator recovery action is to issue the command again at a later time.

- INTERMEDIATE/GOOD. This status shall be returned for every command in a series of linked commands (except the last GOOD command), unless an error, exception, or abnormal condition causes a CHECK CONDITION status to be set. If this status is not returned, the chain of linked commands is broken; no further commands in the series will be requested.

- RESERVATION CONFLICT. This status shall be returned whenever an SCSI device attempts to access a logical unit that is reserved to another SCSI device.

5-4. SCSI Message Support

The disk drive supports messages received from the Initiator in the following manner:

- Multiple byte message out phases are allowed.

- Any message out may be prefixed with an optional identify byte.

- An optional number of No-Op message bytes may be embedded in the message out received by the disk drive prior to the final message byte.

- Only one message type (other than the Identify prefix and the optional No-Op bytes) will be accepted per message out phase. If more than one type is received, the message will be treated as an illegal message.

- A maximum of 16-message out bytes will be accepted by the disk drive. if the ATN line is still set after 16 bytes have been received, the disk drive will treat this as an illegal message type, except that the disk drive will always terminate in a BUS FREE state.

The following message types are supported:

Message Parity Error- Refer to paragraph 5-13.

Initiator Detected Error- Refer to paragraph 5-13.

Abort- This message will cause the disk drive to abort the command in process, clear the Initiator's status and go to the BUS FREE state.

Reset- This message will cause the disk drive to abort the command in process, reset to Power On conditions for all Initiators, and go to the BUS FREE state.

No-Op- This message will be treated as an illegal message type if not followed by some legal message byte, except for one special case. This case is when the No-Op message type is received immediately following a Re-select attempt by the Target. In this case, the Target will attempt to proceed with the interrupted re-select phase.

Message Reject- Refer to paragraph 5-11.

Extended SDTR Message- The SDTR (Synchronous Data Transfer Request) message type will only be accepted prior to the Command phase, and only prior to the first Command phase in a linked command set. At any other time it will be treated as an illegal message type. If the negotiation process is started by the Initiator, the drive will respond with its SDTR message. If the Initiate SDTR Message Option is enabled, the drive will initiate an SDTR message at Power On and RESET.

5-5. Target Error Conditions

Under some error conditions the Target may proceed to the BUS FREE phase without terminating the command (i.e. no DISCONNECT or COMMAND COMPLETE message sent to the host). In this case, the Target will not attempt to re-connect with the Initiator. The Initiator should consider this as a catastrophic error. Information regarding the cause of this abnormal response can be recovered by the Initiator with the REQUEST SENSE command.

5-6. Message Out Phase Parity Error

If parity checking is enabled and a message out parity error is detected the disk drive will abort the command in process and set the sense key to ABORTED COMMAND with the sense code set to PARITY ERROR. If a valid LUN has been received in an identify or in the CDB, and status phase has not yet begun, then the command will be terminated with a CHECK CONDITION status; otherwise, the Target will go the the BUS FREE state.

5-7. Command or Data Out Phase Parity Error

If parity checking is enabled and a Command or Data Out phase parity error is detected then disk drive will terminate the command in process with a CHECK CONDITION status. The sense information will have the sense key set to ABORTED COMMAND with the sense code set to PARITY ERROR.

5-8. Illegal Messages

If an illegal or unexpected message out is received from the Initiator, the disk drive will abort the command in process and set the sense key to ABORTED COMMAND with the sense code set to INAPPROPRIATE/ILLEGAL MESSAGE. If a valid LUN has been received in an identify or in the CDB, and the status phase has not yet begun, then the command will be terminated with a CHECK CONDITION status; otherwise the Target will go to the BUS FREE phase.

5-9. Reject Messages

If a MESSAGE REJECT message is received from the Initiator it will normally be treated like an illegal message (see previous paragraph). Only if the Target is in the MESSAGE IN phase and attempting to send one of the following messages will it be treated differently.

Disconnect Message In, Save Data Pointer Message In- The Target will not disconnect and will proceed with the command in process. This will not prevent the disk drive from attempting to disconnect from the Initiator at a later time.

Synchronous Data Transfer Message In- The Target will assume that an asynchronous transfer is expected. This will affect all later data transfer phases.

5-10. Reselection Timeout

If the Target attempts to reselect the Initiator and the Initiator does not respond within a SELECTION TIMEOUT DELAY, the Target will attempt to reselect a second time. If the second attempt fails, the Target will abort the command in process and make no further attempts to reselect the host. The sense information will be set with a sense key of HARDWARE ERROR and a sense code of SELECT/RESELECT FAILED.

5-11. Message Parity Error or Initiator Detected Error Message Out

If either of these messages is received from the Initiator, the disk drive will abort the command in process and set the sense key to ABORTED COMMAND with the sense code set to INITIATOR DETECTED ERROR. If a valid LUN has been received in an identify or CDB, and a status phase has not yet begun, then the command will be terminated with a CHECK CONDITION status; otherwise the Target will go to the BUS FREE phase.

5-12. Command Descriptions

The following paragraphs provide a detailed description of the SCSI commands executed by the drive. The descriptions include CDB formats, data formats, and all device-specific information involved in command execution. For a detailed explanation of the commands, refer to the ANSI SCSI specification.

The following information applies to all commands:

- The Target only supports a single Logical Unit (LUN). All commands must be addressed to LUN 0, except an INQUIRY command which may be directed to any LUN.
- All reserved fields in each command must be set to 0.
- All reserved and vendor-unique fields in each command are tested for proper values (normally 0).

5-13. Access Log

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = F2H							
01	LOGICAL UNIT NUMBER			RESERVED			CLEAR	PHYS
02	RESERVED							
03	RESERVED							
04	RESERVED							
05	RESERVED							
06	RESERVED							
07	ALLOCATION LENGTH (MSB)							
08	ALLOCATION LENGTH (LSB)							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

The ACCESS LOG command allows the Initiator to read the entries contained in the disk drive's maintenance log. This information is available for maintenance purposes. By setting the CLEAR bit to 1, the Initiator can clear all the current log entries after reading them.

The log information is maintained in a RAM table which is initialized from the disk log on power-on or reset. It is only posted to the disk when an error entry is added. The ACCESS LOG command will always return this information from the RAM log; there is no disk access.

If the Physical Address (PHYS) bit is clear (0), all addresses and block counts are in terms of logical blocks. Any addresses that are outside the user data space are set to addresses higher than the maximum block address when logical block references are requested. If PHYS is set to 1, all addresses and block counts are in terms of physical sectors.

The log information is preceded by a four-byte header (refer to table 5-4). The Available Length field defines the number of bytes following the header. This length does not include the four-byte header itself. The header is followed by zero or more log entries. Each log entry begins with a 2-byte header identifying the type and length (excluding the header) of the following entry. The log types are defined as follows:

00H - No information
01H - Usage log entry
02H - Data Error log entry
03H - Hardware Error log entry

Usage log Entry. The Usage log entry conveys usage information about the entire device. The length of this entry is 12 bytes. The format for a Usage log entry is shown in table 5-5.

The Reporting Area field is set to FFH, indicating that the entry refers to the entire device. The Access Count field indicates the number of media positionings since the last hardware error occurred. This field is reset to zero each time a Hardware Error log entry is added to the log. If no Hardware Error log entries are included in the ACCESS LOG data, this field reflects the total number of media accesses. If Hardware Error log entries are included, this field and the values in corresponding Access Count fields in those entries must be combined to yield the total number of media accesses. The number of accesses represented by the Access Count field are shown in table 5-6.

The Blocks Read Count field is the count of the blocks read over the entire disk drive. If the PHYS bit in the CDB is clear, this field counts logical blocks. If PHYS is set, the count represents physical blocks.

The First Retry Count field indicates the number of instances when the data error recovery algorithm was forced to perform data read retrys and the data was recovered on the first retry. The Multiple Retry Count field indicates the number of times data was not recovered on the first retry. Note that this count is incremented only once per complete recovery action, not once for each retry within one recovery action.

Data Error Log Entry. This 6-byte entry is used to convey data error information about a specific data block. The format of the Data Error log entry is shown in table 5-7.

The Block Address field contains the block address of the data block that encountered multiple read retrys during one or more data error recovery attempts. If the PHYS bit in the CDB is clear, this field contains the logical block address. If PHYS is set, this field contains the physical block address in the following format:

- Byte 2: Cylinder Address (MSB)
- Byte 3: Cylinder Address (LSB)
- Byte 4: Head Address
- Byte 5: Sector Address

The Data Error Code byte is bit-significant, and multiple errors at the same location will have their respective bits merged into the reported byte as follows:

Bit 7 - Unclassifiable error
Bit 6 - Error occurred in header field
Bit 5 - Error occurred in data field
Bit 4 - Unrecoverable error
Bit 3 - Error recovered with ECC
Bit 2 - Error recovered with retries
Bit 1 - Write fault
Bit 0 - Reserved

The Occurrence Count field is incremented each time the specified block is uncorrectable or requires multiple read retries in a given transaction. This field is incremented only once for each data recovery.

Hardware Error Log Entry. This entry conveys hardware fault information. The format for this 8-byte log entry is shown in table 5-8.

The Block Address field contains the block address the disk drive was attempting to access when the error occurred. If the PHYS bit in the CDB is clear, this is a logical block address. If PHYS is set, this is a physical block address in the same format described for the Data Error log entry.

The Internal Device Status field contains an error code corresponding to the Additional Sense code returned by the REQUEST SENSE command (refer to table 5-29). The Device Error and FRU code values will be returned as zero. The Access Count field contains access information as defined in the Usage log entry.

