CE Service Handbook For HP Series 6000 Disk Storage Systems

Models 335H (C2200A), 670H (C2203A), 670XP (C2202A), 670FL (C2201A), and 1.34FL (C2204A)

HEWLETT PACKARD

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Notice

Printing History

New editions incorporate all update material since the previous edition. Updating Supplements, which are issued between editions, contain additional and revised information to be incorporated into the manual by the user. The date on the title page changes only when a new edition is published.

Edition 1	February 1990
Edition 2	November 1990

Safety Symbols and Conventions

The following conventions are used throughout this manual:

- *Italic* is used for emphasis, and also for manual titles and diskette names.

Note

Notes contain important information set off from the text.

Caution

Caution messages indicate procedures which, if not observed, could result in damage to equipment. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

Warning

Warning messages indicate procedures or practices which, if not observed, could result in personal injury. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

About This Manual

This manual provides detailed technical information about the following models of the HP Series 6000 disk storage systems:

- 335H (product number C2200A)
- 670H (product number C2203A)
- 670XP (product number C2202A)
- 670FL (product number C2201A)
- 1.34FL (product number C2204A)

This manual is intended for service-trained HP Customer Engineers and others involved in the service and support of these products. It is assumed the reader has been properly trained and is familiar with the installation, operation, and service of these products.

This manual should be inserted into handbook binder part number 9282-0683.

FCC Statement

FOR U.S.A. ONLY

The Federal Communications Commission (in 47 CFR 15.105) has specified that the following notice be brought to the attention of the users of this product.

FEDERAL COMMUNICATIONS COMMISSION RADIO FREQUENCY INTERFERENCE STATEMENT

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

The end user of this product should be aware that any changes or modifications made to this equipment without the approval of Hewlett-Packard could result in the product not meeting the Class A limits, in which case the FCC could void the user's authority to operate the equipment.

FTZ Statements

FUNKENTSTÖRUNGSVORSCHRIFTEN FÜR DEUTSCHLAND HERSTELLERBESCHEINIGUNG

Hiermit wird bescheinigt, daß das Gerät in Übereinstimmung mit den Bestimmungen von Postverfügung 1046/84 funkentstört ist. Der Deutschen Bundespost wurde das Inverkehrbringen dieses Gerätes angezeigt und die Berechtigung zur Überprüfung der Serie auf Einhaltung der Bestimmungen eingeräumt.

Wird das Gerät innerhalb eines Systems betrieben, so muß bei Inanspruchnahme der Allgemeinen Genehmigung FTZ 1046/84 das gesamte System der oben genannten Genehmigung entsprechen. Wird das Gerät innerhalb eines Systems betrieben das mit einer FTZ-Serienprüfnummer gekennzeichnet ist, und für welches eine Betriebsgenehmigung vorliegt oder beantragt wird, so sind in der Regel keine weiteren Schritte notwendig.

ELECTROMAGNETIC INTERFERENCE REGULATIONS FOR GERMANY MANUFACTURER'S DECLARATION

This is to certify that the equipment is in accordance with the Radio Interference Requirements of Directive FTZ 1046/84. The German Bundespost was notified that this equipment was put into circulation and the right to check the series for compliance with the requirements was granted.

If this equipment is to be operated with a system, and if the General License is being claimed, the complete system must comply with the General Licensing requirements. If this equipment is to be operated with a system which has its own FTZ-Serial-License, and for which an operating license has been submitted or applied, usually no further steps are necessary.

VCCI Statements

FOR JAPAN ONLY

この装置は，第二種情報装置（住宅地域又はその隣接した地域において使用されるべき情報装置）で住宅地域での電波障害防止を目的とした情報処理装置等電波障害自主規制協議会（ＶＣＣＩ）基準に適合しております。

しかし，本装置をラジオ，テレビジョン受信機に近接してご使用になると，受信障害の原因となることがあります。

取扱説明書に従って正しい取り扱いをして下さい。

This apparatus is a class 2 ITE (information apparatus which may be used in residential and adjacent areas) which meets the VCCI standards to prevent radio interference in residential and adjacent areas. However, this apparatus may become a source of radio interference if used within close range of radio or television receivers. To ensure compliance, this apparatus must be operated according to instructions included with the product.

Communication Statement For Canada Only

This digital apparatus does not exceed the Class A limits for radio noise emissions from digital apparatus as set out in the radio interference regulations of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de Classe A prescrites dans le règlement sur le brouillage radioélectrique édicté par le Ministère des Communications du Canada.

Contents

Figures

Tables

1

Product Information

Product Description

The product features include:

- HP 335H: 335-megabyte capacity with standard HP-IB controller
- HP 670H: 670-megabyte capacity with standard HP-IB controller
- HP 670XP: 670-megabyte capacity with HP-IB cache controller
- HP 670FL: 670-megabyte capacity with HP-FL controller
- HP 1.34FL: 1.34-gigabyte capacity with HP-FL controller
- 5.25-inch Winchester disk mechanism
- Integrated controller and power supply
- 17 millisecond average seek time
- Thin-film heads
- Built-in diagnostics

Parts Supplied

The following parts are supplied with the standard disk storage system:

- A product owner's manual
- Power cord
- 1-meter HP-IB cable, part no. 8120-3445 (models 335H, 670H, and 670XP)
- 807-mm PBus cable, part no. 5061-3174 (models 670FL and 1.34FL)

Note A 1008-mm PBus cable (5061-3197) is available for connecting 92211Y or 19511A cabinets together. There is no PBus cable available for connecting any other cabinet configurations together.

Documentation

In addition to the owner's manual included with each disk storage system, the following documentation is also available:

- *HP Series 6000 Disk Storage Systems Installation Guide, Models 335H, 670H, and 670XP*, part number C2200-90902. This guide is included with each HP-IB product.
- *CE Service Handbook for HP Series 6000 Disk Storage Systems , Models 335H, 670H, 670XP, 670FL, and 1.34FL*,HP part number C2200-90905 (this manual).
- *Disk Product Specifications and Site Environmental Requirements*, part number 5955-3456.

Accessories

The following accessories are available:

- HP C2205A HP-IB Cache Controller Upgrade Kit - converts a 670H to a 670XP by replacing the standard HP-IB controller PCA with a cache HP-IB controller PCA.
- HP C2206A HP-FL Controller Upgrade Kit - converts a 670H or 670XP to a 670FL by replacing the HP-IB interface controller PCA with an HP-FL fiber optic interface controller PCA.

Note There are no accessories available to add a second disk mechanism to a single mechanism disk storage system. The 1.34FL (C2204A) is the only supported dual-mechanism product.

Options

- 1BG - Delete fiber optic interface circuitry from 670FL and 1.34FL disk storage systems.
- 0D4 - Delete CE installation for H- and XP-model disk storage systems. This option allows customers familiar with HP-IB to install their own disk storage systems. This option is not available on FL-model disk storage systems.
- AAM - Media retention option for products on HP service contracts. If the disk mechanism fails while under contract, then the customer retains the mechanism. This option is available for customers who store highly confidential data.
- The local language options for owner's documentation are
  - ABJ - Japanese
  - ABF - French
  - ABD -German

Cabinets

The following four cabinet configurations are approved for mounting the disk storage systems. If the disk storage systems are installed in any other cabinets than those listed, the customer assumes the responsibility for ensuring the cabinet configuration meets the necessary environmental and regulatory requirements.

- HP 46299A - up to eight disk storage systems can be mounted in this 63-inch (1600-mm) high, 19-inch EIA cabinet. The cabinet includes eight HP 35199C rack adapter kits, a PDU, and eight power cords.
- HP 92211Y - this product accommodates up to four disk storage systems and includes an HP 92211R Design Plus cabinet, an HP 92211S rack mounting kit, a PDU, and four power cords.
- HP 19514A - up to eight disk storage systems can be mounted in this cabinet. An HP 92211Q rack adapter kit is required to mount each disk storage system.

- HP 19511A - up to two disk storage systems can be mounted in this cabinet. The HP 92211S rack mounting kit is used to mount the disk storage systems.

Two rack adapter kits are available for mounting the disk storage systems.

- HP 92211Q Rack Adapter Kit - used to mount one disk storage system in an HP 19514A cabinet.
- HP 35199C Rack Adapter Kit - used to mount one disk storage system in the HP 46299A cabinet.

Packaging Material

The following items are used to repackage the disk storage system:

- Shipping carton, part no. C2200-80017
- Foam cushions (2 pieces), part no. C2200-80016
- Anti-static plastic bag, part no. 9222-1030

Support Strategy

The product is designed to be repaired on-site to the field replaceable assembly (FRA) level. The internal self-test and limited number of replaceable assemblies allow the product to be repaired and returned to service quickly.

Operating Specifications

The operating specifications and characteristics for the disk storage systems are included in the product owner's manual and the *Disk Product Specifications and Site Environmental Requirements,* part number 5955-3456.

Product Support Package

Table 1-1 lists the contents of the recommended Product Support Package.

Table 1-1. Product Support Package Contents

Part No.	Description
5960-0153	CS80DISK Diagnostic Reference Manual
9300-1155	Field Service Grounding Kit
8710-1426	TORX* Field Kit
07937-60192	PBus Connector Box
5061-3151	PBus Terminators
HFBR-3020	HP-FL Fiber Optic Loopback Cable
	**TORX is a product of the Camcar Division of Textron, Inc.*

2

Environmental/Installation/PM

Introduction

This chapter provides information on the environmental, installation, and preventive maintenance requirements of the disk storage system.

Environmental Requirements

The operating specifications and characteristics for the disk storage systems are included in the product owner's manual and the *Disk Product Specifications and Site Environmental Requirements*, part number 5955-3456.

Preinstallation

The following paragraphs describe the steps that must be performed before installing the disk storage system.

Unpacking and Inspecting the Disk Storage System

Before unpacking the disk storage system, inspect the shipping carton carefully for any signs of damage or mishandling that may have occurred during shipping. If you suspect that damage may have occurred during shipping, request that the carrier's agent be present when the disk storage system is unpacked. An unpacking sheet included in the shipping carton shows how the disk storage system is unpacked and the contents of the shipping carton.

After unpacking the disk storage system, inspect it carefully for any signs of damage that may have occurred in shipment. If any damage is evident, contact the local Hewlett-Packard Sales Office and the carrier involved.

Note

Keep the packing material in case it should ever become necessary to repack the disk storage system for shipment.

In addition to the drive itself, the package also contains an interface cable (HP-IB or PBus), a power cord, and user documentation.

Handling the Disk Storage System

To avoid accidentally damaging the disk storage system during installation, observe the following precautions:

- When moving the disk storage system to its installation site, avoid any sudden or jarring movements. The disk storage system can be placed back into its original packing container to provide protection when moving.
- During installation, avoid dropping or bumping the disk storage system. A sudden mechanical shock can damage it.
- The installation of FL-model disk storage systems requires handling the HP-FL controller PCA. Remember to take all necessary precautions regarding static electricity. Use the field service grounding kit (p/n 9300-1155) to provide the proper protection. The HP-FL controller PCA and the disk mechanism are highly sensitive to electrostatic discharge (ESD) and may be damaged if the proper precautions are not taken.

Serial Number

Locate the serial number on the rear panel of the disk storage system and record the number in the product owner's manual.

Cabinet Mounting the Disk Storage System

The following paragraphs contain information on mounting the disk storage system in the four approved cabinets. Refer to the appropriate information for the cabinet that will be used. If the disk storage system will not be installed in a cabinet, skip this section.

Note

- The four cabinets included here have been fully tested and found to comply with the necessary environmental and regulatory requirements. To ensure compliance with UL Listing and CSA Certification requirements, only HP Series 6000 Disk Storage Systems may be installed in the cabinet.
- If using a cabinet other than the four listed below, make sure the cabinet meets the necessary regulatory and environmental requirements. The regulatory requirements are listed at the front of this manual. In addition, factors such as temperature, electromagnetic interference (EMI), and adequate power distribution must be considered before installing the disk storage system in an unapproved cabinet. A complete regulatory evaluation of the proposed cabinet configuration is strongly recommended.
- Some Hewlett-Packard computer systems include their own cabinets which may be approved for mounting the disk storage systems. Consult the system documentation for approved cabinet configurations.

HP 46299A Cabinet

The HP 46299A Cabinet has been designed to accommodate eight disk storage systems. Eight HP 35199C Rack Adapters have been installed in the cabinet in the proper positions. The first adapter mounting tray is installed in the 17^{th} hole down from the top, and the remaining mounting trays are installed in every 9^{th} hole.

Warning

To ensure cabinet stability, the leveling feet on the cabinet must be lowered before installing the disk storage systems. Also, do not transport the cabinet with disk storage systems installed. Moving a fully loaded cabinet could cause it to tip over.

To install each disk storage system, perform the following steps.

1. Open the cabinet front door.
2. Loosen the two screws securing each flange to the cabinet. See Figure 2-1.
3. Slide the flanges aside so they will not interfere when putting the disk storage system into the cabinet. Tighten the flange mounting screws just enough to hold them out of the way.
4. Carefully set the disk storage system on the mounting tray and slide it back until it contacts the stop at the rear of the tray.
5. Loosen the flange mounting screws and slide the flanges up against the disk storage system. The flanges fit into the groove directly behind the front panel. See Figure 2-1. If necessary, slide the disk storage system forward slightly until the flanges are aligned properly.
6. Tighten the two mounting screws on each flange to hold the disk storage system in place.

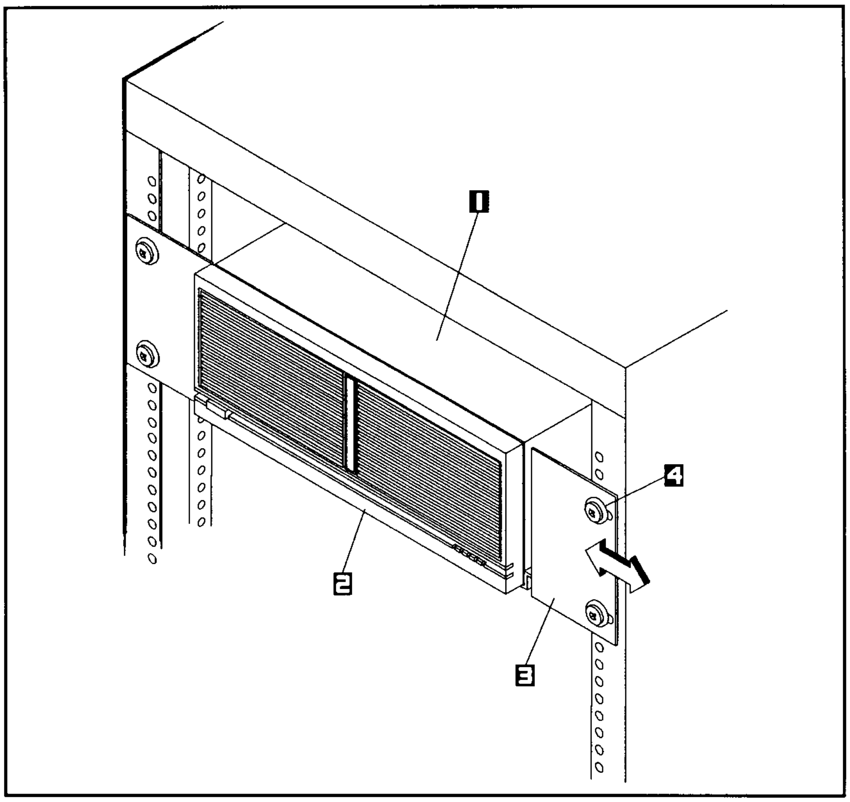

Figure 2-1. Installing the Disk Storage System in an HP 46299A Cabinet

1. Disk storage system
2. Front panel
3. Flange
4. Mounting screws

HP 92211Y Cabinet

The HP 92211Y Cabinet has been designed to accommodate four disk storage systems. The disk storage systems are installed using the HP 92211S Mounting Rail Kit. The kit mounting rails have already been installed in the cabinet in the proper positions. The instructions for installing the disk storage system are included with the remaining pieces of the mounting kit. Follow these instructions, but skip the steps involving the installation of the rails.

Caution The installation instructions included with HP 92211S Mounting Rail Kit tell you to turn the product upside-down and remove the feet. The disk storage system does not have feet that need to be removed. Never turn the disk storage upside-down or it may be damaged.

To accommodate four disk storage systems, the mounting rails have been installed in the proper hole positions in the cabinet upright posts. These hole positions, counting from the bottom of the cabinet, are:

- 3
- 8
- 13
- 18

HP 19514A Cabinet

Up to eight disk storage systems can be installed in this cabinet. An HP 92211Q Rack Adapter kit is required to mount each disk storage system. Complete instructions for mounting the disk storage system in the HP 19514A Cabinet are included with the HP 92211Q kit.

HP 19511A Cabinet

Up to two disk storage systems can be installed in this cabinet. The disk storage systems are installed using the HP 92211S Mounting Rail Kit, which includes complete mounting instructions.

To position the disk storage systems properly in the HP 19511A Cabinet, the rails included with the kit must be installed in the proper hole positions in the cabinet upright posts. These hole positions, counting from the bottom of the cabinet, are:

- 4
- 15

Caution

The installation instructions included with HP 92211S Mounting Rail Kit tell you to turn the product upside-down and remove the feet. The disk storage system does not have feet that need to be removed. Never turn the disk storage upside-down or it may be damaged.

Connecting the Disk Storage System to AC Power

Warning

- **The ac branch service must be properly current protected by either a fuse or circuit breaker.**
- **Use only a UL/CSA approved power cord, SVT type, rated for suitable voltage and current. These power cords have two conductors plus a ground. Failure to use the proper power cord could result in a shock or fire hazard.**

The method of connecting the disk storage system to ac power varies slightly depending on whether the disk storage system is being installed in a cabinet. Use the following list to determine how to connect the ac power cord for each cabinet configuration.

- No cabinet - use the power cord supplied with the disk storage system to connect to an ac power outlet.
- HP 19511A cabinet - use the power cord supplied with the disk storage system to connect to an ac power outlet.
- HP 92211Y cabinet - use one of the power cords supplied with the cabinet to connect the disk storage system to the power strip in the cabinet. Use the power cord supplied with the disk storage system to connect the cabinet power strip to an ac power outlet.
- HP 46299A cabinet - use one of the power cords supplied with the cabinet to connect the disk storage system to the PDU in the cabinet. Instructions for connecting the PDU power cord are included with the cabinet. If the disk storage system has a voltage select switch, the switch must be set to the 240V position.

Warning

- **Due to high leakage current, reliable ground circuit continuity is vital for safe operation of the HP 46299A Cabinet. Never operate the cabinet with the ground conductor disconnected. If there is any doubt about the integrity of the ground provided by the supply circuit, a redundant ground path should be created. An additional grounding terminal is installed at the base of the left rear cabinet column for this purpose. See Figure 2-2. To create a redundant ground path, connect a conductor (12 AWG minimum) from the grounding terminal to a reliable earth ground. Do not use conduit as the grounding conductor because electrical shock can result if the ground conductor opens.**
- **When installing the disk storage system in an HP 46299A cabinet, make sure the power cables are routed properly to avoid any pinching or binding when the cabinet door is closed. The proper routing of the power cords is shown in Figure 2-2.**

Route the disk storage system power cords inside the left rear cabinet column. The four power cords from the upper half of the cabinet should be routed down through the top and center cable clamps and then to the PDU. The four power cords from the lower half of the cabinet should be routed up through the bottom and center cable clamps and then to the PDU. Proper cable routing is shown in Figure 2-2.

- HP 19514A cabinet - use one of the power cords supplied with the cabinet to connect the disk storage system to the PDU in the cabinet.
- Other cabinets - follow the instructions included with the cabinet to determine how to connect the ac power cord.

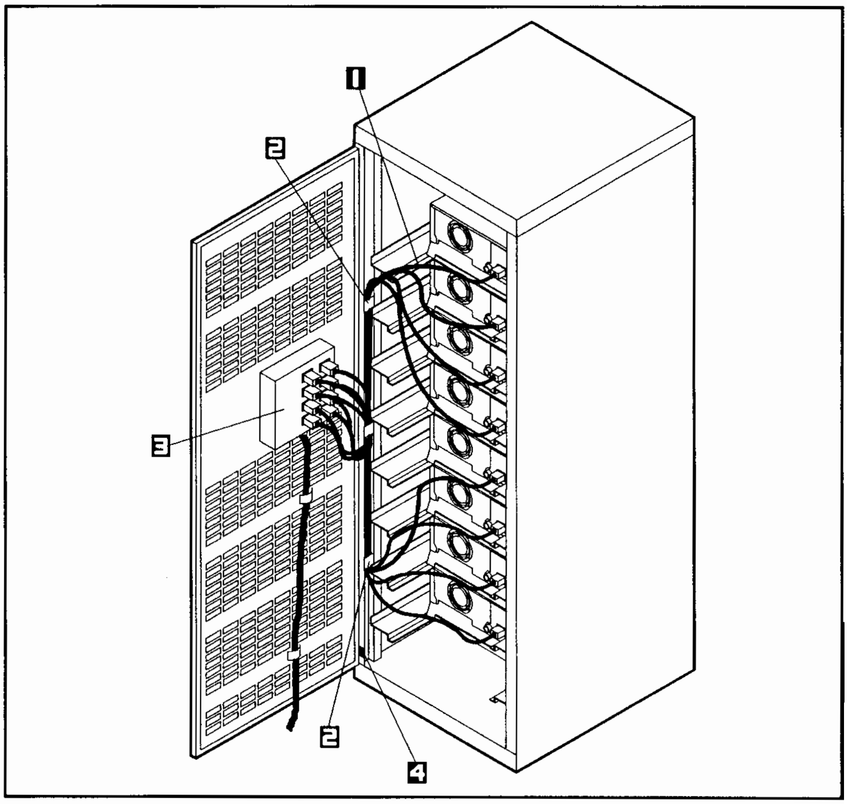

Figure 2-2. Routing Power Cords in an HP 46299A Cabinet

1. Power cords
2. Cable clamps
3. PDU
4. Redundant ground terminal

Installing HP-IB Disk Storage Systems

This section contains detailed instructions for installing model 335H, 670H, and 670XP Disk Storage Systems.

Parts Required For Installation

The following items are required to install HP-IB disk storage systems:

- HP-IB cable - supplied with the disk storage system.
- Power cord - supplied with the disk storage system.

Controls and Connectors

The various controls and connectors used during installation of an HP-IB disk storage system are shown in Figure 2-3 and Figure 2-4. Use the figures to locate the corresponding parts on the disk storage system.