Table 5-4. Access Log Data Header Format

	BIT							
BYTE	7	6	5	4	3	2	1	0
00	RESERVED							
01	RESERVED							
02	AVAILABLE LENGTH (MSB)							
03	AVAILABLE LENGTH (LSB)							

Table 5-5. Usage Log Entry Format

HEADER FORMAT

BYTE	BIT 7	6	5	4	3	2	1	0
00	LOG ENTRY TYPE = 01H							
01	LOG ENTRY LENGTH = 0CH							

LOG ENTRY

BYTE	7	6	5	4	3	2	1	0
02	REPORTING AREA = FFH							
03	RESERVED				ACCESS COUNT			
04	BLOCKS READ COUNT (MSB)							
05	BLOCKS READ COUNT							
06	BLOCKS READ COUNT							
07	BLOCKS READ COUNT							
08	BLOCKS READ COUNT							
09	BLOCKS READ COUNT (LSB)							
10	FIRST RETRY COUNT (MSB)							
11	FIRST RETRY COUNT (LSB)							
12	MULTIPLE RETRY COUNT (MSB)							
13	MULTIPLE RETRY COUNT (LSB)							

Table 5-6. Access Count Range Values

VALUE (HEX)	MINIMUM OF ACCESS RANGE	MAXIMUM OF ACCESS RANGE
0	No Accesses	No Accesses
1	1	1
2	2	10
3	11	100
4	101	1,000
5	1,001	10,000
6	10,001	100,000
7	100,001	500,000
8	500,001	1,000,000
9	1,000,001	5,000,000
A	5,000,001	10,000,000
B	10,000,001	50,000,000
C	50,000,001	100,000,000
D	100,000,001	500,000,000
E	500,000,001	1,000,000,000
F	1,000,000,001	>1,000,000,001

Table 5-7. Data Error Log Entry Format

HEADER FORMAT

BYTE	BIT 7	6	5	4	3	2	1	0
00	LOG ENTRY TYPE = 02H							
01	LOG ENTRY LENGTH = 06H							

LOG ENTRY

02	BLOCK ADDRESS (MSB)
03	BLOCK ADDRESS
04	BLOCK ADDRESS
05	BLOCK ADDRESS (LSB)
06	DATA ERROR CODE
07	OCCURRENCE COUNT

Table 5-8. Hardware Error Log Entry Format

HEADER FORMAT

BYTE	BIT 7	6	5	4	3	2	1	0
00	LOG ENTRY TYPE = 03H							
01	LOG ENTRY LENGTH = 08H							

LOG ENTRY

02	BLOCK ADDRESS (MSB)							
03	BLOCK ADDRESS							
04	BLOCK ADDRESS							
05	BLOCK ADDRESS (LSB)							
06	INTERNAL DEVICE STATUS							
07	DEVICE ERROR							
08	FIELD REPLACEABLE UNIT (FRU)							
09	RESERVED				ACCESS COUNT			

5-14. Execute Data

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = FEH							
01	LOGICAL UNIT NUMBER			0	0	0	INST	EXE
02	PARAMETER FIELD							
03	PARAMETER FIELD							
04	PARAMETER FIELD							
05	PARAMETER FIELD							
06	PARAMETER FIELD							
07	PARAMETER FIELD							
08	PARAMETER FIELD							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

CAUTION

The EXECUTE DATA command allows the Initiator to execute code that may cause damaging results. It should be performed only when no data retention is required. Use of this command should be restricted to factory or other highly controlled environments. Development of the code for this command should be carefully coordinated with the product's support team. Execution of this command with code not approved by Hewlett-Packard may be deemed a violation of warranty.

The EXECUTE DATA command allows the Initiator to download special code for the Target to execute, thus providing functions not available in the standard command set. This command causes code bytes sent by the Initiator to the data buffer via a WRITE BUFFER command to be executed. It is suggested that each EXECUTE DATA command be immediately preceded by the appropriate WRITE BUFFER command to ensure proper code execution.

When set to one, the Install (INST) bit indicates that the code segment in the buffer is to be "permanently" installed in executable RAM, but not executed. When set to one, the Execute (EXE) bit indicates that the previously installed command is to be executed and no code is transferred from the data buffer. If both bits are set, the code segment will be installed and executed. If both bits are clear (0), the command will fail with CHECK CONDITION status and ILLEGAL FIELD sense.

The code segment in the data buffer will consist of an 8-byte header followed by the executable code. The header consists of four (4) revision bytes; which must be equal to the current ASCII firmware revision (refer to CAUTION); a 2-byte Checksum calculated over the code length; and a 2-byte Code Length field which does not include the length of the header (refer to table 5-9). The entire header must be received or the command will be rejected with CHECK CONDITION status and ILLEGAL REQUEST sense.

A Code Length of zero will be accepted with no error, and no code will be executed. In this case, no checksum verification will be performed.

A checksum verification will be done over the code length for all cases , except when only the EXE bit is set to 1. If the verification fails, the command will fail with CHECK CONDITION status and ILLEGAL REQUEST sense.

If the code length is nonzero and all verification succeeds, execution will begin at the first byte of received code. It is the responsibility of that code to maintain proper firmware integrity and to terminate its function in an acceptable manner.

Table 5-9. Execute Data Header Format

	BIT							
BYTE	7	6	5	4	3	2	1	0
00	ASCII REV BYTE 1							
01	ASCII REV BYTE 2							
02	ASCII REV BYTE 3							
03	ASCII REV BYTE 4							
04	CHECKSUM (MSB)							
05	CHECKSUM (LSB)							
06	CODE LENGTH (MSB)							
07	CODE LENGTH (LSB)							

5-15. Format Unit

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 04H							
01	LOGICAL UNIT NUMBER			FMTDAT	CMPLST	DEFECT LIST FORMAT		
02	VENDOR UNIQUE							
03	INTERLEAVE (MSB)							
04	INTERLEAVE (LSB)							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The FORMAT UNIT command ensures that the medium is formatted so that all data blocks can be accessed. Any data residing on the medium before this command is issued will be lost. Any log information will be cleared by the format operation. The current MODE SELECT operating parameters will become the saved values.

There are three possible sources of defect information during a format operation:

P = Primary Defect List: The P list is the list of original manufacturer permanent flaws on the media.

D = Data Defect List: This list is supplied by the Initiator in the Data Phase of the FORMAT UNIT command using the physical block format for defect information.

G = Growing Defect List: This list includes defects identified to or by the Target after original manufacture. It does not include the P list. Sources for the G list are:

1) All defects sent by the Initiator in D lists during previous FORMAT UNIT operations.

2) Any defects identified by the REASSIGN BLOCKS command.

Table 5-10. FORMAT UNIT Defect Sources

FMT DAT	CMP LST	DEFECT LIST FORMAT	INITIATOR D LIST	DEFECT SOURCES
0*	X	X X X	No	P and G lists retained.
1	0	1 0 1 or 1 0 0 or 0 X X**	Yes	D appended to current G list. P list retained.
1	1	1 0 1 or 1 0 0 or 0 X X**	Yes	Current G list deleted. D becomes new G list. P list retained.

* The preferred option is FMTDAT = 0.
** Defect list length of zero only.

The Format Data (FMTDAT) bit is used to indicate whether the Initiator will send additional defect information (D list) to the Target (refer to table 5-10). If FMTDAT is zero, the Target does not receive a D list and all previous defect list information (P and G) is retained. In this situation, no data phase will occur.

If FMTDAT is set to 1, a D list will be supplied by the Initiator. When FMTDAT is set, the Complete List (CMPLST) bit determines whether or not existing defects in the G list will be retained during the format. If CMPLST equals 0, the G list is retained and the D list is appended to it. If CMPLST is set to 1, the existing G list is deleted and replaced by the D list from the Initiator.

Interleave specifies the order in which logical blocks are related to physical blocks. Any interleave value will be accepted, but the Target will always use its default interleave of (1) so logical blocks are placed in consecutive physical order.

The DEFECT LIST FORMAT field must be set to 5 for physical sector format (recommended), or to 4 for bytes from index format, or if the defect list length is less than zero, to less than four (0XX) for block format.

The defect list consists of a header indicating the total number of bytes in the set of descriptors to follow (refer to table 5-11). Each descriptor consists of an eight-byte physical sector address or bytes from address index. Each address is bounds checked by the Target except for the sector or bytes from index field. If any address is out of bounds an ILLEGAL REQUEST Sense Key is generated, and the format operation is discontinued. Any defect locations prior to the error location will have been reallocated.

The following bits in the defect list header shall be set to 0: Disable Primary (DPRY) and Stop Format (STPF). If the Format Options Valid (FOV) bit is set to 1, the drive will accept a Disable Certification (DCRT) bit set to 1. All other option bits must be zero(0). The drive does not perform a certification pass in any case.

A sector number of FFFFFFFFH indicates that the entire track is to be reallocated. Normally, a new track will be assigned for each defect in the defect list.

Table 5-11. Format Unit Defect List Format

HEADER FORMAT

BYTE	BIT							
	7	6	5	4	3	2	1	0
00	RESERVED							
01	FOV	DPRY=0	DCRT	STPF=0	RESERVED			VU=0
02	DEFECT LIST LENGTH (MSB)							
03	DEFECT LIST LENGTH (LSB)							

DEFECT DESCRIPTOR FORMAT

00	CYLINDER NUMBER OF DEFECT (MSB)
01	CYLINDER NUMBER OF DEFECT
02	CYLINDER NUMBER OF DEFECT (LSB)
03	HEAD NUMBER OF DEFECT
04	DEFECT SECTOR NUMBER OR BYTES FROM INDEX (MSB)
05	DEFECT SECTOR NUMBER OR BYTES FROM INDEX
06	DEFECT SECTOR NUMBER OR BYTES FROM INDEX
07	DEFECT SECTOR NUMBER OR BYTES FROM INDEX (LSB)

5-16. Inquiry

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 12H							
01	LOGICAL UNIT NUMBER			RESERVED				
02	RESERVED							
03	RESERVED							
04	ALLOCATION LENGTH							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The INQUIRY command requests that information regarding parameters of the Target be sent to the Initiator.

The Allocation Length specifies the number of bytes that the Initiator has allocated for returned INQUIRY data. An Allocation Length of zero indicates that no INQUIRY data shall be transferred. This condition shall not be considered as an error. Any other value indicates the maximum number of bytes that shall be transferred. The Target shall terminate the DATA IN phase when the specified number of bytes have been transferred or when all available INQUIRY data have been transferred to the Initiator, whichever is less. The Target returns 36 bytes of information in the format shown in table 5-12.

The INQUIRY command shall return a CHECK CONDITION status only when the Target cannot return the requested INQUIRY data. INQUIRY data will be returned even though the peripheral device may not be ready for other commands. The INQUIRY command will execute even if the drive is reserved to another host.

If an INQUIRY command is received from an Initiator with a pending UNIT ATTENTION condition (before the Target reports CHECK CONDITION status), the Target shall execute the INQUIRY command and shall not clear the UNIT ATTENTION condition. This will also be true for a pending HARDWARE ERROR condition.

NOTE

An INQUIRY command directed to an invalid LUN (≠ 0) will return a Peripheral Device Type of 7FH (Logical Unit Not Present) in byte 0 of the parameter list. This condition is not considered to be an error. The INQUIRY command will be executed with no error reported even if the Target is reserved by/to a different initiator.

Table 5-12. Inquiry Parameter List Format

BYTE	BIT							
	7	6	5	4	3	2	1	0
00	PERIPHERAL DEVICE TYPE = 00 (or 7FH)							
01	RMB=0	DEVICE TYPE QUALIFIER = 0						
02	0	0	ECMA VERSION = 0			ANSI VERSION = 1		
03	0	0	0	0	REGISTRATION = 01 (CCS)			
04	ADDITIONAL PARAMETER LENGTH = 31							
05	VENDOR UNIQUE							
06	RESERVED							
07	RESERVED							
08-15	VENDOR IDENTIFICATION BYTES (in ASCII) *							
16-31	PRODUCT IDENTIFICATION BYTES (in ASCII) **							
32-35	PRODUCT REVISION NUMBER (in ASCII) ***							

*** VENDOR IDENTIFICATION**

Byte 8 = H
9 = P
10-15 = spaces

**** PRODUCT IDENTIFICATION**

Byte 16 = 9
17 = 7
18 = 5
19 = 3
20 = X****
21 = S
22-31 = spaces

**** = 2, 3 or 6 based on the number of surfaces in the product.

***** PRODUCT REVISION**

Byte 32 =
33 =
34 =
35 =
} date code

5-17. Interface Control

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = EFH							
01	LOGICAL UNIT NUMBER			RESERVED				STAT
02	COMMAND (MSB)							
03	COMMAND (LSB)							
04	RESERVED							
05	RESERVED							
06	RESERVED							
07	RESERVED							
08	RESERVED							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

This command will cause the ESDI command bits supplied to be sent to the disk controller.