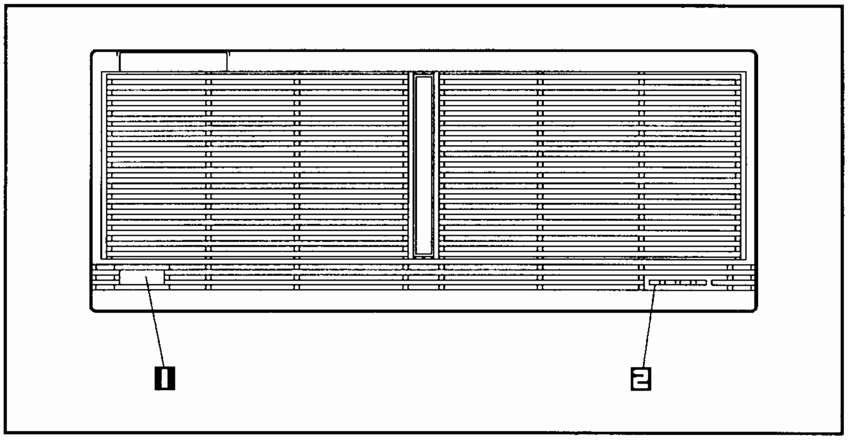

Figure 2-3. HP-IB Front Panel

1. LINE ~ switch
2. Status display

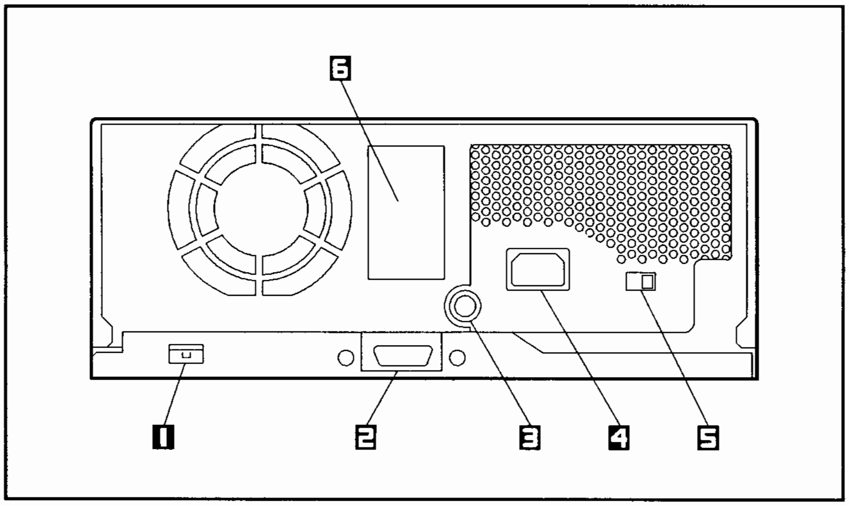

Figure 2-4. HP-IB Rear Panel

1. Address switch
2. HP-IB connector
3. Fuse [1]
4. Power cord connector
5. Voltage select switch [1]
6. Serial Number

[1] *A fuse and voltage select switch are not included on disk storage systems equipped with an automatic ranging power supply.*

Connecting the HP-IB Cable

Note

The HP-IB has certain cabling restrictions that must be observed when connecting any component to the bus. These restrictions and other technical information on HP-IB are included in the product owner's manual.

1. Switch off power to all components connected to the HP-IB.
2. Locate the HP-IB cable supplied with the disk storage system, or use a suitable alternative.
3. Connect one end of the HP-IB cable to the HP-IB connector on the rear of the disk storage system.
4. Connect the other end of the HP-IB cable to the computer system HP-IB.
5. Set the address switch to the desired HP-IB address.

Connecting the AC Power Cord

Before connecting the ac power cord, refer to "Connecting the Disk Storage System to AC Power" in this chapter to determine how the power cord is connected for your cabinet configuration.

1. Check the LINE~ switch on the front of the disk storage system and make sure it is in the 0 (OFF) position.

Note

Disk storage systems equipped with an automatic ranging power supply do not have a voltage select switch. This type of power supply automatically adjusts itself to operate on either of the voltage ranges listed in step 2.

2. If the disk storage system has a voltage select switch, check the switch and make sure it is set for the available ac line voltage. Set the voltage select switch according to the following information:

If the input voltage range is:	Set the switch to this setting:
100 V to 120 V, 50 or 60 Hz	120V
200 V to 240 V, 50 or 60 Hz	240V

3. Locate the power cord you will use to connect to ac power.
4. Connect the power cord to the power cord connector on the rear of the disk storage system.
5. Plug the power cord into the appropriate ac power outlet.

Power-On Checkout

Caution

- If the disk storage system has been exposed to temperature extremes, allow two hours for the disk storage system to stabilize at room temperature and humidity before operating it. Operating a disk storage system that is either very cold or very hot could damage it.
- Following the installation of a HP C2205A Cache Controller Upgrade Kit, the cache memory must be initialized before performing a power-on checkout. Refer to "Initializing 670XP Disk Storage System Cache Memory" for instructions on initializing the cache memory.

1. Switch the disk storage system power on by setting the LINE~ switch to the 1 (ON) position.
2. Wait for the disk storage system to complete its internal self-test. The self-test takes about 30 seconds to complete for a 335H or a 670H, and about 60 seconds for a 670XP.
3. Check the status display. The green LED should be on and the amber LED should be off, indicating a successful self-test.

If the status display indicates the self-test was successful, the disk storage system is now ready for use.

If the disk storage system experienced a problem during the power-on self-test, the front panel status display will indicate something other than a successful test. Use Table 2-2 to determine the type of problem that occurred.

Note

On drives with serial prefixes earlier than 3046, certain self-test failures are not indicated on the status display. When such a failure occurs, the status display indicates that the drive is ready. Drives with serial prefix 3046 and later have updated diagnostic firmware that corrects this problem. On these drives, *all* self-test failures are indicated on the status display.

Although you should be aware of this problem, it is not serious enough to warrant a mandatory firmware update. The only situation in which you may want to consider updating the firmware is when troubleshooting a drive. The part numbers for the updated firmware are listed in Table 2-1. The firmware is located on the HP-IB or HP-FL controller PCA.

Table 2-1. Updated Firmware

Model	Original Firmware	Updated Firmware
335H, 670H	C2200-89070	C2200-89080
	C2200-89071	C2200-89081
670XP	C2202-89070	C2202-89080
	C2202-89071	C2202-89081
670FL, 1.34FL	C2201-89050	C2201-89060
	C2201-89051	C2201-89061

Table 2-2. Status Display Indications

Amber	Green	Disk Storage System Status
Off	Off	NO POWER. There is no ac power to the disk storage system. If the disk storage system is connected to ac power and the ~LINE switch is in the 1 (ON) position, the problem may be a fuse or a failure of the internal power supply.
Off	On	READY. The disk storage system has passed its self-test and is ready to communicate with the computer. This is normal operating status for the disk storage system.
On	Off	SELF-TEST FAILURE. The disk storage system failed its self-test. The failure was most likely caused by something other than the controller PCA.
On	On	BAD CONTROLLER PCA. The disk storage system failed its self-test due to a problem with the controller PCA.
Off	Flashing	DISK ACTIVE. The disk storage system is communicating with the computer. This is normal operating status for the disk storage system.

Table 2-2. Status Display Indications (continued)

Amber	Green	Disk Storage System Status
Flashing	Flashing	SELF-TEST IN PROGRESS. The disk storage system is executing its internal self-test. This is the status you will see immediately after turning the disk storage system on. The self-test takes about 30 seconds to complete for a 335H or a 670H, about 60 seconds for a 670XP, and about 40 seconds for a 670FL or 1.34FL. If this display pattern continues, it indicates that the disk storage system has entered a special diagnostic mode of operation. This mode is activated by setting the address switch to address 8 or 9. If the address switch has inadvertently been set to one of these two addresses, turn the disk storage system off, set the address switch to the proper address, and turn the disk storage system back on.
Flashing	Off	DIAGNOSTIC MODE ERROR. This is an indication you should not see under normal circumstances. It indicates that the disk storage system has detected a data error during a special diagnostic mode of operation. This mode is activated by setting the address switch to address 8 or 9. If the address switch has inadvertently been set to one of these two addresses, turn the disk storage system off, set the address switch to the proper address, and turn the disk storage system back on.

Initializing 670XP Disk Storage System Cache Memory

The model 670XP semiconductor write cache nonvolatile RAM (NVRAM) must be initialized following the installation of the HP C2205A Cache Controller Upgrade Kit, or when installing a cache controller PCA containing new NVRAM. The initialization routine clears the NVRAM, thus ensuring that unwanted data is not written to the disk media at power-on. Once the NVRAM is initialized, a power-on checkout can be performed on the disk storage system.

Caution

The cache memory should only be initialized following the installation of the HP C2205A Cache Controller Upgrade Kit, or when installing a cache controller PCA containing new NVRAM. If the NVRAM is not initialized, unwanted data in the NVRAM may be written to the disk media at power-on.

The cache initialization routine should not be performed on NVRAM that has been in use in the disk storage system. Initializing NVRAM that has been in use may destroy data that has not yet been updated to the disk media.

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1. Set the address switch to address 9.
2. Switch the disk storage system power on by setting the LINE~ switch to the 1 (ON) position.
3. Wait for the disk storage system to complete its initialization of the cache memory. This takes approximately 60 seconds. Both status display LEDs should be flashing when the initialization completes.
4. Switch the disk storage system power off by setting the LINE~ switch to the 0 (OFF) position.
5. Set the address switch to the desired HP-IB address.

Installing HP-FL Disk Storage Systems

This section contains detailed instruction for installing model 670FL and 1.34FL Disk Storage Systems.

Caution Installation of the HP-FL disk storage system involves handling the HP-FL controller PCA. Make sure you use the field service grounding kit (p/n 9300-1155), and handle the HP-FL controller PCA only by its edges. The HP-FL controller PCA is highly sensitive to ESD and may be damaged if the proper precautions are not taken.

Note The HP-FL interface bus has certain cabling restrictions that must be observed when connecting the fiber optic cable and the PBus cabling. These restrictions and other technical information on HP-FL are included in the product owner's manual.

Parts Required For Installation

The following items are required to install HP-FL disk storage systems:

- PBus cable - supplied with the disk storage system.
- Power cord - supplied with the disk storage system.
- Fiber optic cable - supplied with the computer HP-FL interface.
- PBus terminators - supplied with the computer HP-FL interface.
- TORX screwdriver with T15 bit.
- Anti-static work station and wrist strap (part number 9300-1155).

Controls and Connectors

The various controls and connectors used during installation of an HP-FL disk storage system are shown in Figure 2-5 and Figure 2-6. Use the figures to locate the corresponding parts on the disk storage system.

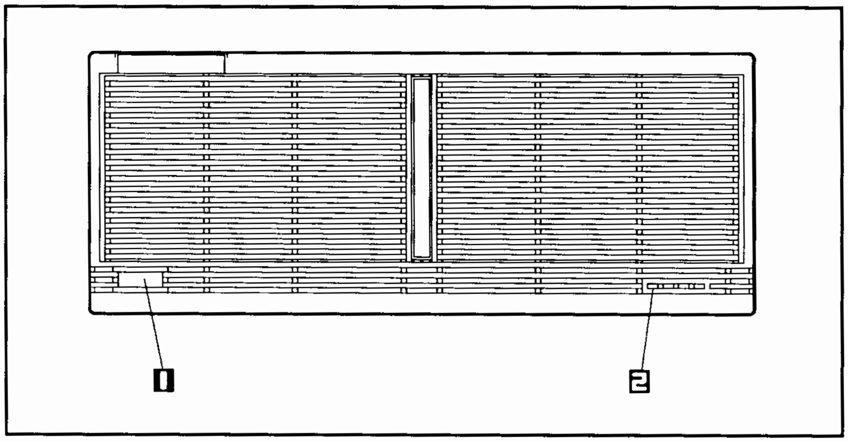


Figure 2-5. HP-FL Front Panel

1. LINE ~ switch
2. Status display

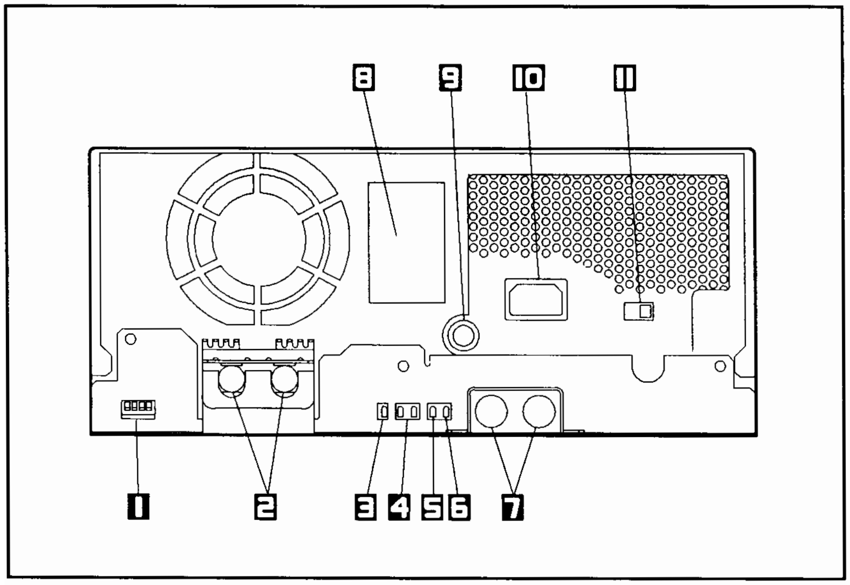


Figure 2-6. HP-FL Rear Panel

1. Address switch
2. PBus connectors (located behind I/O panel)
3. Configuration error LED
4. PBus fault LEDs
5. FL optical status LED
6. FL activity LED
7. Fiber optic connectors
8. Serial number
9. Fuse [1]
10. Power cord connector
11. Voltage select switch [1]

[1] *A fuse and voltage select switch are not included on disk storage systems equipped with an automatic ranging power supply.*

Performing the Stand-Alone Self-Test

Before connecting a new disk storage system to the HP-FL interface, a stand-alone self-test can be performed on the disk storage system. This procedure verifies that the disk storage system is operating properly before it is connected to the HP-FL interface. It is easier to isolate problems with the disk storage system before it is connected to the HP-FL interface.

1. Remove the I/O panel. The panel is held in place with five T15 mounting screws. See Figure 2-7.
2. Slide the HP-FL controller PCA out the rear of the disk storage system until the PBus connectors are easily accessible. A mechanical stop will prevent you from pulling the PCA out too far. See Figure 2-8.
3. Install PBus terminators in both PBus connectors on the HP-FL controller PCA. Press the terminator into the connector until the extraction levers snap into place. Make sure the terminators are installed in opposite orientations. That is, one terminator must be installed with the white side toward you, and the other terminator must have the gray side toward you.
4. Make sure diagnostic segment 1 of the address switch is set to the normal position (0). See Figure 2-9.
5. Slide the HP-FL controller PCA back into the disk storage system.
6. Connect the ac power cord to the disk storage system. Refer to the following section, "Connecting the AC Power Cord", for information on connecting the power cord.
7. Switch the disk storage system power on by setting the LINE~ switch to the 1 (ON) position.

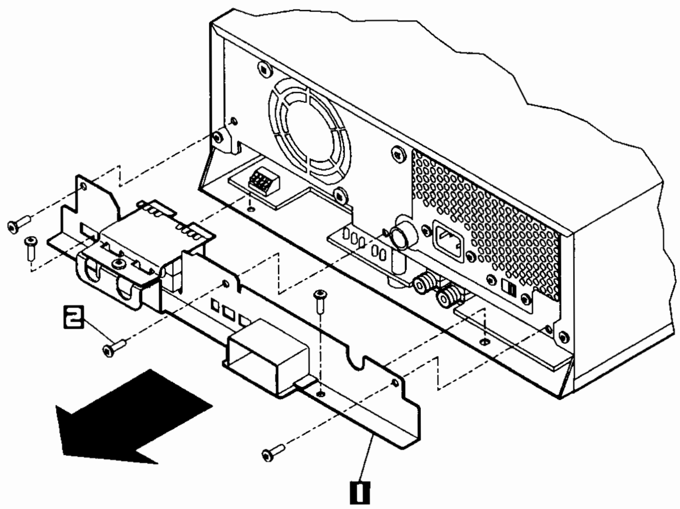


Figure 2-7. Removing the I/O Panel

1. I/O panel
2. T15 mounting screws

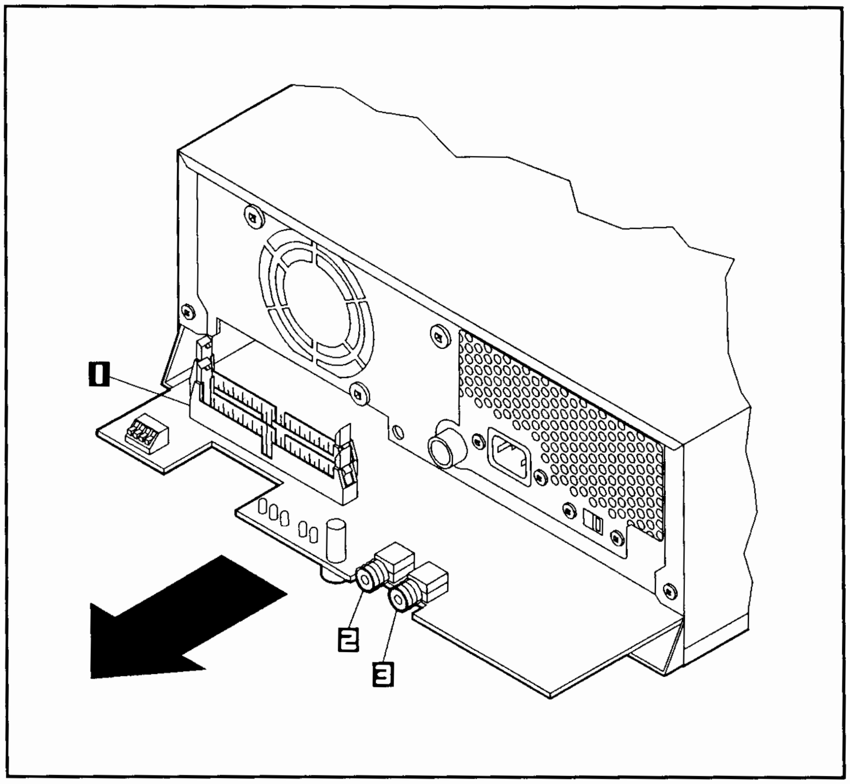


Figure 2-8. Accessing the HP-FL Controller PCA

1. PBus connectors
2. Receive fiber optic connector
3. Transmit fiber optic connector

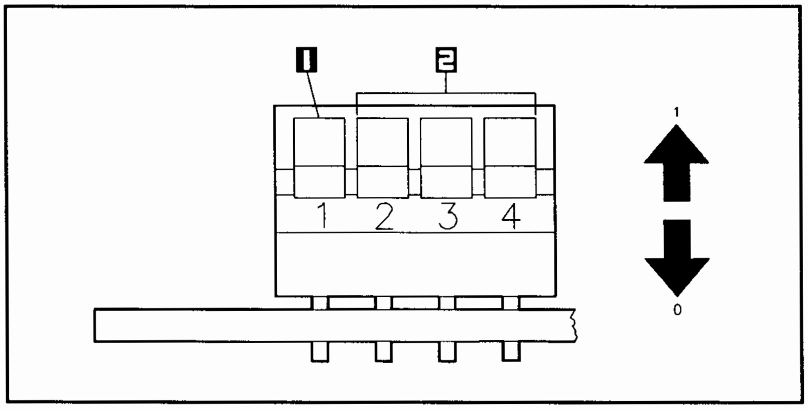


Figure 2-9. HP-FL Address Switch

1. Diagnostic switch segment
2. Address switch segments

ADDRESS	SWITCH SEGMENT 1	2	3	4
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
Diagnostic Mode[1]	1	X	X	X

[1] *Diagnostic segment 1 of the address switch must be set to 0 for normal operation. Setting the diagnostic segment to 1 places the disk storage system in a special diagnostic mode used for troubleshooting.*

8. Wait for the disk storage system to complete its internal self-test. The self-test takes approximately 40 seconds to complete.
9. Check the front panel status display. The green LED should be on and the amber LED should be off, indicating a successful self-test.

Note

- If the disk storage system experienced a problem during the self-test, the front panel status display will indicate the type of failure. Use Table 2-2 to determine the type of problem that occurred. The problem must be solved before proceeding with the installation of the disk storage system.
- On drives with serial prefixes earlier than 3046, certain self-test failures are not indicated on the status display. When such a failure occurs, the status display indicates that the drive is ready. Drives with serial prefix 3046 and later have updated diagnostic firmware that corrects this problem. On these drives, *all* self-test failures are indicated on the status display.

  Although you should be aware of this problem, it is not serious enough to warrant a mandatory firmware update. The only situation in which you may want to consider updating the firmware is when troubleshooting a drive. The part numbers for the updated firmware are listed in Table 2-1. The firmware is located on the HP-IB or HP-FL controller PCA.

---

10. Switch the disk storage system power off by setting the LINE~ switch to the 0 (OFF) position.
11. Disconnect the ac power cord from the disk storage system.
12. Slide the HP-FL controller PCA out the rear of the disk storage system.
13. Remove the PBus terminators from the PBus connectors on the HP-FL controller PCA.

The disk storage system is now ready to be connected to the HP-FL interface.

Connecting the AC Power Cord

Before connecting the ac power cord, refer to "Connecting the Disk Storage System to AC Power" earlier in this chapter to determine how the power cord is connected for your cabinet configuration.

1. Check the LINE~ switch on the front of the disk storage system and make sure it is in the 0 (OFF) position.

Note

Disk storage systems equipped with an automatic ranging power supply do not have a voltage select switch. This type of power supply automatically adjusts itself to operate on either of the voltage ranges listed in step 2.

---

2. If the disk storage system has a voltage select switch, check the switch and make sure it is set for the available ac line voltage. Set the voltage select switch according to the following information:

If the input voltage range is:	Set the switch to this setting:
100 V to 120 V, 50 or 60 Hz	120V
200 V to 240 V, 50 or 60 Hz	240V

3. Locate the power cord you will use to connect to ac power.
4. Connect the power cord to the power cord connector on the rear of the disk storage system.
5. Plug the power cord into the appropriate ac power outlet.

Connecting the PBus

The steps involved in making the proper PBus connections are determined by whether more than one disk storage system will be connected to the HP-FL interface. Follow the appropriate procedure for your installation.

Connecting a Single Disk Storage System to the PBus

1. If not already removed, remove the I/O panel. The panel is held in place with five T15 mounting screws. See Figure 2-7.
2. Slide the HP-FL controller PCA out the rear of the disk storage system until the PBus connectors are easily accessible. See Figure 2-8.
3. Locate the two PBus terminators. The PBus terminators are included with the computer HP-FL interface, not the disk storage system.
4. Install a PBus terminator in the inner PBus connector on the HP-FL controller PCA. Install this terminator with the white side facing you. Press the terminator into the connector until the extraction levers snap into place.
5. Install the second PBus terminator in the outer PBus connector. Make sure this terminator has the gray side toward you. The terminators must be installed in opposite orientations. That is, one terminator must be installed with the white side toward you, and the other terminator must have the gray side toward you.
6. Set the address switch to the desired HP-FL address. See Figure 2-9.

You are now ready to connect the fiber optic cable to the disk storage system.

Connecting Multiple Disk Storage Systems to the PBus

Caution

- The 670FL/1.34FL PBus cable (5061-3174) is not interchangeable with the 7936FL/7937FL PBus cable (5061-3149). When connecting these two types of products, use only the 670FL/1.34FL PBus cable. The 7936FL/7937FL PBus cable may be damaged if it is used to connect a 670FL or 1.34FL disk storage system.
- Make sure you observe the maximum cable length of 6.4 meters when connecting multiple disk storage systems to the PBus. The PBus cable included with the disk storage system should be used to make all PBus connections within a cabinet. A 1008-mm PBus cable (5061-3197) is available for connecting 92211Y or 19511A cabinets together without exceeding the PBus cable limitation. There is no PBus cable available for connecting any other cabinet configurations together.

Note

When installing multiple disk storage systems in a cabinet, select the disk storage system in the bottom of the cabinet to serve as one end of the PBus. This will be the last disk storage system you connect to the PBus, and will also be the one you connect the fiber optic cable to. Using the disk storage system in the bottom of the cabinet reduces the amount of fiber optic cable exposed and reduces the possibility of damaging the cable.

The disk storage system you choose to connect the fiber optic cable to cannot be an option 1BG disk storage system; the fiber optic cable cannot be connected to an option 1BG disk storage system.

1. Prepare each disk storage system for PBus connections by performing the following:
   a. If not already removed, remove the I/O panel. The panel is held in place with five T15 mounting screws. See Figure 2-7.
   b. Remove the PBus cable clamp from the I/O panel. The clamp is held in place with two T15 screws. See Figure 2-10.
   c. Slide the HP-FL controller PCA out of the disk storage system until the PBus connectors on the PCA are easily accessible.