If the STAT bit is sent, 2 bytes of ESDI status information will be received from the disk controller and returned to the host in addition to the interface status byte.

NOTE

There is no interface timeout on this command. It is the initiator's responsibility to issue valid commands and to set the STAT bit only for commands which will normally return status information.

A single byte will be returned to the host when the disk controller completes its operation. The byte has the following bit definitions:

Bit 0 - Disk drive selected
Bit 1 - Command complete
Bit 2 - Ready
Bit 3 - Attention
Bits 4-7 - Undefined

5-18. Manage Primary

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = FDH							
01	LOGICAL UNIT NUMBER			FMTDAT	CMPLST	DEFECT LIST FORMAT		
02	RESERVED							
03	RESERVED							
04	RESERVED							
05	RESERVED							
06	RESERVED							
07	RESERVED							
08	RESERVED							
09	RESERVED						FLAG	LINK

CAUTION

The MANAGE PRIMARY command allows the Target to overwrite any or all of the initiator-addressable data space. This command should be performed only when no data retention is required. Use of this command should be restricted to factory or other highly controlled environments. Any use of this command other than at Hewlett-Packard approved sites may be deemed a violation of warranty.

The MANAGE PRIMARY command is used to manage the primary defect list (P list). This command can delete the current P list, install a new P list, or append defects to the current P list. When installing or appending the P list, this command causes the specified physical blocks to be reassigned as primary defects and added to the P list. This command is implemented by performing a full device format, which will cause the loss of all user data and log information. Any existing G list defect information will also be lost. The current operating MODE SELECT parameters will become the saved parameters following this command.

The Format Data (FMTDAT) bit is used to indicate if the Initiator will send defect information to the Target. If FMTDAT is zero, the Initiator does not send any defect list, consequently no data phase occurs. If FMTDATA is set to 1, a defect list must be supplied by the Initiator.

When FMTDAT is set, the Complete List (CMPLST) bit determines whether or not existing defects in the P list will be retained. If CMPLST is set to 0, the existing P list is retained and the defect list is appended to it. If CMPLST equals 1, the existing P list is deleted and replaced by the list from the Initiator. If the append option is selected, only the spare track area of the drive will be reformatted.

The operation of this command is similar to the FORMAT UNIT command, and is shown in table 5-13.

The DEFECT LIST FORMAT field must be set to 5 for the physical sector format or 4 for bytes from index format. The defect list consists of a header indicating the total number of bytes in the set of descriptors to follow (refer to table 5-14). Each descriptor consists of an eight-byte physical sector address. A defect list length of zero (0) is not considered an error.

Table 5-13. Manage Primary Defect Sources

FMT DAT	CMP LST	DEFECT LIST FORMAT	INITIATOR D LIST	DEFECT SOURCES
0	X	X X X	No	No defect list retained.
1	0	1 0 1 or 1 0 0	Yes	D appended to current P list. No G list retained.
1	1	1 0 1 or 1 0 0	Yes	D becomes new P list. No G list retained.

Table 5-14. Manage Primary Defect List Format

HEADER FORMAT

BYTE	BIT 7	6	5	4	3	2	1	0
00	RESERVED							
01	VENDOR UNIQUE = 0							
02	DEFECT LIST LENGTH (MSB)							
03	DEFECT LIST LENGTH (LSB)							

DEFECT DESCRIPTOR FORMAT

00	CYLINDER NUMBER OF DEFECT (MSB)
01	CYLINDER NUMBER OF DEFECT
02	CYLINDER NUMBER OF DEFECT (LSB)
03	HEAD NUMBER OF DEFECT
04	DEFECT SECTOR NUMBER OR BYTES FROM INDEX (MSB)
05	DEFECT SECTOR NUMBER OR BYTES FROM INDEX
06	DEFECT SECTOR NUMBER OR BYTES FROM INDEX
07	DEFECT SECTOR NUMBER OR BYTES FROM INDEX (LSB)

5-19. Media Test

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = F1H							
01	LOGICAL UNIT NUMBER			WRT	R=0	INT	RND	RST
02	LOGICAL BLOCK ADDRESS (MSB)							
03	LOGICAL BLOCK ADDRESS							
04	LOGICAL BLOCK ADDRESS							
05	LOGICAL BLOCK ADDRESS (LSB)							
06	TRANSFER LENGTH (MSB)							
07	TRANSFER LENGTH							
08	TRANSFER LENGTH (LSB)							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

The MEDIA TEST command instructs the Target to automatically perform testing over a specified area of the media.

The Write (WRT) bit defines what type of test will be performed on the specified media area. If WRT is clear (0), the Target performs a read; if WRT is set (1), the Target performs a write operation.

The Internal Pattern (INT) bit selects the source of the data pattern used when a write test is selected. If INT is set to 1, the Target uses an internally generated worst-case data pattern (6DBH). If INT is clear, the current contents of the first logical block of the Target's data buffer is used for the write pattern. Therefore, immediately preceding a MEDIA TEST command with INT clear, the Initiator should perform a WRITE BUFFER command (of at least one block length) which loads the desired data pattern into the data buffer. If WRT is clear, INT must also be clear.

The Random (RND) bit selects either random or sequential addressing. The media testing begins with the logical block address specified in the CDB. If RND is clear (0), the test proceeds sequentially from the specified logical block. Logical block zero follows the last logical block on the media when using sequential addressing. If RND is set (1), the next address is generated randomly from any block on the media.

The Reset Seed (RST) bit is used only when RND is set. When RST is set, the Target initializes its random number seed using the specified block address. This capability provides a method to enable a repeatable sequence of random addresses for pairs of MEDIA TEST commands (i.e., a write followed by a read). If RND is set and RST is clear, the random number seed is not reset. If RND is clear, RST must also be clear.

The Transfer Length field indicates the number of blocks to be tested, unless terminated by an error. An unrecoverable error terminates the MEDIA TEST command and generates CHECK CONDITION status with the appropriate sense information. If only recoverable errors occur, the media test will run to completion and return a CHECK CONDITION status with sense information set for the last recoverable error which occurred. Information on any additional errors can be obtained from the drive error log. A transfer length of zero shall not cause any media transfer to occur and shall not be considered an error.

On a sequential media test, if the Transfer Length is greater than the length remaining from the start address to the maximum block address, the test will continue to run from address zero (0) after the maximum block address is reached. This is not considered an error. This "wrap around" may occur more than once during a long test.

For random tests, only single block operations are performed. The transfer length field indicated the number of these operations to be performed.

5-20. Mode Select

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 15H							
01	LOGICAL UNIT NUMBER			PF	RESERVED			SP
02	RESERVED							
03	RESERVED							
04	PARAMETER LIST LENGTH							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The MODE SELECT command provides a means for the Initiator to specify medium, logical unit, or peripheral device parameters to the Target.

The parameter list length specifies the length in bytes of the MODE SELECT parameter list that shall be transferred during the DATA OUT phase. A parameter list length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. If non-zero, the parameter length must contain a header and optionally a Block Descriptor (if Block Descriptor Length is 8) and optionally page data. The minimum page length accepted is 2 bytes (page code plus length). The length of data received for page 1 is determined by the page length field (up to a maximum of 6 bytes). Illegal parameter lengths will result in a CHECK CONDITION status with a Sense Key of ILLEGAL REQUEST. Pages 3 and 4, if sent, must be identical to those returned in MODE SENSE or zero length.

The SP bit indicates that the target should save any savable pages sent with this command. When the SP bit is set, the current block size will also be saved. Only one page is saveable for this product.

The Page Format (PF) bit (when set to 1) indicates that the data is sent in the Common Command Set (CCS) page format. When set to 0, the data is sent in the vendor unique format. For this product both formats are the same and the PF bit is ignored.

If a MODE SELECT modifies operating parameters that are common to other Initiators, the Target will report CHECK CONDITION status and UNIT ATTENTION Sense Key with Additional Sense Code of MODIFIED PARAMETERS when next accessed by other Initiators but not by the Initiator issuing the MODE SELECT command. This rule does NOT override the normal first access rule for each Initiator, nor does it override the normal rules for INQUIRY and REQUEST SENSE.

The MODE SELECT parameter list contains a four-byte header, optionally followed by a single block descriptor, followed by the optional page parameters (refer to table 5-15).

Table 5-15. Mode Select Parameter List Format

HEADER FORMAT

BYTE	BIT 7	6	5	4	3	2	1	0
00	RESERVED							
01	MEDIUM TYPE = 0							
02	RESERVED							
03	BLOCK DESCRIPTOR LENGTH = 0, 8							

BLOCK DESCRIPTOR FORMAT

04	DENSITY CODE = 0
05-07	NUMBER OF BLOCKS = 0
08	RESERVED
09	BLOCK LENGTH (MSB)
10	BLOCK LENGTH
11	BLOCK LENGTH (LSB)

PAGE DESCRIPTOR FORMAT

12	SPO=0	R=0	PAGE CODE = 01					
13	PAGE LENGTH (BYTES) = 6							
14	AWRE=0	ARRE=0	TB	RC=0	EEC=0	PER	DTE	DCR
15	RETRY COUNT							
16	CORRECTION SPAN							
17	HEAD OFFSET COUNT							
18	DATA STROBE OFFSET COUNT							
19	RECOVERY TIME LIMIT							

The Page Descriptors (Pages) may be sent to the Target following the MODE SELECT header. The optional Block Descriptor Length field in the header does not include the length of the appended pages.

The three-byte Number Of Blocks field in the block descriptor must be zero to indicate all blocks on the logical unit are affected. The Block Length field supports values of 256, 512, 1024, 2048, and 4096 bytes. Unsupported values are rejected with ILLEGAL REQUEST Sense Key. The new block length takes effect immediately. If the setting of a block length affects other Initiators, the rules stated for UNIT ATTENTION will be followed.

The only saveable page supported is the Error Recovery Parameters page (Page Code = 01).

A Disable Correction (DCR) bit set to a value of one indicates that no ECC correction will be performed. The ECC check still occurs and errors will be reported. A value of zero results in a full ECC check and correction operation (if required).

A Disable Transfer on Error (DTE) bit 1 set to one and if the PER bit is set to one, indicates that the Target shall create the CHECK CONDITION status and terminate the data transfer to the initiator immediately upon detection of an error. The Transfer Length is then not exhausted. The data of the block in error, which is the first erring block encountered, may or may not be transferred to the initiator depending upon the setting of the TB bit. The DTE bit can only be set to one by the initiator if the PER bit is set to one. The Target shall create the CHECK CONDITION status with Illegal Request Sense Key, if it receives PER bit of zero and DTE bit set to one. A DTE bit set to zero enables data transfer for any data which can be recovered within the limits of the Error Recovery Flags. Any erring block that would be posted, which is the last recovered block encountered, is not posted until the Transfer Length is exhausted.

A Post Error (PER) bit 2 set to one indicates that the Target shall enable the reporting of the CHECK CONDITION status for recovered errors, with the appropriate Sense Key. The CHECK CONDITION status shall happen during the data transfer depending either on the DTE bit value or if an unrecoverable error occurred. If multiple errors occur, the REQUEST SENSE data shall report the block address of either the last block on which the recovered error occurred or of the first unrecoverable error. A PER bit set to zero indicates that the Target shall not create the CHECK CONDITION status for errors recovered within the limits established by the other Error Recovery Flags. Recovery procedures exceeding the limits established by the other Error Recovery Flags shall be posted accordingly by the Target. The transfer of data may terminate prior to exhausting the Transfer Length, depending upon the error and the state of the other Error Recovery Flags.

A Transfer Block (TB) bit 5 set to one indicates that the failing data block (recovered or unrecoverable) data shall be transferred to the initiator. A TB bit set to zero indicates that the failing data block (recovered or unrecoverable) data shall not be transferred to the initiator.

Retry Count is the number of times that the Target should attempt its read recovery algorithm. Typically, this is performed before applying correction. If both Retry Count and Recovery Time Limit are specified in a MODE SELECT command, the field which specifies the shorter time period of recovery actions shall dominate. In this case, the non-dominant field shall be returned as FFH in subsequent MODE SENSE commands requesting current values. A FFH value indicates the maximum number of retries allowable (255). The limit in this field specifies the maximum recovery action allowed for any individual logical block. With a Target supporting both the Retry Count and Recovery Time Limit fields, an initiator wishing to specify a preferred field should set the undesired field to FFH.

If both Retry Count and Recovery Time Limit are specified in a MODE SELECT command, the field which specifies the shorter time period of recovery actions shall dominate. In this case, the retry count will be set from the dominant field, and so reported in subsequent MODE SENSE commands. The Recovery Time Limit field will revert to 0FFH.

Recovery Time Limit is the maximum time that the Target shall attempt error recovery actions in order to correctly recover data, if such recovery is allowed in other fields of this page. The field is defined in one (1) millisecond increments. The Target may round the value to its nearest convenient value. A zero value indicates that no retries are allowed. A FFH value indicates that the maximum number of retries is allowed. The limit in this field specifies the maximum recovery action allowed for any individual logical block.

The following bits in byte 14 of the page descriptor must be set to 0: Automatic Write Reallocation (AWRE), Automatic Read Reallocation (ARRE), Read Continuous (RC), and Enable Early Correction (EEC).

5-21. Mode Sense

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 1AH							
01	LOGICAL UNIT NUMBER			RESERVED				
02	PCF		PAGE CODE					
03	RESERVED							
04	ALLOCATION LENGTH							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The MODE SENSE command provides a means for a Target to report its medium, logical unit, or peripheral device parameters to the Initiator. It is a complementary command to the MODE SELECT command.

The Allocation Length specifies the number of bytes that the Initiator has allocated for returned MODE SENSE data. An Allocation Length of zero indicates that no MODE SENSE data shall be transferred. This condition shall not be considered as an error. Any other value indicates the maximum number of bytes that shall be transferred. The Target shall terminate the DATA IN phase when the specified number of bytes have been transferred or when all available MODE SENSE data have been transferred to the Initiator, whichever is less.

The Page Control Field (PCF) defines the type of Page Parameter value to be returned. The values for this field are defined as follows:

00 = Report Current Values
01 = Report Changeable Values
10 = Report Default Values
11 = Report Saved Values

The PAGE CODE field specifies which page(s) are to be returned to the Initiator. The Target supports three pages and will accept the following page codes:

01H = Error Recovery Parameters
03H = Direct Access Device Format Parameters
04H = Rigid Disk Drive Geometry Parameters
3FH = Return All Pages

The MODE SENSE data contains a four-byte header, followed by one eight-byte block descriptor, followed by the page parameters, if any (refer to table 5-16).

The MODE SENSE Data Length specifies the length in bytes of the following MODE SENSE data that is available to be transferred during the Data In phase. The MODE SENSE Data Length does not include itself. The Block Descriptor Length specifies the length in bytes of the block descriptor, and does not include the page parameters.

The block descriptor specifies the medium characteristics for the entire logical unit. The block descriptor contains a Density Code of zero, and A Number Of Blocks of zero indicating the entire medium has the block length returned.

The formats for the three page descriptors are shown in tables 5-17, 5-18, and 5-19. The parameter values contained in the page descriptors are determined by the value of the PCF field in the CDB. When the PCF equals 01, the page descriptor contains the changeable parameters for the requested page(s). The changeable parameters for the Error Recovery Parameters page are shown in table 5-20. There are no changeable parameters for the Direct Access Device Format Parameters page (03) or the Rigid Disk Geometry Parameters page (04).

When the PCF bits are set to 10, the page descriptor contains the default parameters for the requested page(s). The default values for each page are shown in table 5-21. This mode will report the default block size in the block descriptor.

When the PCF bits are set to 11, the saved parameters of the requested pages are returned. This mode will save the default values for pages 3 and 4. The save block size will be reported in the block descriptor.

If the PCF field and the PAGE CODE field in the CDB are both zero, only the block descriptor information is returned. This is not considered an error.

Table 5-16. Mode Sense Parameter List Format

HEADER FORMAT

BYTE	BIT 7	6	5	4	3	2	1	0
00	MODE SENSE DATA LENGTH							
01	MEDIUM TYPE = 0							
02	RESERVED							
03	BLOCK DESCRIPTOR LENGTH = 8							

BLOCK DESCRIPTOR FORMAT

04	DENSITY CODE = 0
05-07	NUMBER OF BLOCKS = 0
08	RESERVED
09	BLOCK LENGTH (MSB)
10	BLOCK LENGTH
11	BLOCK LENGTH (LSB)

SPECIFIED PAGE DESCRIPTOR(S)

(Refer to tables 5-17, 5-18, 5-19.)

Table 5-17. Error Recovery Page Format

BYTE	BIT 7	6	5	4	3	2	1	0
00	PS	R=0	PAGE CODE = 01					
01	PAGE LENGTH (BYTES) = 6							
02	AWRE=0	ARRE=0	TB	RC=0	EEC=0	PER	DTE	DCR
03	RETRY COUNT							
04	CORRECTION SPAN							
05	HEAD OFFSET COUNT = 0							
06	DATA STROBE OFFSET COUNT = 0							
07	RECOVERY TIME LIMIT							

Table 5-18. Direct Access Device Format Page Format

BYTE	BIT 7	6	5	4	3	2	1	0
00	PS=0	0	PAGE CODE = 03H					
01	PAGE LENGTH (BYTES) = 22							
02	TRACKS PER ZONE (MSB)							
03	TRACKS PER ZONE (LSB)							
04	ALTERNATE SECTORS PER ZONE (MSB)							
05	ALTERNATE SECTORS PER ZONE (LSB)							
06	ALTERNATE TRACKS PER ZONE (MSB)							
07	ALTERNATE TRACKS PER ZONE (LSB)							
08	ALTERNATE TRACKS PER VOLUME (MSB)							
09	ALTERNATE TRACKS PER VOLUME (LSB)							
10	SECTORS PER TRACK (MSB)							
11	SECTORS PER TRACK (LSB)							
12	BYTES PER PHYSICAL SECTOR (MSB)							
13	BYTES PER PHYSICAL SECTOR (LSB)							
14	INTERLEAVE (MSB)							
15	INTERLEAVE (LSB)							
16	TRACK SKEW FACTOR (MSB)							
17	TRACK SKEW FACTOR (LSB)							
18	CYLINDER SKEW FACTOR (MSB)							
19	CYLINDER SKEW FACTOR (LSB)							
20	SSEC=0	HSEC=1	RMB=0	SURF=0	0	0	0	0
21-23	RESERVED = 0							

Table 5-19. Rigid Disk Drive Geometry Page Format

BYTE	BIT 7	6	5	4	3	2	1	0
00	PS=0	0	PAGE CODE = 04H					
01	PAGE LENGTH (BYTES) = 4							
02	NUMBER OF CYLINDERS (MSB)							
03	NUMBER OF CYLINDERS							
04	NUMBER OF CYLINDERS (LSB)							
05	NUMBER OF HEADS							

Table 5-20. Changeable Error Recovery Parameters

BYTE	BIT 7	6	5	4	3	2	1	0
00	PS	R=0	PAGE CODE = 01					
01	PAGE LENGTH (BYTES) = 6							
02	0	0	1	0	0	1	1	1
03	1	1	1	1	1	1	1	1
04	0	0	0	0	0	0	0	0
05	0	0	0	0	0	0	0	0
06	0	0	0	0	0	0	0	0
07	1	1	1	1	1	1	1	1

Table 5-21. Default Page Parameters

ERROR RECOVERY PAGE (01H):

FIELD	DEFAULT VALUE (HEX [DEC])	
DTE	0	[0]
TB	0	[0]
PER	1	[1]
DCR	0	[0]
Retry Count	08	[8]
Correction Span	0C	[12]
Head Offset Count	00	[0]
Data Strobe Offset Count	0	[0]
Recovery Limit	FF	[255]

DIRECT ACCESS DEVICE FORMAT PARAMETERS PAGE (03H):

FIELD	DEFAULT VALUE (HEX [DEC])	
Tracks Per Zone	0000	[0]
Alternate Sectors Per Zone	0000	[0]
Alternate Tracks Per Zone	4B/71/E3*	[75/113/227*]
Alternate Tracks Per Volume	4B/71/E3*	[75/113/227*]
Sectors Per Track	0040	[64]
Bytes Per Physical Sector	0100	[256]
Interleave	0001	[1]
Track Skew Factor	0012	[18]
Cylinder Skew Factor	0012	[18]

RIGID DISK DRIVE GEOMETRY PARAMETERS PAGE (04H):

FIELD	DEFAULT VALUE (HEX [DEC])	
Number Of Cylinders	00067F	[1663]
Number Of Heads	04/06/0C*	[4/6/12*]

*Values are for models 97532/97533/97536 respectively.

5-22. Read

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 08H							
01	LOGICAL UNIT NUMBER			LOGICAL BLOCK ADDRESS (MSB)				
02	LOGICAL BLOCK ADDRESS							
03	LOGICAL BLOCK ADDRESS (LSB)							
04	TRANSFER LENGTH							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The READ command requests that the Target transfer data to the Initiator. The Target accepts both the nonextended (6-byte) and extended (10-byte) CDB formats.