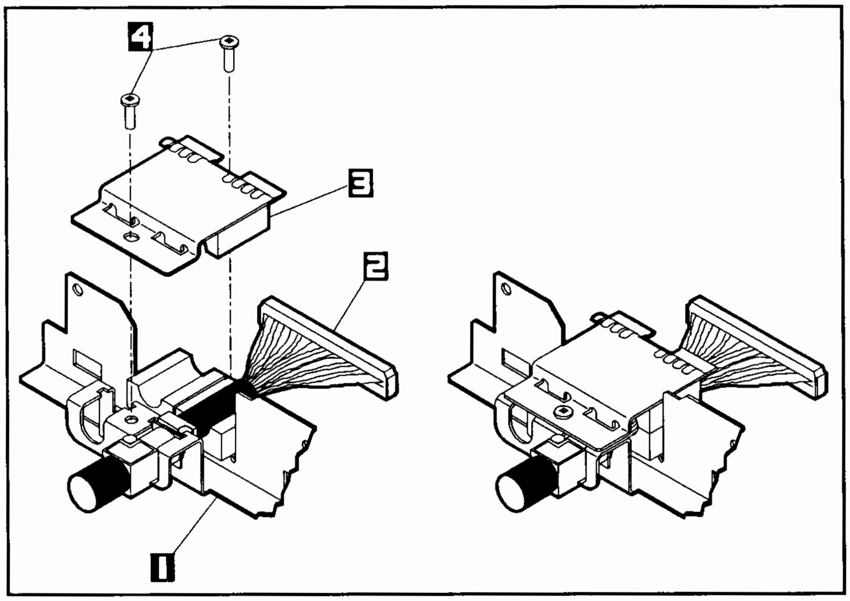


Figure 2-10. Installing the PBus Cable Clamp

1. I/O panel
2. PBus cable
3. PBus cable clamp
4. T15 mounting screws

2. Locate the PBus cables. One PBus cable is included with each disk storage system.
3. Locate the two PBus terminators. The PBus terminators are included with the computer HP-FL interface, not the disk storage system.
4. To connect the first disk storage system to the PBus:
   a. Select the first disk storage system and install a PBus terminator in the inner PBus connector. Install the terminator so the white side is facing toward you. Press the terminator into the connector until the extraction levers snap into place.
   b. Select a PBus cable and an I/O panel.
   c. Insert the strain relief fitting on one end of the PBus cable into the right-hand cable clamp cutout on the I/O panel. See Figure 2-10.
   d. Place the PBus cable clamp over the strain relief on the PBus cable. Make sure the clamp is positioned properly to hold the PBus cable securely in place. See Figure 2-10.
   e. Fasten the PBus cable clamp to the I/O panel using the clamp mounting screw. See Figure 2-10.
   f. Connect the PBus cable to the outer PBus connector on the disk storage system.
   g. Set the address switch to the desired HP-FL address. See Figure 2-9.
   h. Slide the HP-FL controller PCA back into the disk storage system.
   i. Install the I/O panel on the disk storage system using the five T15 mounting screws.
5. To connect disk storage systems in the middle of the PBus:
   a. Select another PBus cable and an I/O panel.
   b. Install the selected PBus cable and the PBus cable from the preceding disk storage system in the I/O panel cable clamp as described above.
   c. Connect both PBus cables to the PBus connectors on the disk storage system. The cable in the left-hand side of the cable clamp connects to the inner PBus connector, and the right-hand cable connects to the outer PBus connector.

d. Set the address switch to the desired HP-FL address. See Figure 2-9.

e. Slide the HP-FL controller PCA back into the disk storage system.

f. Install the I/O panel on the disk storage system using the five T15 mounting screws.

g. Continue connecting disk storage systems in this manner until only one disk storage system remains to be connected.

6. To connect the last disk storage system to the PBus:

Note If HP 7936 or HP 7937 disk drives are also connected to the PBus, refer to the information at the end of this procedure before installing the second PBus terminator.

a. Install a PBus terminator in the inner PBus connector on the last disk storage system. Make sure this terminator has its gray side facing toward you.

b. Locate the last I/O panel.

c. Install the PBus cable from the next-to-last disk storage system in the right-hand side of the I/O panel cable clamp.

d. Connect the PBus cable to the outer PBus connector on the disk storage system.

e. Set the address switch to the desired HP-FL address. See Figure 2-9.

f. Do not install the I/O panel on the last disk storage system until the fiber optic cable is connected..

Terminating a PBus That Includes HP 7936/7937 Disk Drives

Caution

The 670FL/1.34FL PBus cable (5061-3174) is not interchangeable with the 7936FL/7937FL PBus cable (5061-3149). When connecting these two types of products, use only the 670FL/1.34FL PBus cable. The 7936FL/7937FL PBus cable may be damaged if it is used to connect a 670FL or 1.34FL disk storage system.

The HP 670FL and 1.34FL disk storage systems can share the same HP-FL interface with HP 7936FL and HP 7937FL disk drives. When installing terminators on a PBus containing these two types of products, make sure the PBus is terminated as follows:

- If the disks at each end of the PBus are of the same type (both 670FL/1.34FL or both 7936FL/7937FL), the terminators must be installed in *opposite* orientations. That is, one terminator must be installed with the white side toward you, and the other terminator must have the gray side toward you.
- If the disks at each end of the PBus are of different types (one 670FL/1.34FL and one 7936FL/7937FL), the terminators must be installed in the *same* orientation. That is, both terminators must have the same color (white or gray) toward you.

Connecting the Fiber Optic Cable

Note

This procedure is only required if a fiber optic cable will be connected to the disk storage system. When installing multiple disk storage systems on HP-FL, it is most convenient to connect the fiber optic cable to a disk storage system located in the bottom of the cabinet. This reduces the amount of fiber optic cable exposed and reduces the possibility of damaging the cable.

1. If not already removed, remove the I/O panel. The panel is held in place with five T15 mounting screws. See Figure 2-7.
2. Slide the HP-FL controller PCA out the rear of the disk storage system until the fiber optic cable connectors are easily accessible. See Figure 2-8.
3. Locate the fiber optic cable to be used. The fiber optic cable is included with the computer HP-FL interface, not the disk storage system.
4. Identify the optical fiber marked with the white collar. This is the transmit fiber. The unmarked fiber is the receive fiber.

Caution

When handling and routing the fiber optic cable, avoid making any sharp bends or kinks that may damage the cable. All bends in the cable must have a radius of 25 mm (1 inch) or greater.

5. Route the optical fibers through the circular FL openings in the I/O panel. The transmit fiber goes through the right-hand opening, and the receive fiber goes through the left-hand opening. See Figure 2-11.

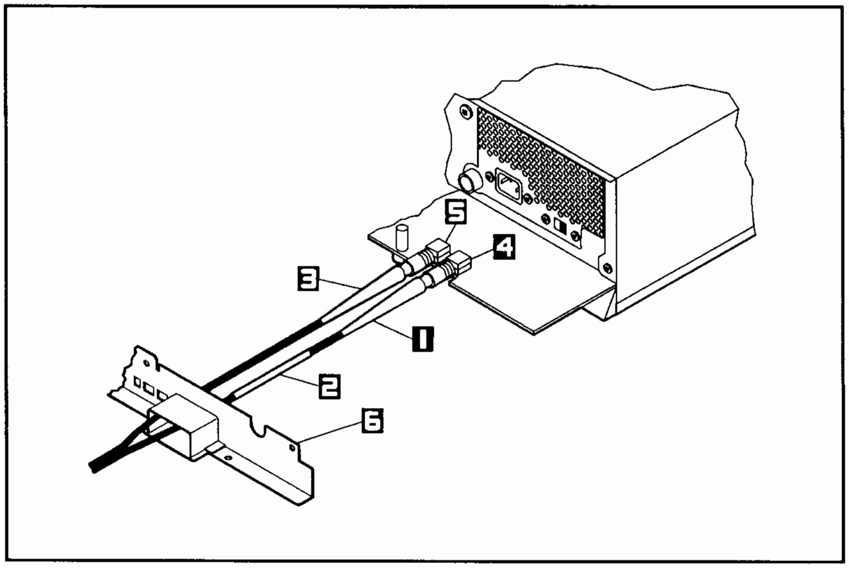


Figure 2-11. Connecting the Fiber Optic Cable

1. Transmit optical fiber
2. White collar (identifies transmit optical fiber)
3. Receive optical fiber
4. Transmit fiber optic connector
5. Receive fiber optic connector
6. I/O panel

Caution Tighten the fiber optic cable connectors only finger tight. Using tools or excessive force to tighten the connectors may damage the HP-FL controller PCA.

6. Connect the transmit optical fiber to the light-colored connector on the HP-FL controller PCA. See Figure 2-11.
7. Connect the receive optical fiber to the dark-colored connector on the HP-FL controller PCA.
8. Slide the HP-FL controller PCA back into the disk storage system.
9. Install the I/O panel using the five T15 mounting screws.

Power-On Checkout

Caution If the disk storage system has been exposed to temperature extremes, allow two hours for the disk storage system to stabilize at room temperature before operating it. Operating a disk storage system that is very cold or very hot could damage it.

1. Connect the ac power cord to the disk storage system. Refer to "Connecting the AC Power Cord" earlier in this chapter for information on connecting the power cord.
2. Switch the disk storage system power on by setting the LINE~ switch to the 1 (ON) position.
3. Wait for the disk storage system to complete its internal self-test. The self-test takes approximately 40 seconds to complete.
4. Check the front panel status display. The green LED should be on and the amber LED should be off, indicating a successful self-test.
5. Check the rear-panel HP-FL status LEDs to make sure the HP-FL interface is configured properly. The HP-FL status LEDs should display one of the following patterns:
   - If a fiber optic cable is connected to the disk storage system *and* to a functioning host computer, the green FL optical status LED should be on, and all other LEDs should be off.
   - If no fiber optic cable is connected to the disk storage system, all LEDs should be off.

If the front panel status display and HP-FL status LEDs show the proper indications, the disk storage system is ready for use.

If the disk storage system experienced a problem during the self-test, the front panel status display and/or the HP-FL status LEDs will indicate something other than a successful test. Use Table 2-2 and Table 2-3 to determine the type of problem that occurred.

Table 2-3. HP-FL Interface Status LEDs

LED	State	Indication
FL Optical Status (green) (Deleted on option 1BG.)	Off	No fiber optic cable is connected to the disk storage system. This is the normal indication on any disk storage system not connected to the computer. If a functioning computer is connected and this LED is off, it may indicate a bad fiber optic cable, an improper fiber optic cable connection, or a problem with the HP-FL circuits in either the disk storage system or computer HP-FL interface.
	On	A fiber optic cable is properly connected to the disk storage system *and* a functioning host computer.
FL Optical Activity (green)	Off	No activity is detected on the fiber optic cable. This is the normal indication on any disk storage system not connected to the computer.
	On	Activity is detected on the fiber optic cable, indicating that the computer is communicating with the disk storage system.
PBUS Fault (1 amber, 1 orange)	Off	All PBus connections have been made properly. In properly connected multiple disk storage system clusters, both PBus fault LEDs on all disk storage systems will be off.
	On (Either or both)	A problem exists with the PBus connections. In single disk storage system installations, this indicates a missing or improperly installed PBus terminator. In multiple disk storage system clusters, this indicates a terminator or cabling problem as follows: •The same LED pattern on all disk storage systems indicates a missing or improperly installed PBus terminator. •A change in LED pattern indicates a PBus cabling problem. The LED pattern changes between the two disk storage systems not connected properly.

335H, 670H, and 670XP Installation Quicklist

1. Connect the HP-IB cable.
2. Set the address switch to the desired HP-IB address.
3. Check that the LINE~ switch is set to 0 (OFF).
4. Check the voltage selection switch for the proper setting. (If an automatic ranging power supply is installed in the disk storage system, there will be no voltage selection switch.)
5. Connect the ac power cable.
6. Switch the disk storage system power on.
7. Check the status display for a successful self-test indication. See Table 2-2.
8. Configure the disk storage system into the host operating system.