The Logical Block Address specifies the logical block at which the read operation shall begin.

The Transfer Length specifies the number of contiguous logical blocks of data to be transferred. When using the nonextended command format, a Transfer Length of zero indicates that 256 logical blocks shall be transferred. When using the extended command format, a Transfer Length of zero indicates that no logical blocks shall be transferred. This condition shall not be considered an error (it is functionally equivalent to a SEEK command).

The most recent data value written in the addressed logical block(s) shall be returned.

Read (cont)

EXTENDED COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 28H							
01	LOGICAL UNIT NUMBER			RESERVED				REL=0
02	LOGICAL BLOCK ADDRESS (MSB)							
03	LOGICAL BLOCK ADDRESS							
04	LOGICAL BLOCK ADDRESS							
05	LOGICAL BLOCK ADDRESS (LSB)							
06	RESERVED							
07	TRANSFER LENGTH (MSB)							
08	TRANSFER LENGTH (LSB)							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

5-23. Read Capacity

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 25H							
01	LOGICAL UNIT NUMBER			RESERVED				REL=0
02	LOGICAL BLOCK ADDRESS (MSB)							
03	LOGICAL BLOCK ADDRESS							
04	LOGICAL BLOCK ADDRESS							
05	LOGICAL BLOCK ADDRESS (LSB)							
06	RESERVED							
07	RESERVED							
08	VEND UNQ = 0		RESERVED					PMI
09	VEND UNQ = 0		RESERVED				FLAG	LINK

The READ CAPACITY command provides a means for the Initiator to request information regarding the capacity of the logical unit.

A Partial Medium Indicator (PMI) bit of zero indicates that the information returned in the Read Capacity data shall be the logical block address and block length (in bytes) of the last logical block of the logical unit. The Logical Block Address in the CDB shall be set to zero for this option.

A PMI bit of one indicates that the information returned shall be the logical block address and block length (in bytes) of the last logical block address after which a substantial delay in data transfer will be encountered. This logical block address shall be greater than or equal to the logical block address specified in the CDB. (Implementor's Note: This function is intended to assist storage management software in determining whether there is sufficient space on the current track, cylinder, etc. to contain a frequently accessed data structure such as a file directory or file index. The address returned will normally be the last block on the addressed track.)

Table 5-22 shows the format of the Read Capacity data returned by the Target during the DATA IN phase of the command.

Table 5-22. Read Capacity Data Format

BYTE	BIT 7	6	5	4	3	2	1	0
00	LOGICAL BLOCK ADDRESS (MSB)							
01	LOGICAL BLOCK ADDRESS							
02	LOGICAL BLOCK ADDRESS							
03	LOGICAL BLOCK ADDRESS (LSB)							
04	BLOCK LENGTH (MSB)							
05	BLOCK LENGTH							
06	BLOCK LENGTH							
07	BLOCK LENGTH (LSB)							

5-24. Read Data Buffer

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 3CH							
01	LOGICAL UNIT NUMBER			RESERVED				BCV=0
02	RESERVED							
03	RESERVED							
04	RESERVED							
05	RESERVED							
06	RESERVED							
07	ALLOCATION LENGTH (MSB)							
08	ALLOCATION LENGTH (LSB)							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

The READ DATA BUFFER command allows the Initiator to read the Target's data buffer. This is provided to allow the buffer to be tested by the Initiator in conjunction with the WRITE DATA BUFFER command.

The Allocation Length field specifies the number of bytes that the Initiator has allocated for returned data. An Allocation Length of zero specifies that no data be transferred and shall not be considered an error. The Target shall terminate the data phase when the specified number of bytes or when all available data buffer data has been transferred, whichever is less.

The READ DATA BUFFER return data contains a four-byte header (refer to table 5-23) followed by the buffer data.

Table 5-23. Read Buffer Header Format

BYTE	BIT							
	7	6	5	4	3	2	1	0
00	RESERVED							
01	RESERVED							
02	AVAILABLE LENGTH (MSB)							
03	AVAILABLE LENGTH (LSB)							

The Available Length field may be up to 65,535 bytes or the Target's maximum data buffer size, whichever is less. An Available Length of zero indicates that no data transfer will take place. If the Allocation Length of the CDB is too small to allow all of the Available Length, the Available Length field is NOT adjusted to reflect the truncation.

The data in the buffer may have been corrupted since the last WRITE DATA BUFFER command. It is recommended that the Target be placed in Reserve or that the WRITE DATA BUFFER and subsequent READ DATA BUFFER be linked to ensure that the Initiator can reliably test the Target's data buffer.

If any command has been executed by the controller between the execution of the WRITE BUFFER command and the READ BUFFER command, a status of CHECK CONDITION will be returned. In this case the sense information will have a sense key of MISCOMPARE set. The amount of requested buffer data will be returned regardless of the MISCOMPARE error status, but the contents should be suspect.

5-25. Read Defect Data

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 37H							
01	LOGICAL UNIT NUMBER			RESERVED				
02	RESERVED			P	G	DEFECT LIST FORMAT		
03	RESERVED							
04	RESERVED							
05	RESERVED							
06	RESERVED							
07	ALLOCATION LENGTH (MSB)							
08	ALLOCATION LENGTH (LSB)							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

The READ DEFECT DATA command requests that the Target transfer the medium defect data to the Initiator.

The P bit set to one indicates that the Initiator requests that the primary (P) list of defects be returned. The G bit set to one indicates that the Initiator requests the G list of defects. If both bits are set, the combination of both lists is requested. If neither bit is set, only the header will be returned.

The Defect List Format indicates the preferred format for the returned defect list. The bits are as defined for the Format command. The Target will return the list in the physical sector format (5) or bytes from index (4) format. If any other format is requested, the list will be returned in the physical sector format and a CHECK CONDITION / RECOVERED ERROR will be reported.

The Allocation Length specifies the number of bytes that the Initiator has allocated for returned data. An Allocation Length of zero indicates that no data should be transferred and should not be considered an error. Any other value indicates the maximum number of bytes that shall be transferred. The Target shall terminate the data phase when either the allocation length or all available READ DEFECT DATA has been sent, whichever is less.

The data returned by the READ DEFECT DATA command contains a four-byte header, followed by zero or more defect descriptors (refer to table 5-24). The Defect List Length specifies the total length of the following defect descriptors in bytes. If the Allocation Length field of the CDB is less than the length of the available defect list data, the Defect List Length is NOT adjusted to reflect the truncation. The defect descriptors are in ascending address order. Ascending address order for physical sector format is defined as cylinder most-significant and sector least-significant. A sector number of all ones (FFFFFFFFH) indicates that the entire track has been spared.

The defect data is supplied in such a manner that the list can be issued in a FORMAT UNIT command to restore the current media reassignment mapping without re-ordering.

Table 5-24. Read Defect Data Defect List Format

HEADER FORMAT

BYTE	BIT 7	6	5	4	3	2	1	0
00	RESERVED							
01	RESERVED			P	G	DEFECT LIST FORMAT=5		
02	DEFECT LIST LENGTH (MSB)							
03	DEFECT LIST LENGTH (LSB)							

DEFECT DESCRIPTOR FORMAT

00	CYLINDER NUMBER OF DEFECT (MSB)
01	CYLINDER NUMBER OF DEFECT
02	CYLINDER NUMBER OF DEFECT (LSB)
03	HEAD NUMBER OF DEFECT
04	DEFECT SECTOR NUMBER OR BYTES FROM INDEX (MSB)
05	DEFECT SECTOR NUMBER OR BYTES FROM INDEX
06	DEFECT SECTOR NUMBER OR BYTES FROM INDEX
07	DEFECT SECTOR NUMBER OR BYTES FROM INDEX (LSB)

5-26. Read Full

NOTE

For this command to succeed, the header of the sector prior to the requested sector must be readable, except for operations on sector zero (0) of the selected track.

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = FOH							
01	LOGICAL UNIT NUMBER			RESERVED				PHYS
02	ADDRESS (MSB)							
03	ADDRESS							
04	ADDRESS							
05	ADDRESS (LSB)							
06	RESERVED							
07	ALLOCATION LENGTH (MSB)							
08	ALLOCATION LENGTH (LSB)							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

The READ FULL command allows the Initiator to request all available information fields for the specified logical or physical block. This information includes the header, data, and ECC field contents. The Target returns to the Initiator a complete image of one physical block. Included with the contents of the physical block is a header that defines the amount and type of data available.

The Address field specifies which block to return. The interpretation of the address is determined by the state of the Physical Address (PHYS) bit. If PHYS is clear (0), the Address field is treated as a logical block address per normal conventions and all normal position verifications are performed. The first *physical* block in the specified *logical* block is returned. To access all physical blocks, the Initiator must use the MODE SELECT command to set the logical block size equal to the physical block size (256 bytes). Otherwise, only the first physical block in each logical block is accessible.

When PHYS is set (1), the Address field is treated as a physical block address with the Address field defined as follows:

- Byte 2: Cylinder Address (MSB)
- Byte 3: Cylinder Address (LSB)
- Byte 4: Head Address
- Byte 5: Sector Address

The Allocation Length field specifies the number of bytes the Initiator is prepared to accept. If the number of bytes available from the Target is greater than that specified in the CDB, the data will be truncated to the Allocation Length value.

The physical block returned by the Target is preceded by a 10-byte header (refer to table 5-25). The Total Available Length field of the header contains the number of bytes that the device can return for this command. The length does not include itself but does include the remaining eight bytes of the header. If the Allocation Length field in the CDB is smaller than the Total Available Length, the Total Available length is not adjusted to show the truncation.

The Field Descriptor code values are defined as follows:

001 - Physical Block Header Field
010 - User Data Field
100 - Error Correction/Detection Field
000 - End Fields Mark

The individual Field Length fields define the number of bytes to follow them in the associated field. The Field Length for the End Fields Mark is set to zero.

The complete format for the READ FULL data message is shown in table 5-25. The physical block consists of 266 bytes: 4 bytes of header, 256 bytes of data, and 6 bytes of ECC. No error correction is applied to the data bytes returned.

Table 5-25. Read Full Data Format

HEADER FORMAT

BYTE	BIT							
	7	6	5	4	3	2	1	0
00	TOTAL AVAILABLE LENGTH (MSB) = 01H							
01	TOTAL AVAILABLE LENGTH (LSB) = 12H							
02	FIELD DESCRIPTOR=001			FIELD LENGTH (MSB) = 00H				
03	FIELD LENGTH (LSB) = 04H							
04	FIELD DESCRIPTOR=010			FIELD LENGTH (MSB) = 01H				
05	FIELD LENGTH (LSB) = 00H							
06	FIELD DESCRIPTOR=100			FIELD LENGTH (MSB) = 00H				
07	FIELD LENGTH (LSB) = 06H							
08	FIELD DESCRIPTOR=000			FIELD LENGTH (MSB) = 00H				
09	FIELD LENGTH (LSB) = 00H							

PHYSICAL BLOCK CONTENTS

00-03	HEADER BYTES
04-259	DATA BYTES
260-265	ECC BYTES

5-27. Read Headers

COMMAND FORMAT:

<table>
<tr><th rowspan="2">BYTE</th><th colspan="8">BIT</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>00</td><td colspan="8">OPCODE = EEH</td></tr>
<tr><td>01</td><td colspan="3">LOGICAL UNIT NUMBER</td><td colspan="4">RESERVED</td><td>PHYS</td></tr>
<tr><td>02</td><td colspan="8">ADDRESS (MSB)</td></tr>
<tr><td>03</td><td colspan="8">ADDRESS</td></tr>
<tr><td>04</td><td colspan="8">ADDRESS</td></tr>
<tr><td>05</td><td colspan="8">ADDRESS (LSB)</td></tr>
<tr><td>06</td><td colspan="8">RESERVED</td></tr>
<tr><td>07</td><td colspan="8">ALLOCATION LEN (MSB)</td></tr>
<tr><td>08</td><td colspan="8">ALLOCATION LEN (LSB)</td></tr>
<tr><td>09</td><td colspan="2">VEND UNQ = 0</td><td colspan="4">RESERVED</td><td>FLAG</td><td>LINK</td></tr>
</table>

This command will read all the headers on the addressed track and return the requested number of bytes of this information. An allocation length of zero (0) will cause a seek to the addressed track with the header information read from the disk, but no data transfer to the host.

If the phys bit is set to a one (1), then the address is interpreted as a physical address in the form:

- Byte 2: Cylinder Address (MSB)
- Byte 3: Cylinder Address (LSB)
- Byte 4: Head Address
- Byte 5: Sector Address

If the phys bit is a zero (0), then the address is assumed to be a logical block address.

The header information will always be returned starting from sector 0 of the addressed track regardless of the addressed block or sector.

5-28. Reassign Blocks

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 07H							
01	LOGICAL UNIT NUMBER			RESERVED				
02	RESERVED							
03	RESERVED							
04	RESERVED							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The REASSIGN BLOCKS command requests the Target to reassign the defective logical blocks to an area on the logical unit reserved for this purpose.

The Initiator transfers a defect list that contains the logical block addresses to be reassigned. The Target reassigns the physical medium used for each logical block address in the list. The data contained in the logical blocks specified in the defect list will be lost, but the data in all other logical blocks on the medium will be preserved.

A specific logical block address may be reassigned more than once; thus, over the life the medium, a logical block can be assigned to multiple physical addresses (until no more spare locations remain on the medium).

The REASSIGN BLOCKS defect list contains a four-byte header followed by one or more defect descriptors (refer to table 5-26). The length of each defect descriptor is four bytes.

NOTE

The REASSIGN BLOCKS command is intended to be used to reassign a single block defect. The provision to handle multiple defects in a single command is made to allow recovery from a situation where multiple defects occur on a single track. Therefore, the maximum length defect list that will be accepted by the Target is the number of sectors per track (64). Duplicate entries in the defect list result in a single spare operation.

Table 5-26. Reassign Blocks Defect List Format

HEADER FORMAT

BYTE	BIT 7	6	5	4	3	2	1	0
00	RESERVED							
01	RESERVED							
02	DEFECT LIST LENGTH (MSB)							
03	DEFECT LIST LENGTH (LSB)							

DEFECT DESCRIPTOR FORMAT

00	DEFECT LOGICAL BLOCK ADDRESS (MSB)
01	DEFECT LOGICAL BLOCK ADDRESS
02	DEFECT LOGICAL BLOCK ADDRESS
03	DEFECT LOGICAL BLOCK ADDRESS (LSB)

The Defect List Length specifies the total length in bytes of the defect descriptors that follow. The Defect List Length is equal to four times the number of defect descriptors.

The defect descriptor specifies a four-byte defect logical block address that contains the defect. The defect descriptors shall be in ascending order.

If the logical unit has insufficient capacity to reassign all of the defective logical blocks, the command shall terminate with a CHECK CONDITION status and the Sense Key shall be set to MEDIUM ERROR. The additional Sense Code will be No Defect Spare Location Available (32H). The logical block address of the first logical block not reassigned shall be returned in the Information Bytes of the sense data.

During a reassign operation, all data residing on the track with the specified defective block(s), except that contained within the defective block(s), is moved to a new physical track. If the Target is unable to recover data from any of these block(s) affected by the operation but *not* contained in the defect descriptor list, the command is terminated with Check Condition status and a Sense Key of MEDIUM ERROR. The additional Sense Code will be sent to Unrecovered Read Error (11H), and the information bytes will contain the logical block address of the new field. These additional defect(s) should be added to the reassignment defect list and the command reissued.

All blocks affected by the reassignment operation but *not* included in the defect descriptor list, are verified following the reassignment. If the verification fails, the data will be reassigned to another physical location.

If this second reassignment operation fails, the command is terminated with CHECK CONDITION status, a Sense Key of MEDIUM ERROR, and an additional sense code of SPARE OPERATION FAILED. In this case, the media configuration remains as it was prior to the command. The spare track on which the original verify failed is marked as bad. This allows a reissue of the same Reassign Blocks command to step through spare tracks if consecutive spare tracks are defective. Multiple failures of this command probably indicate a hardware failure.

5-29. Reformat Track

CAUTION

The REFORMAT TRACK command will cause the loss of the entire track's worth of user information. Improper use of this command may cause the reformatted tracks to become unusable, or other user tracks to become inaccessible. Loss of defect information may also result. Any use of this command other than at Hewlett-Packard approved sites and by HP approved methods may be deemed a violation of warranty.

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = EDH							
01	LOGICAL UNIT NUMBER			RESERVED				HS
02	CYLINDER (MSB)							
03	CYLINDER (LSB)							
04	HEAD							
05	SECTOR (IGNORED)							
06	HEADER LOGICAL ADDR (MSB)							
07	HEADER LOGICAL ADDR (LSB)							
08	HEADER FLAG BYTE							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

This command will cause the addressed track on the disk drive to be formatted according to the setting of the HS bit.

If the HS (Header Supplied) bit is zero (0), the track will be formatted with the normally correct default header information. The supplied header information bytes will be ignored.

If the HS bit is a one (1) the supplied header information bytes will be used for the track logical address and flag bytes.

5-30. Release

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 17H							
01	LOGICAL UNIT NUMBER			3RDPTY	THIRD PARTY DEVICE ID			XTNT=0
02	RESERVATION IDENTIFICATION = 00							
03	EXTENT LIST LENGTH = 00 (MSB)							
04	EXTENT LIST LENGTH = 00 (LSB)							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The RELEASE command is used to release previously reserved logical units. It is not an error for an Initiator to attempt to release a reservation that is not currently active. In this case, the Target returns GOOD status without altering any other reservation.

The third-party release option for the RELEASE command allows an Initiator to release a logical unit, or extents within a logical unit, that were previously reserved using the third-party reservation option. If the third-party (3RDPTY) bit is zero, then the third-party release option is not requested. If the 3RDPTY bit is one, then the Target shall release the specified logical unit, but only if the reservation was made using the third-party reservation option by the same Initiator for the same SCSI device as specified in the Third-Party Device ID field.

5-31. Request Sense

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 03H							
01	LOGICAL UNIT NUMBER			RESERVED				
02	RESERVED							
03	RESERVED							
04	ALLOCATION LENGTH							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The REQUEST SENSE command requests that the Target transfer sense data to the Initiator. Only the extended sense data format is supported (refer to table 5-27).

The sense data shall be valid for a CHECK CONDITION status returned on the prior command. This sense data shall be preserved by the Target for the Initiator until retrieved by the REQUEST SENSE command or until the receipt of any other command for the same logical unit from the Initiator that issued the command resulting in the CHECK CONDITION status. Sense data shall be cleared upon receipt of any subsequent command to the logical unit from the Initiator receiving the CHECK CONDITION status. In the case of the single initiator option, the Target shall assume that the REQUEST SENSE command is from the same Initiator. Sense information will be cleared by the Request Sense command following the transfer of the data.

The Allocation Length specifies the number of bytes that the Initiator has allocated for returned sense data. An Allocation Length of zero indicates that four bytes of sense data shall be transferred. Any other value indicates the maximum number of bytes that shall be transferred. The Target shall terminate the DATA IN phase when the specified number of bytes have been transferred or when all available sense data has been transferred to the Initiator, whichever is less. The drive will return a maximum of 22 bytes of sense data (refer to table 5-27).

The REQUEST SENSE command shall return the CHECK CONDITION status only to report fatal errors for the REQUEST SENSE command. The REQUEST SENSE command will be executed even if the drive is reserved to another initiator.

If any nonfatal error occurs during the execution of the REQUEST SENSE command, the Target shall return the sense data with GOOD status. When a fatal error occurs on a REQUEST SENSE command, the returned sense data may be invalid.

Table 5-27. Extended Sense Data Format

BYTE	BIT 7	6	5	4	3	2	1	0
00	VALID	ERROR CLASS = 7			ERROR CODE = 0			
01	SEGMENT NUMBER = 0							
02	FM=0	EOM=0	ILI=0	RESERVD	SENSE KEY			
03	INFORMATION BYTES (MSB)							
04	INFORMATION BYTES							
05	INFORMATION BYTES							
06	INFORMATION BYTES (LSB)							
07	ADDITIONAL SENSE LENGTH = 14							
08-11	COPY/SEARCH INFORMATION = 0							
12	ADDITIONAL SENSE CODE							
13	RESERVED							
14	FAILED FIELD REPLACEABLE UNIT (FRU) = 0							
15	FPV=0	C/D=0	VEND UNQ = 0		BPV=0	BIT POINTER = 0		
16	FIELD POINTER (MSB) = 00							
17	FIELD POINTER (LSB) = 00							
18	DEVICE ERROR (FIRST)							
19	DEVICE ERROR							
20	DEVICE ERROR							
21	DEVICE ERROR (LAST)							

The 22 bytes of extended sense data are listed in table 5-27. When set to 1, the Valid bit indicates that the Information Bytes contain valid information. The exact significance of the Information Bytes depends on the Sense key.

The Error Class is specified as seven (7) for extended sense format.

The Sense Key is used to indicate the type of error which has occurred, and the recovery action which should be taken by the Initiator. It is the primary piece of information available to the Initiator for making decisions based on errors detected by the Target. The Sense Key Codes are listed in table 5-28.

The Additional Sense Code byte is specific for each Sense Key and provides additional information about precisely what was the cause for that particular Sense Key. The Additional Sense Codes are listed in table 5-29.

The FRU Failed byte refers to the field replaceable unit that has been determined to be the cause of the current error reported in this Sense. This field will be set to 0.