670FL and 1.34FL Installation Quicklist

1. Remove the I/O panel and slide the HP-FL controller PCA out of the disk storage system.
2. Install PBus terminators in both PBus connectors.
3. Check that the LINE~ switch is set to 0 (OFF).
4. Check the voltage selection switch for the proper setting. (If an automatic ranging power supply is installed in the disk storage system, there will be no voltage selection switch.)
5. Connect the ac power cable.
6. Switch the disk storage system power on.
7. Check the status display for a successful self-test indication. See Table 2-2.
8. Switch the disk storage system power off.
9. Disconnect the ac power cable.
10. Connect the HP-FL fiber optic cable, PBus cables, and PBus terminators as required.
11. Set the address switch to the desired HP-FL address.
12. Slide the HP-FL controller PCA into the disk storage system and install the I/O panel.
13. Connect the ac power cable.
14. Switch the disk storage system power on.
15. Check the status display for a successful self-test indication. See Table 2-2.
16. Check the rear panel HP-FL interface status LEDs for proper indication. See Table 2-3.
17. Configure the disk storage system into the host operating system.

Preventive Maintenance

The disk storage system requires no preventive maintenance.

3

Configuration

The disk storage system itself requires no configuration other than voltage selection and address switch setting described in the installation section of chapter 2.

The information on configuring the disk storage system into the host operating system is included in the system documentation. Table 3-1 identifies the system manual containing the configuration information.

Table 3-1. Locating Configuration Information

Computer	Operating System	System Manual
HP 9000 Series 300	HP-UX (7.0 and later)	*HP-UX System Administration Tasks Manual* and *HP-UX Installing Peripherals*
HP 9000 Series 800	HP-UX (7.0 and later)	*Configuring HP-UX for Peripherals*
HP 1000	RTE-A (5.2 and later)	*Driver Reference Manual*
HP 1000	RTE-6 (5.2 and later)	*Driver Reference Manual*
HP 3000 Series	MPE/XL (2.0 and later)	*System Configuration Reference Manual*
HP 3000 Series	MPE V (Delta 8 and later)	*System Operation and Resource Management Reference Manual*

4

Troubleshooting

Introduction

This chapter discusses the strategy for troubleshooting the disk storage system. Also discussed in this chapter are additional procedures involved in troubleshooting the disk storage system. This includes steps such as isolating the failing assembly, troubleshooting the disk mechanism, checking the power supply, and troubleshooting HP-FL interface problems. Information on FRA location and disk storage system cabling are included in this chapter. The power-on self-test, an important tool for troubleshooting the disk storage system, is also discussed in detail.

Troubleshooting Strategy

The basic troubleshooting strategy is to replace a suspect assembly and see if the problem is solved. Because of the limited number of replaceable assemblies, this procedure can be used to quickly repair the disk storage system.

The exact replacement procedure used depends on the nature of the failure: repeatable or intermittent. The procedures for both types of faults are discussed in the following paragraphs. By following these procedures, you will be able to consistently isolate and repair problems as quickly as possible.

Although not discussed in the following procedures, the first troubleshooting steps should always involve checking the cabling and the power supply. If the power supply is suspect, refer to the section on checking the power supply included in this chapter.

Troubleshooting Repeatable Faults

A repeatable fault is one that can be easily reproduced within a reasonable amount of time. Such failures may occur during self-test, or when exercising the disk storage system using system diagnostics or the CS80DISK program. In either case, the troubleshooting process is the same.

1. Replace the controller PCA first. Even if the status display or fault log indicates a bad disk mechanism, replacing the controller PCA should be your first action. Because the disk storage system diagnostics are not fool-proof, there may be some situations where a controller fault is disguised as a disk mechanism problem. Changing the controller PCA is the quickest and most effective way of determining whether the controller PCA is at fault. If the controller PCA is the problem, you have avoided unnecessarily handling a good disk mechanism.

Note When replacing the controller PCA, make sure you follow the removal and replacement procedures in Chapter 8. Especially obey the statements regarding the NVRAM when replacing an XP cache controller PCA, and the statements regarding the power supply jumper when replacing an HP-FL controller PCA.

2. Try to recreate the problem. If the problem is gone, the controller PCA was at fault. If the problem still exists, the problem lies with the disk mechanism. If you are troubleshooting a dual-mechanism 1.34FL, your next task is identifying which of the two mechanisms is bad.
3. If a repeatable fault is traced to the disk mechanism, the fault must be isolated to either the ESDI PCA or the HDA. If the ESDI PCA is bad, it can be replaced separately. If the HDA is bad, the entire disk mechanism must be replaced. For more instruction on isolating disk mechanism failures, refer to Disk Mechanism Troubleshooting in this chapter.

The steps involved in troubleshooting repeatable faults are illustrated in Figure 4-1 and Figure 4-2.

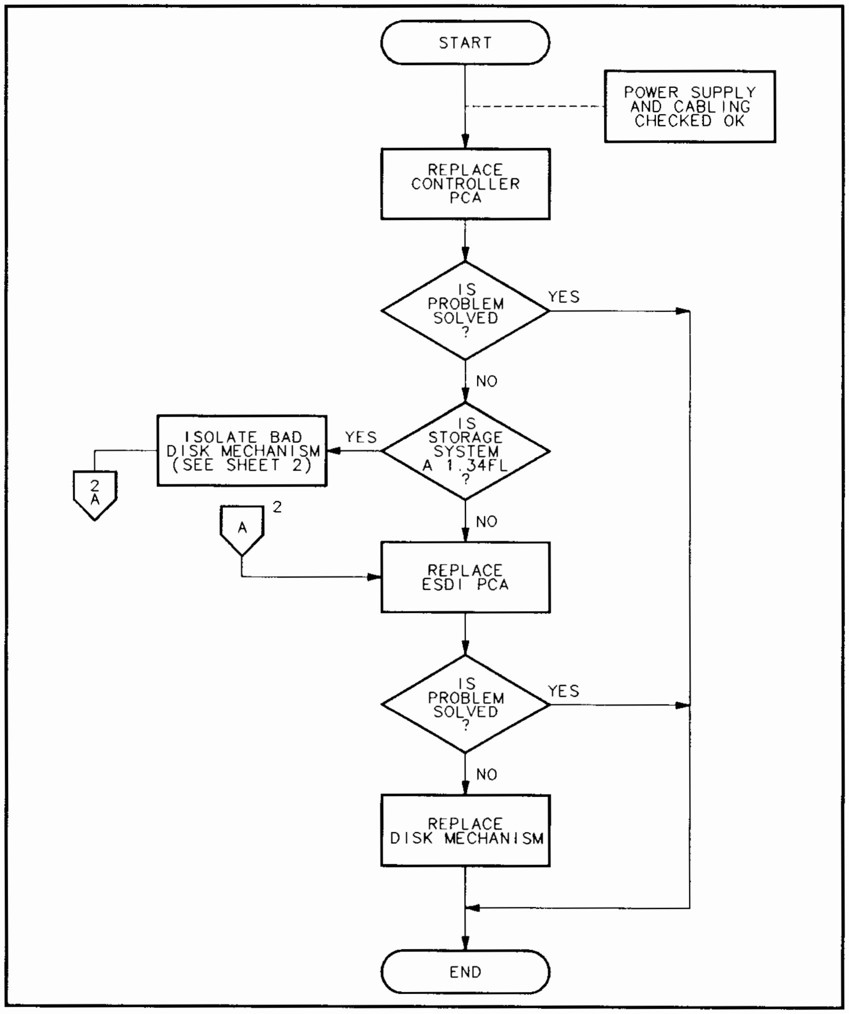


Figure 4-1. Troubleshooting Flowchart (Sheet 1)

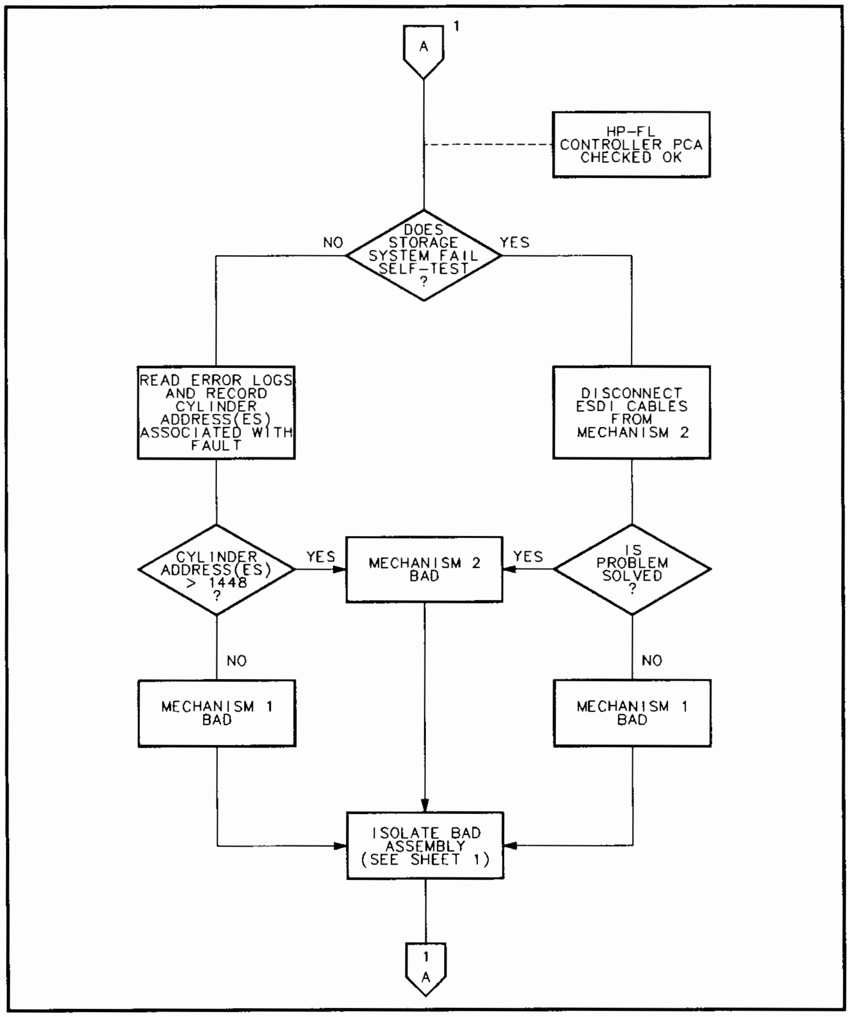


Figure 4-2. Troubleshooting Flowchart (Sheet 2)

Troubleshooting Intermittent Faults

As the name implies, an intermittent fault occurs randomly and cannot be duplicated easily. Such problems are difficult to isolate and repair. Because the disk storage system already appears to be working normally, it is difficult, if not impossible, to tell if replacing a particular assembly has corrected the problem. The only course of action is to replace the most suspect assembly and wait to see if the problem still occurs.

The contents of the error logs may provide important information in helping you determine which assembly to replace when troubleshooting intermittent failures. Using system level or off-line diagnostics, read the disk error logs and the host system logs. Record any DERROR codes entered in the logs.

Table 5-2 is a detailed error code list which relates each error code to a suspect hardware assembly. Locate the DERROR code(s), and note the suspect hardware identified in the table. This information should help you make the most correct choice on which assembly to replace.

Disk Mechanism Troubleshooting

The disk mechanism is the storage area for all user data. When a disk mechanism is replaced, the customer must perform the time-consuming process of restoring the data to the new disk mechanism. Consequently, thorough troubleshooting must be performed to avoid replacing a disk mechanism whenever possible.

Isolating a Defective ESDI PCA

The disk mechanism is made up of two separate assemblies: the ESDI PCA, and the head/disk assembly (HDA). The disk storage system's self-test diagnostic can isolate a problem to the disk mechanism, but cannot identify which of these two assemblies is defective.

Before replacing the entire disk mechanism, you must determine which assembly is defective. If the problem is isolated to the ESDI PCA, the PCA can be replaced separately, thus preserving the data on the HDA. If the problem is with the HDA, the entire disk mechanism must be replaced.

However, the entire disk mechanism should not be replaced until you have determined conclusively that the HDA is defective.