Device Error (DError) bytes indicate device unique error codes designed to aid service personnel in more detailed analysis of any drive faults. This information is NOT pertinent to system operation, although it is highly recommended that the system log all sense data including these bytes in cases of drive failures.

The following bits are all set to 0: File Mark (FM), End Of Medium (EOM), Incorrect Length Indicator (ILI), Field Pointer Value (FPV), Command/Data (C/D), and Bit Pointer Valid (BPV).

After Sense is returned, all conditions are cleared except for a UNIT ATTENTION Sense Key if power-on verification failed. In this case the HARDWARE ERROR Sense Key is set by the Target for the first REQUEST SENSE and UNIT ATTENTION is set for the subsequent command. This is done to insure that diagnostic failures and RESET conditions are observed.

Table 5-28. Sense Key Codes

VALUE (HEX)	DESCRIPTION
0	NO SENSE. Indicates that there is no specific sense key information to be reported for the designated logical unit.
1	RECOVERED ERROR. Indicates that the last command completed successfully with some recovery action performed by the Target. Details may be determinable by examining the additional sense bytes and the information bytes.
2	NOT READY. Indicates that the logical unit addressed cannot be accessed.
3	MEDIUM ERROR. Indicates that the command terminated with a nonrecovered error condition that was probably caused by a flaw in the medium or an error in the recorded data.
4	HARDWARE ERROR. Indicates that the Target detected a nonrecoverable hardware failure (for example, controller failure, device failure, parity error, etc.) while performing the command or during a self test.
5	ILLEGAL REQUEST. Indicates that there was an illegal parameter in the command descriptor block or in the additional parameters supplied as data for some commands.
6	UNIT ATTENTION. Indicates that the Target has been reset or there has been a power on.
B	ABORTED COMMAND. Indicates that the Target aborted the command due to Initiator request/action.
E	MISCOMPARE. Indicates data in buffer may have been corrupted between READ BUFFER and WRITE BUFFER commands.

Table 5-29. Additional Sense Codes

VALUE (HEX)	DESCRIPTION
00	No Additional Sense Information
01	No Index/Sector signal
02	No Seek Complete
03	Write Fault
04	Drive Not Ready
08	Logical Unit Communication Failure
10	ID CRC or ECC error
11	Unrecovered Read error of data blocks
14	No record found
15	Seek Positioning error
17	Recovered Read data with Target's Read retries (not with ECC)
18	Recovered Read data with Target's ECC correction (not with retries)
19	Defect List error
1A	Parameter Overrun
1B	Synchronous Transfer error
1D	Compare error
20	Invalid Command Operation Code
21	Illegal Logical Block Address. Address greater than the maximum LBA returned by the READ CAPACITY data with PMI not set.
24	Illegal field in CDB
25	Invalid LUN
26	Invalid field in Parameter List
27	Write Protected
29	Power On or Reset or Bus Device Reset occurred
2A	MODE SELECT Parameters changed.
31	Medium Format Corrupted
32	No Defect Spare Location Available
33	Spare Operation Failed
40	RAM failure
41	Data Path Diagnostic failure
42	Power-On Diagnostic Failure
43	Message Reject Error
44	Internal Controller Error
45	Select/Reselect failed
46	Unsuccessful Soft Reset
47	SCSI Interface Parity Error
48	Initiator Detected Error
49	Inappropriate/Illegal Message

REQUEST SENSE - Device Error field usage on 9753XS/T/D drive (bytes 18-21):

These bytes are used to return device unique error information intended to aid service personnel in more detailed analysis of any drive problems. The type of information returned can be determined by examining the first Device Error byte.

If the first byte is in the range of 80H through FFH then the error information returned is from the Hard Disk Controller (HDC) chip. This information will normally be returned for RECOVERED ERROR or MEDIUM ERROR sense keys. The device error bytes contain the following information:

Byte 18 Bit 7 - Error detected
Byte 18 Bit 6 - Correction cycle active
Byte 18 Bit 5 - Local command busy
Byte 18 Bit 4 - Remote command busy
Byte 18 Bit 3 - Local request
Byte 18 Bit 2 - Header match complete
Byte 18 Bit 1 - Next disk command
Byte 18 Bit 0 - ignore

Byte 19 Bit 7 - Late interlock
Byte 19 Bit 6 - Correction failed
Byte 19 Bit 5 - FIFO data lost
Byte 10 Bit 4 - No data synch
Byte 19 Bit 3 - Sector overrun
Byte 19 Bit 2 - Sector not found
Byte 19 Bit 1 - Data field error
Byte 19 Bit 0 - Header failed although sector matched

Byte 20 zero

Byte 21 number of retries attempted

REQUEST SENSE - Device Error field usage on 9753XS/T/D drive (bytes 18-21):

If the first byte is in the range 00H through 3FH then the device error bytes contain HDA status information. This information may be returned with either RECOVERED ERROR or HARDWARE ERROR sense keys and is defined as follows:

Byte 18 Bit 1 - Spindle motor stopped
Byte 18 Bit 0 - Reset condition exists

Byte 19 Bit 7 - Command data parity fault
Byte 19 Bit 6 - Interface fault
Byte 19 Bit 5 - Invalid command fault
Byte 19 Bit 4 - Seek fault
Byte 19 Bit 3 - Write gate with track offset fault
Byte 19 Bit 2 - Extended status available (byte 21)
Byte 19 Bit 1 - Write fault
Byte 19 Bit 0 - zero

Byte 20 zero

Byte 21 (Zero unless byte 19 bit 2 set)
01H = Spindle won't start
02H = Spindle spinning but not at speed
03H = Spindle at speed but no lock
04H = Command interface timeout
05H = Not used
06H = Write while offtrack
07H = Write while offspeed
08H = Write when 2 STP's missing
09H = Not used
0AH = Not used
0BH = Command parity error
0CH = Illegal command
0DH = Write while illegal head selected
0EH = Not used
0FH = Not used
10H = Status timeout
11H = Target cylinder exceeds maximum
12H = Wrong mode fault
13H = Consecutive sectors skipped
14H = Servo timeout for Gray code validation
15H = Servo fine settle fault
16H = Servo gross settle fault
17H = Servo interrupt timeout
18H = Seek while servo shut down
19H = Aggressive seek write fault
1AH = Write while protected
1BH = Possible stuck latch (on power on)
1CH = Aggressive write while offtrack (aggressive seeks enabled)
1DH = Write while offtrack (not seek related)

REQUEST SENSE - Device Error field usage on 9753XS/T/D drive (bytes 18-21):

If the first byte is in the range of 40H through 5FH then the device error bytes contain diagnostic failure result information. These codes will normally be returned with a HARDWARE ERROR sense key after power on or a Send Diagnostic command. The device error information is defined as follows:

Byte 18: 41H = Microprocessor failure
- Byte 19: 11H = Data register failure
  - 12H = Data register fade failure
  - 21H = Address register failure
  - 22H = Address register fade failure
  - 31H = Condition code failure
  - 32H = Addressing mode failure

Byte 18: 42H = Microprocessor RAM failure
- Byte 19: 11H = RAM failed walking 0's test
  - 12H = RAM failed walking 1's test
  - 20H = RAM failed marching test
  - 30H = RAM failed compliment test
  - 40H = RAM failed address test

Byte 18: 43H = ROM checksum failure
- Byte 19: zero

Byte 18: 44H = SCSI interface chip failure
- Byte 19: 30H = SCIPI failed RAM test
  - 50H = SCIPI failed register test
  - 51H = SCIPI failed command test
  - 52H = SCIPI failed message out test
  - 53H = SCIPI failed message in test
  - 54H = SCIPI functional failure
  - 55H = SCIPI failed status test
  - 56H = SCIPI failed data path test

Byte 18: 45H = Buffer RAM failure
- Byte 19: 11H = RAM failed walking 0's test
  - 12H = RAM failed walking 1's test
  - 20H = RAM failed marching test
  - 30H = RAM failed compliment test
  - 40H = RAM failed address test

Byte 18: 46H = HDC chip failure
- Byte 19: 60H = HDC failed register test

Byte 18: 47H = Write/Read failure
- Byte 19: 00H-7FH = defined as same as additional sense code
  - 81H = Buffer compare error

Bytes 20-21: zero

5-32. Reserve

COMMAND FORMAT:

<table>
<tr><td rowspan="2">BYTE</td><td colspan="8">BIT</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>00</td><td colspan="8">OPCODE = 16H</td></tr>
<tr><td>01</td><td colspan="3">LOGICAL UNIT NUMBER</td><td>3RDPTY</td><td colspan="3">THIRD PARTY DEVICE ID</td><td>XTNT=0</td></tr>
<tr><td>02</td><td colspan="8">RESERVATION IDENTIFICATION = 00</td></tr>
<tr><td>03</td><td colspan="8">EXTENT LIST LENGTH = 00 (MSB)</td></tr>
<tr><td>04</td><td colspan="8">EXTENT LIST LENGTH = 00 (LSB)</td></tr>
<tr><td>05</td><td colspan="2">VEND UNQ = 0</td><td colspan="4">RESERVED</td><td>FLAG</td><td>LINK</td></tr>
</table>

The RESERVE command is used to reserve logical units for the use of the Initiator. With third-party reservation, the logical units may be reserved for another specified SCSI device. The RESERVE and RELEASE commands provide the basic mechanism for contention resolution in multiple-initiator systems.

This command shall request that the entire logical unit be reserved for the exclusive use of the Initiator until the reservation is superseded by another valid RESERVE command from the same Initiator that made the reservation or until released by a RELEASE command from the same Initiator, by a BUS DEVICE RESET message from any Initiator, or by a "hard" RESET condition. A logical unit reservation shall not be granted if the logical unit is reserved by another Initiator. It shall be permissible for an Initiator to reserve a logical unit that is currently reserved by that Initiator. The Reservation Identification and the Extent List Length fields shall be zero.

If the logical unit is reserved for another Initiator, the Target shall respond by returning a RESERVATION CONFLICT status.

Once a reservation is installed, the reserved logical unit is available only to the Initiator that issued the RESERVE command, or a specified optional third party. If any other Initiator attempts to perform a command on the reserved logical unit the command shall be rejected with RESERVATION CONFLICT status. Exceptions are the RELEASE command, which will be ignored by the Target, and the INQUIRY command, which will be executed.

5-33. Rezero Unit

COMMAND FORMAT:

BYTE	BIT							
	7	6	5	4	3	2	1	0
00	OPCODE = 01H							
01	LOGICAL UNIT NUMBER			RESERVED				
02	RESERVED							
03	RESERVED							
04	RESERVED							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The REZERO UNIT command causes the Target to perform a a recalibrate operation and then seek to logical address zero. The status of the seek is reported as the status of this command. This command is provided for compatibility reasons. Its use is not required for any normal device operation or error recovery.