To isolate the defective disk mechanism assembly:

1. Remove the disk mechanism. Refer to chapter 8 for removal instructions.
2. Remove the ESDI PCA from the HDA.
3. Install a known good ESDI PCA on the HDA. Make sure the ESDI address on the good PCA is set to the same address as the suspect PCA.
4. Reinstall the disk mechanism.
5. Run the self-test diagnostic and check the results.

If the problem persists, the HDA is bad and the entire disk mechanism must be changed. The HDA cannot be replaced as a separate assembly.

Troubleshooting the Dual-Mechanism 1.34FL

When troubleshooting a disk mechanism problem on a dual-mechanism 1.34FL, your first step is to determine which of the disk mechanisms is at fault. The procedure for identifying the defective mechanism varies depending upon when the fault occurred.

Self-Test Failures

If the disk failure occurs during self-test, the failing mechanism can be quickly identified using the following procedure:

1. If you have not already done so, replace the HP-FL controller PCA to ensure it is not the cause of the problem.
2. Disconnect the ESDI data and control cables from disk mechanism 2.
3. Run self-test. If self-test passes, it indicates that mechanism 2 is causing the problem. If self-test still fails, the problem lies with disk mechanism 1. Once you have identified the faulty disk mechanism, use the techniques described in the preceding section to determine if the ESDI PCA is the problem.

Caution Do not change the ESDI address switch setting on a disk mechanism that has been removed from the disk storage system. If you do change the address, you may reinstall the mechanism in the wrong position. If the mechanisms are swapped with addresses that correspond to their new (incorrect) positions, self-test will pass and everything will appear to be OK. However, you have now swapped the address space, and data will be lost when the host attempts to access the disk storage system.

When reinstalling the disk mechanisms in a 1.34FL, make sure each mechanism is installed in its *original* position. If both disk mechanisms have been removed, check the ESDI address switch settings on each mechanism to determine its proper position. Figure 4-10 shows the relationship between the ESDI address and disk mechanism position. The controller PCA associates a specific ESDI address with each position. If the disk mechanisms are installed in the wrong positions, the self-test will fail with a disk mechanism fault.

Run-Time Failures

For problems that do not occur during self-test, the logical cylinder address associated with the fault or error can be used to determine which disk mechanism is involved. The HP-FL controller PCA uses the cylinder address field to select each disk mechanism. Cylinder addresses of 1448 or less indicate a problem with mechanism 1; a cylinder address greater than 1448 indicates a problem with mechanism 2. Refer to Media Addressing in Chapter 12 for a discussion on the addressing structure used on single- and dual-mechanism products.

Once the failing disk mechanism has been identified, you can use the Test Level diagnostic command to isolate the disk mechanism if you wish to troubleshoot further. The disk mechanism can now be handled as if it were a single-mechanism configuration.

Note

The FLEXDIAG diagnostic program allows testing a model 1.34FL at the unit (host) or mechanism level. When performing tests on an individual mechanism, the addressing structure is identical to that for a single-mechanism disk storage system. See Figure 10-6. To properly interpret addresses when testing a dual-mechanism disk storage system, you must remember whether the testing is being performed at the unit or mechanism level.

Checking the Power Supply

Warning

Use caution when checking the output of the power supply. With power applied, hazardous voltages are present inside the disk storage system.

If the power supply is suspect, the output voltages can be checked at any of the three connectors on the side of the power supply. The location for measuring the output voltages and their proper values are shown in Figure 4-11.

If the power supply output voltages are incorrect, check the following:

1. Input line voltage.
2. External fuse. Some disk storage systems are equipped with an automatic ranging power supply which is fused internally. It is not possible to check or replace the fuse on an automatic ranging power supply.
3. The external fan connection to the power supply. If the external fan is not connected to the power supply properly, one of the following will occur:
   a. On an automatic ranging power supply, all output voltages will be disabled if the external fan is not connected properly. To correct the problem, switch the disk storage system power off, connect the external fan, and switch the power on again.
   b. On a standard power supply, the internal cooling fan in the power supply is disabled if the external fan is not connected properly. This will cause the operating temperature of the power supply to rise. If the supply temperature rises too high, a thermal protection circuit shuts down the outputs of the power supply. If thermal shut down occurs, switch the supply off and connect the external fan. When the supply has cooled, it can be switched back on.

HP-FL Interface Troubleshooting

The following paragraphs discuss the special tools and techniques used to isolate problems on the HP-FL interface.

HP-FL Troubleshooting Tools

Two hardware assemblies are available for troubleshooting disk storage systems on the HP-FL interface.

- **PBus connector box, part no. 07937-60192.** Used in group installations to bypass a suspect disk storage system. This allows a disk storage system to be disconnected from the PBus for troubleshooting, while maintaining proper PBus cabling for the remaining disk storage systems in the group.
- **Fiber optic loopback cable, part no. HFBR-3020.** Used during diagnostics to connect the disk storage system fiber optic ports together. This cable must be installed to successfully perform the diagnostic routine invoked when segment 1 of the address switch is set to the diagnostic position.

Locating An HP-FL Cabling Problem

The first step in troubleshooting a problem on an HP-FL interface is to establish that the interface cabling is connected and operating properly. The HP-FL interface status LEDs provide a quick method for determining if the problem lies with the interface cabling.

- Check the two PBus fault LEDs on each disk storage system. If all PBus fault LEDs are off, it can be assumed that the PBus connections are not the problem. If any PBus fault LEDs are on, refer to Table 2-2 to interpret the display and correct the problem.
- Check the optical status LED on the disk storage system the fiber optic cable is connected to. If the LED is on, it can be assumed that the fiber optic cable is not the problem. If the LED is off, try moving the fiber optic cable to another disk storage system in the group. If the optical status LED on the second disk storage system remains off, the fiber optic cable may be defective.

Executing Diagnostic Mode Self-Test

If you suspect a problem with the HP-FL fiber optic interface, run the diagnostic mode self-test. The diagnostic mode self-test is initiated by setting segment 1 of the address switch to the diagnostic position. See Figure 2-9. A fiber optic loopback cable must be connected to execute this test.

The diagnostic mode self-test performs a series of HP-FL interface loopback tests, including a more rigorous test of the fiber optic interface. Data is written out the transmit port and then read back in the receive port. This checks all portions of the HP-FL fiber optic interface circuitry, including circuits not tested during the normal diagnostic.

If a fiber optic loopback cable is not connected to the disk storage system, the loopback test fails with a controller fault indication and the diagnostic mode self-test halts.

Isolating A Defective HP-FL Fiber Optic Cable

If symptoms point to the HP-FL fiber optic cable, the cable should be checked before replacing it. Detailed information on testing the fiber optic cable is contained in the host computer HP-FL interface documentation. Refer to this information to isolate a defective fiber optic cable.

Disconnecting a Disk Storage System From the HP-FL Interface

In some situations it may be desirable to isolate a suspect disk storage system from other disk storage systems connected to the same HP-FL interface. In such cases, the HP-FL interface cabling can be disconnected from the suspect disk storage system without turning off the other disk storage systems in the group. This allows a disk storage system to be serviced or removed with minimal impact on the host computer and the remaining disk storage systems in the group.

The fiber optic cable can be moved from a suspected bad disk storage system to another disk storage system in the group. The fiber optic cable can be connected to any disk storage system in the group, thus allowing the host computer to continue communicating with the remaining disk storage systems.

Note

Option 1BG FL-model disk storage systems do not include fiber optic circuits; the fiber optic cable cannot be connected to these disk storage systems.

The PBus can also be disconnected from the suspect disk storage system while the other disk storage systems are operating. The physical design of the PBus connectors ensures that a PBus cable or terminator can be removed without causing any data corruption.

When the fiber optic or PBus cabling is disconnected, any transaction in progress is aborted. When the cabling is reconnected, communication with the disk storage systems is reestablished and the host computer retries all pending transactions.

While the fiber optic cable or PBus cabling is disconnected, all disk storage systems in the group are inaccessible (off-line) to the host. The length of time the disk storage systems can remain off-line without disrupting the host is system dependent. Refer to the appropriate system documentation for information on system timeout values.

To avoid exceeding the host timeout value, the length of time the PBus is disconnected must be kept to a minimum. To reduce the amount of time the disk storage systems are off-line, use the following guidelines when disconnecting a disk storage system.

- If the suspect disk storage system is at one end of the PBus, identify the PBus cable linking the suspect disk storage system to the adjacent good disk storage system. Disconnect the PBus cable from the good disk storage system and install a PBus terminator in the vacant connector on the disk storage system.
- If the suspect disk storage system is not at one end of the PBus, disconnect both PBus cables from the suspect disk storage system and connect the cables to a PBus connector box. This bypasses the suspect disk storage system and maintains proper PBus cabling for the remaining disk storage systems in the group.

Self-Test

The self-test is executed at power-on or following a reset. The self-test can also be initiated externally using system-level diagnostics or the CS80DISK program. The controller PCA executes the diagnostic firmware routines, checking every facet of the disk storage system operation.

The disk mechanism also performs its own self-test routine during power on. When power is applied, the ESDI controller executes a series of tests to check the operation of the disk mechanism. If the disk mechanism self-test was successful, the controller PCA initiates additional tests on the disk mechanism to verify that everything is operating properly. The results of the self-test are passed to the status display.

Note

- When running self-test on a dual-mechanism 1.34FL, a failure on either disk mechanism will result in the same status display indication. Thus, you will be able to tell that a disk mechanism failure occurred, but not which mechanism was at fault. Refer to the Disk Mechanism Troubleshooting section in this chapter for information on isolating the failing disk mechanism.
- On drives with serial prefixes earlier than 3046, certain self-test failures are not indicated on the status display. When such a failure occurs, the status display indicates that the drive is ready. Drives with serial prefix 3046 and later have updated diagnostic firmware that corrects this problem. On these drives, *all* self-test failures are indicated on the status display.

  Although you should be aware of this problem, it is not serious enough to warrant a mandatory firmware update. The only situation in which you may want to consider updating the firmware is when troubleshooting a drive. The part numbers for the updated firmware are listed in Table 2-1. The firmware is located on the HP-IB or HP-FL controller PCA.

There are two self-test modes. The first is run-time mode, which is executed during normal operation of the disk storage system. The second, or diagnostic mode, performs the same tests as run-time but adds additional tests, including a rigorous test of the disk media. The diagnostic mode is only used when troubleshooting the disk storage system. The setting of the address switch, which is read by the disk storage system at power-on, determines which self-test mode will be executed.

Run-Time Mode Self-Test

When the disk storage system is powered-on or reset with the address switch set to its normal setting, the disk storage system executes the run-time self-test. The run-time self-test evaluates all aspects of disk storage system operation, including seeks, reads, writes, and controller interface operation. Following successful completion of the run-time self-test, the disk storage system comes on-line, ready to communicate with the host computer.

If a failure occurs during run-time self-test, the status display indicates which hardware assembly failed: the disk mechanism or the controller PCA. If the disk mechanism failed, it may still be possible to access the disk storage system to retrieve status and error information about the failure. If the controller PCA failed, it will not be possible to communicate with the disk storage system.

Diagnostic Mode Self-Test

The diagnostic self-test is selected by setting the address switch to a special diagnostic position before the disk storage system is powered-on or reset. When diagnostic mode is selected, the disk storage system begins the self-test with the same series of hardware tests performed during the run-time self-test. When these tests are complete, the disk storage system continues with additional tests, concluding with a series of read-only error rate tests (RO ERT).

The switch setting used to initiate diagnostic mode and the additional tests performed vary according to the model of disk storage system. The following paragraphs explain the test sequence for each model disk storage system.

Note

The address switch position used to select diagnostic self-test constitutes an illegal channel address. Consequently, as long as the address switch remains in the diagnostic position, the disk storage system remains off-line, inaccessible to the host computer. To exit diagnostic mode and bring the disk storage system back on-line, switch off disk storage system power, return the address switch to its normal position, and then switch power back on.

335H and 670H

On 335H and 670H disk storage systems, diagnostic mode self-test is selected by setting the HP-IB address switch to position 8. Following the normal hardware tests, the diagnostic performs a full-volume RO ERT (approximately 10 minutes) followed by a continuous loop of random RO ERTs.