5-34. Seek

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 0BH							
01	LOGICAL UNIT NUMBER			LOGICAL BLOCK ADDRESS (MSB)				
02	LOGICAL BLOCK ADDRESS							
03	LOGICAL BLOCK ADDRESS (LSB)							
04	RESERVED							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The SEEK command requests that the logical unit seek to the specified logical block address. Status will be returned as GOOD when the seek is complete.

This command will return a CHECK CONDITION status with a Sense Key of HARDWARE ERROR if unable to complete. The NOT READY Sense Key may be returned if the drive has not yet spun up.

The Target accepts both the 6-byte and 10-byte (extended) command formats.

Seek (cont)

EXTENDED COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 2BH							
01	LOGICAL UNIT NUMBER			RESERVED				REL=0
02	LOGICAL BLOCK ADDRESS (MSB)							
03	LOGICAL BLOCK ADDRESS							
04	LOGICAL BLOCK ADDRESS							
05	LOGICAL BLOCK ADDRESS (LSB)							
06	RESERVED							
07	RESERVED							
08	RESERVED							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

5-35. Send Diagnostic

COMMAND FORMAT:

BYTE	BIT							
	7	6	5	4	3	2	1	0
00	OPCODE = 1DH							
01	LOGICAL UNIT NUMBER			0	0	ACTIVITY QUALIFIERS		
02	RESERVED							
03	PARAMETER LIST LENGTH (MSB) = 00							
04	PARAMETER LIST LENGTH (LSB) = 00							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

This command will cause the drive to execute the requested diagnostics.

The Activity Qualifier bits tell the Target what diagnostics are allowed. If the selected diagnostic cannot be executed in its entirety it will not be executed at all.

Bit 0 is the Unit Off Line bit. It is ignored by the Target.

Bit 1 is the Device Off Line bit. It is ignored by the Target.

Bit 2 is the Self Test bit. If this bit is a 1 then the Parameter Length must be 0, and the Target will execute the Default Self Test, Buffer Ram Test and Full Write/Read Tests.

If the Self Test bit is a 0, the command is treated as a NOP.

5-36. Special Seek

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = ECH							
01	LOGICAL UNIT NUMBER			RESERVED				
02	CYLINDER (MSB)							
03	CYLINDER (LSB)							
04	HEAD							
05	SECTOR							
06	RESERVED							
07	RESERVED							
08	RESERVED							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

This command will execute a seek to the selected physical location, and will leave the disk drive interface selected when completed to allow special testing to take place at the addressed location. The disk drive LED will remain on, and the disk drive will remain selected until the next command from the initiator is completed (status sent by Target).

5-37. Start/Stop Unit

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 1BH							
01	LOGICAL UNIT NUMBER			RESERVED				IMMED
02	RESERVED							
03	RESERVED							
04	RESERVED							START
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The START/STOP UNIT command requests that the Target enable or disable the logical unit for further operations.

An Immediate (IMMED) bit of 1 indicates that status shall be returned as soon as the operation is initiated. An IMMED bit of 0 indicates that status shall be returned after the operation is completed.

A START bit of 1 requests the logical unit be made ready for use. A START bit of 0 requests that the logical unit be made to be not ready for use until the next START UNIT command is sent (or a Power on/RESET condition). Note that for this product the drive will NOT stop spinning if the STOP UNIT command is sent.

5-38. Test Unit Ready

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 00H							
01	LOGICAL UNIT NUMBER			RESERVED				
02	RESERVED							
03	RESERVED							
04	RESERVED							
05	VEND UNQ = 0		RESERVED				FLAG	LINK

The TEST UNIT READY command provides a means to check if the logical unit is ready. This is not a request for a self test. If the logical unit is up to speed and ready for media access, this command shall return a GOOD status. This does not assure that media access will be successful.

If the drive is not up to speed, this command will return a CHECK CONDITION Status with a Sense Key of NOT READY and an Additional Sense Code of DRIVE NOT READY.

5-39. Verify

COMMAND FORMAT:

BYTE	BIT							
	7	6	5	4	3	2	1	0
00	OPCODE = 2FH							
01	LOGICAL UNIT NUMBER			RESERVED			BYTCK=0	REL=0
02	LOGICAL BLOCK ADDRESS (MSB)							
03	LOGICAL BLOCK ADDRESS							
04	LOGICAL BLOCK ADDRESS							
05	LOGICAL BLOCK ADDRESS (LSB)							
06	RESERVED							
07	VERIFICATION LENGTH (MSB)							
08	VERIFICATION LENGTH (LSB)							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

The VERIFY command requests that the Target verify the data written on the medium by ECC check only (a compare is not performed).

The Logical Block Address specifies the logical block at which the verify operation shall begin.

The Verification Length specifies the number of contiguous logical blocks of data that shall be verified. A length of zero indicates that no logical blocks shall be verified. This condition shall not be considered as an error. It is functionally equivalent to a SEEK command. Any other value indicates the number of logical blocks that shall be verified.

5-40. Write

COMMAND FORMAT:

<table>
<tr><td rowspan="2">BYTE</td><td colspan="8">BIT</td></tr>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>00</td><td colspan="8">OPCODE = 0AH</td></tr>
<tr><td>01</td><td colspan="3">LOGICAL UNIT NUMBER</td><td colspan="5">LOGICAL BLOCK ADDRESS (MSB)</td></tr>
<tr><td>02</td><td colspan="8">LOGICAL BLOCK ADDRESS</td></tr>
<tr><td>03</td><td colspan="8">LOGICAL BLOCK ADDRESS (LSB)</td></tr>
<tr><td>04</td><td colspan="8">TRANSFER LENGTH</td></tr>
<tr><td>05</td><td colspan="2">VEND UNQ = 0</td><td colspan="4">RESERVED</td><td>FLAG</td><td>LINK</td></tr>
</table>

The WRITE command requests that the Target write the data transferred by the Initiator to the medium. The Target accepts both the nonextended (6-byte) and extended (10-byte) CDB formats.

The Logical Block Address specifies the logical block at which the write operation shall begin.

The Transfer Length specifies the number of contiguous logical blocks of data to be transferred. When using the nonextended command format, a Transfer Length of zero indicates that 256 logical blocks shall be transferred. When using the extended command format, a Transfer Length of zero indicates that no logical blocks shall be transferred. This condition shall not be considered an error (it is functionally equivalent to a SEEK command).

Write (cont)

EXTENDED COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 2AH							
01	LOGICAL UNIT NUMBER			RESERVED				REL=0
02	LOGICAL BLOCK ADDRESS (MSB)							
03	LOGICAL BLOCK ADDRESS							
04	LOGICAL BLOCK ADDRESS							
05	LOGICAL BLOCK ADDRESS (LSB)							
06	RESERVED							
07	TRANSFER LENGTH (MSB)							
08	TRANSFER LENGTH (LSB)							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

5-41. Write Data Buffer

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = 3BH							
01	LOGICAL UNIT NUMBER			RESERVED				BCV=0
02	RESERVED							
03	RESERVED							
04	RESERVED							
05	RESERVED							
06	RESERVED							
07	BYTE TRANSFER LENGTH (MSB)							
08	BYTE TRANSFER LENGTH (LSB)							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

The WRITE DATA BUFFER command allows the Initiator to set the contents of the Target's data buffer for test purposes.

The WRITE DATA BUFFER command is used in conjunction with the READ DATA BUFFER command to test the channel and the Target's data buffer. The Byte Transfer Length specifies the number of bytes to be transferred to the Target during the data phase. The transfer length includes the number of bytes to written to the data buffer plus four for the header. (The four bytes of header are ignored by the Target and not written to the buffer.) A transfer length of zero indicates that no data transfer will take place and shall not be considered an error. It shall not be considered an error to request a transfer length smaller than the Target data buffer size.

If the transfer length is greater than the maximum size of the Target's data buffer, the data phase will not be performed. The Target progresses immediately to the Status phase with CHECK CONDITION, ILLEGAL REQUEST Sense Key.

To avoid the possibility of causing data buffer corruption between a WRITE DATA BUFFER and a subsequent READ DATA BUFFER, it is recommended that the Target be placed in Reserve or that the commands be linked to ensure that the Initiator can reliably test the Target's data buffer.

5-42. Write Full

NOTE

For this command to succeed, the header of the sector prior to the requested sector must be readable, except for operations on sector zero (0) on the requested track.

COMMAND FORMAT:

BYTE	BIT 7	6	5	4	3	2	1	0
00	OPCODE = FCH							
01	LOGICAL UNIT NUMBER			RESERVED				PHYS
02	ADDRESS (MSB)							
03	ADDRESS							
04	ADDRESS							
05	ADDRESS (LSB)							
06	RESERVED							
07	BYTE TRANSFER LENGTH (MSB) = 01H							
08	BYTE TRANSFER LENGTH (LSB) = 0AH							
09	VEND UNQ = 0		RESERVED				FLAG	LINK

CAUTION

The WRITE FULL command allows the Initiator to directly control the formatting of a physical block of media. Use of this command should be restricted to development or other highly controlled environments. The use of this command may adversely affect the reliability of data recovery and proper device operation at media addresses other than the one specified. This command is intended strictly to test Target and Initiator reaction to certain induced media errors. Any use of this command other than at Hewlett-Packard approved sites and by Hewlett-Packard approved methods may be deemed a violation of warranty.

The WRITE FULL command allows the Initiator to request the Target to write the specified logical or physical block with the exact block formatting information included with the command. This information may include the header, data, and ECC field contents.

Using the WRITE FULL command, the Initiator transfers to the Target the complete information to write one physical block. A WRITE FULL command is usually preceded by a READ FULL command, which returns the entire contents (266 bytes) of a specified block. The Initiator receives the READ FULL data, strips off the 10-byte header, and modifies the block contents as required. The resultant 266 bytes constitute the data phase of the WRITE FULL command. The WRITE FULL command and the preceding READ FULL command should both address the same block; thus ensuring that the modified data is returned to its original location.

The Address field specifies which block to write. The interpretation of the address is determined by the state of the Physical Address (PHYS) bit. If PHYS is clear (0), the Address field is treated as a logical block address per normal conventions and all normal position verifications are performed. The first *physical* block in the specified *logical* block is written. To access all physical blocks, the Initiator must use the MODE SELECT command to set the logical block size equal to the physical block size (256 bytes). Otherwise, only the first physical block in each logical is accessible.

When PHYS is set (1), the Address field is treated as a physical block address with the Address field defined as follows:

- Byte 2: Cylinder Address (MSB)
- Byte 3: Cylinder Address (LSB)
- Byte 4: Head Address
- Byte 5: Sector Address

The Byte Transfer Length field specifies the number of bytes to be transferred in the data phase. This field is set to 010AH (266 decimal) indicating the full physical block length. Setting this field to any other value will generate an ILLEGAL REQUEST sense key.

Manual Part Number: 5959-1412
Printed in U.S.A., December 1988
Edition 1, Rev 12/20/88
E1288

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PACKARD