670XP

The 670XP disk storage system executes two different test sequences depending on the position of the HP-IB address switch.

When the address switch is set to position 8, the disk storage system performs the same additional tests as an H-model disk storage system: a full-volume RO ERT (approximately 10 minutes) followed by a continuous loop of random RO ERTs.

Caution

The NVRAM should not be initialized for any conditions other than the two cited below. It is particularly important not to initialize the NVRAM following a loss of power to the disk storage system, whether due to power failure or when switching off power to service the disk storage system.

When power is removed from the disk storage system, the NVRAM may contain valid data which has not yet been written to the disk media. When power is restored, the disk storage system will transfer any valid data still in NVRAM to the disk media. However, if the address switch is set to 9 when power is restored, the disk storage system will initialize the NVRAM and any valid data will be lost.

When the HP-IB channel address is set to position 9, the disk storage system initializes the 4 kilobytes of write cache nonvolatile RAM (NVRAM) before beginning the RO ERT cycle. Initialization of the NVRAM should only be performed following the installation of the HP C2205A Cache Controller Upgrade Kit, or when installing a cache controller PCA containing new NVRAM. In these two situations it is desirable to clear the NVRAM of any data it might contain. If the NVRAM is not cleared, unwanted data may be written to the disk media at power-on.

670FL and 1.34FL

On 670FL and 1.34FL disk storage systems, the diagnostic mode self-test is selected by setting segment 1 of the address switch to the diagnostic position. A fiber optic loopback cable must be connected to the disk storage system before beginning diagnostic mode.

The additional diagnostic tests begin with a series of HP-FL interface loopback tests. This is a more rigorous test of the fiber optic interface. Data is written out the transmit port and then read back in the receive port. This checks all portions of the HP-FL fiber optic interface circuitry, including some not tested during the normal diagnostic. This test is useful in isolating problems in the controller fiber optic interface that may not be detected by the normal run-time self-test.

If a fiber optic loopback cable is not connected to the disk storage system, the loopback test fails with a controller fault indication and the self-test halts.

If the loopback tests are successful, the disk storage system continues with a full-volume RO ERT followed by a continuous loop of random RO ERTs. The full-volume RO ERT takes approximately 10 minutes for a model 670FL and approximately 20 minutes for the dual-mechanism 1.34FL.

Note

On Option 1BG FL-model disk storage systems, the HP-FL loopback tests are not performed during the diagnostic mode self-test.

Status Display

The activity and results of the self-test diagnostic are shown on the status display.

During execution of the run-time mode self-test, both status display LEDs flash. If the self-test is successful, the amber LED goes off and the green LED remains on. If a hardware failure occurs during the self-test, the status display is used to encode the failed hardware assembly.

When executing the diagnostic mode self-test, both LEDs in the status display flash. Both LEDs continue flashing as long as the disk storage system executes its RO ERT loop without detecting an error. If a data error is detected during the RO ERT portion of the diagnostic mode self-test, the green LED goes off and the amber LED remains flashing. If a hardware failure occurs, the status display is again used to encode the failed hardware assembly.

The significance of the LED patterns is summarized in Table 2-2.

Configuration Error LED

The amber configuration error LED on the rear of the FL-model products indicates a disk mechanism fault. If this LED is on, a disk mechanism fault was detected during self-test. The mechanism fault status passed to the configuration error LED is also passed to the front panel status LED display. Consequently, if a disk mechanism fault occurred, it will be displayed by both the configuration error LED and the front panel status display.

FRA Location and Layout

Caution

The disk mechanism and controller PCA in the disk storage system are very susceptible to electrostatic damage. Use the field service grounding kit (p/n 9300-1155) to reduce the risk of electrostatic damage when servicing the disk storage system. Store static sensitive assemblies in an anti-static bag immediately after removing them.

The locations of all FRAs within each model disk storage system are shown in Figure 4-3 through Figure 4-6. The layout and cable connections for each FRA are shown in Figure 4-7 through Figure 4-10.

Cabling

Before replacing any FRA, check all cabling inside the disk storage system for proper connections. The cabling for each model disk storage system is shown in Figure 4-12 through Figure 4-15.

Note

- On dual-mechanism 1.34FL model products, the ESDI data cables must be connected to the proper connectors on the controller PCA. Disk mechanism 1 must be connected to data port 1 (J3) on the HP-FL controller PCA, and disk mechanism 2 must be connected to data port 2 (J5). See Figure 4-15. If the connectors are inadvertently swapped, self-test will fail with a disk mechanism fault.
- The three connectors (J1 -J3) on the power supply provide identical outputs. The connectors can be used interchangeably.

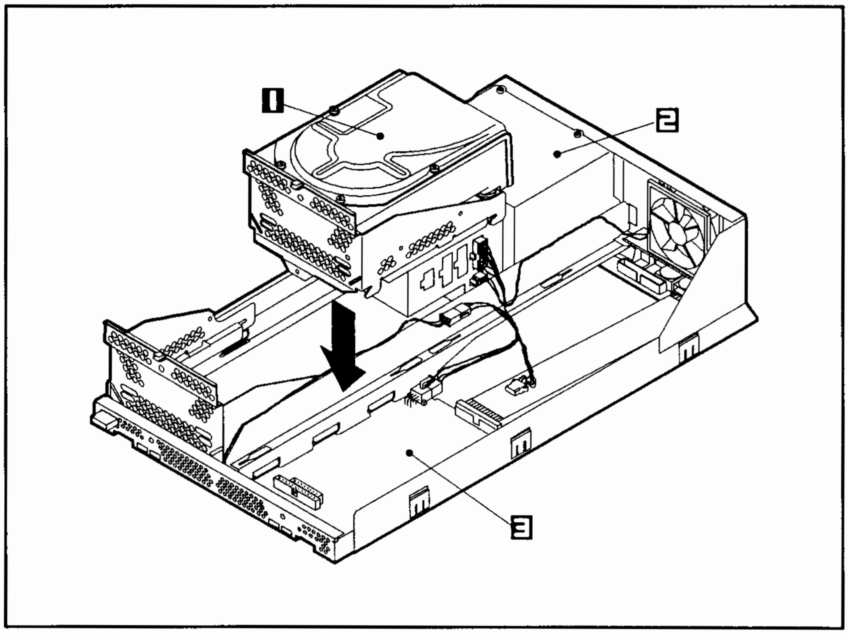


Figure 4-3. 335H and 670H FRA Locations

1. Disk mechanism
2. Power supply
3. HP-IB controller PCA

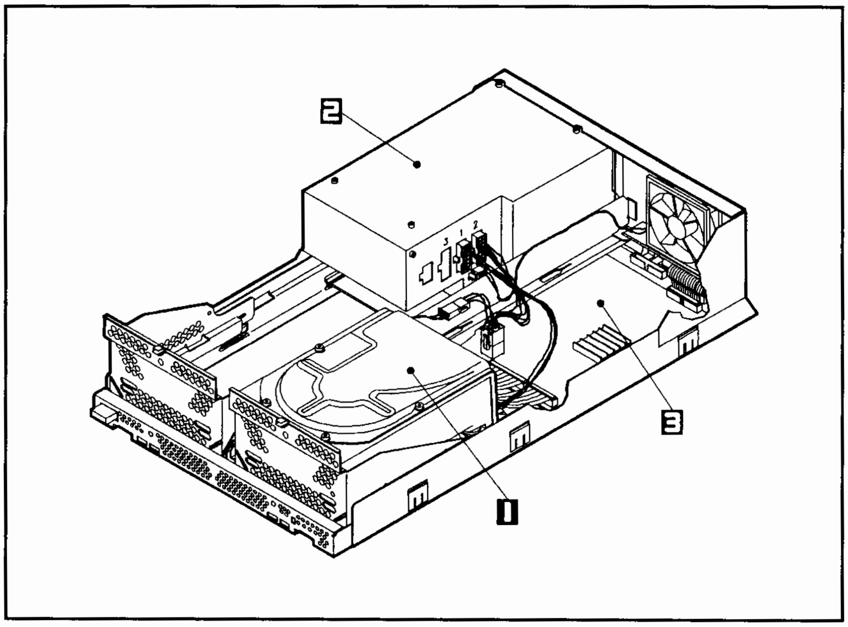


Figure 4-4. 670XP FRA Locations

1. Disk mechanism
2. Power supply
3. HP-IB cache controller PCA

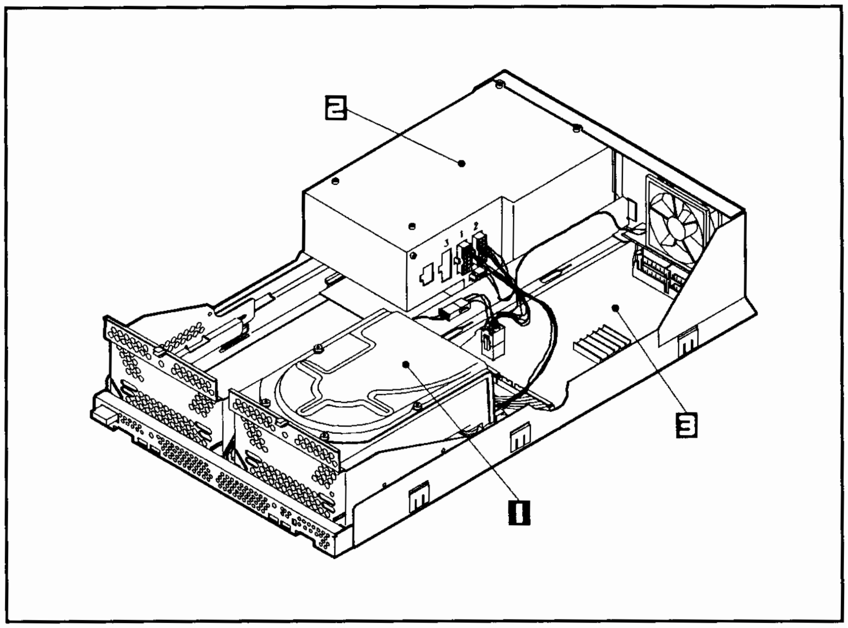


Figure 4-5. 670FL FRA Locations

1. Disk mechanism
2. Power supply
3. HP-FL controller PCA

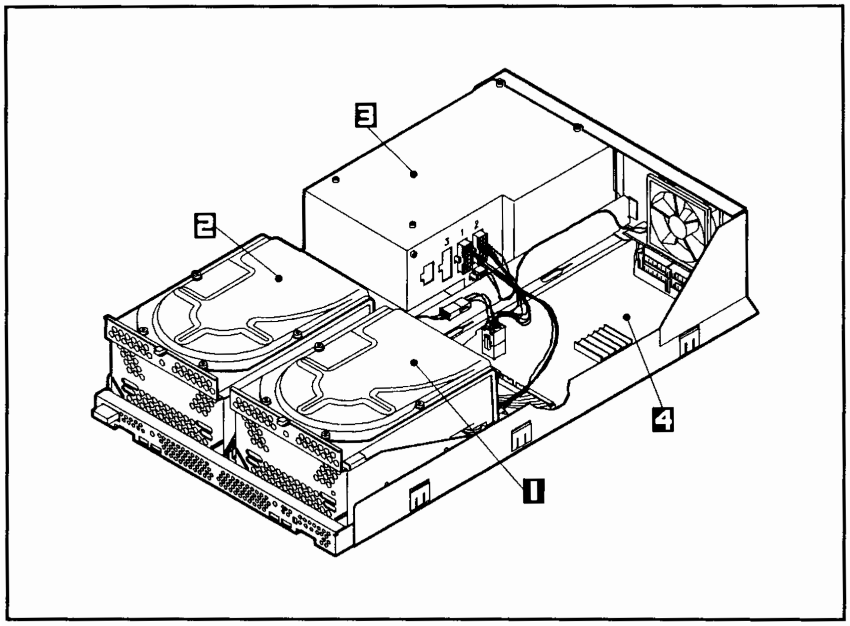


Figure 4-6. 1.34FL FRA Locations

1. Disk mechanism 1
2. Disk mechanism 2
3. Power supply
4. HP-FL controller PCA

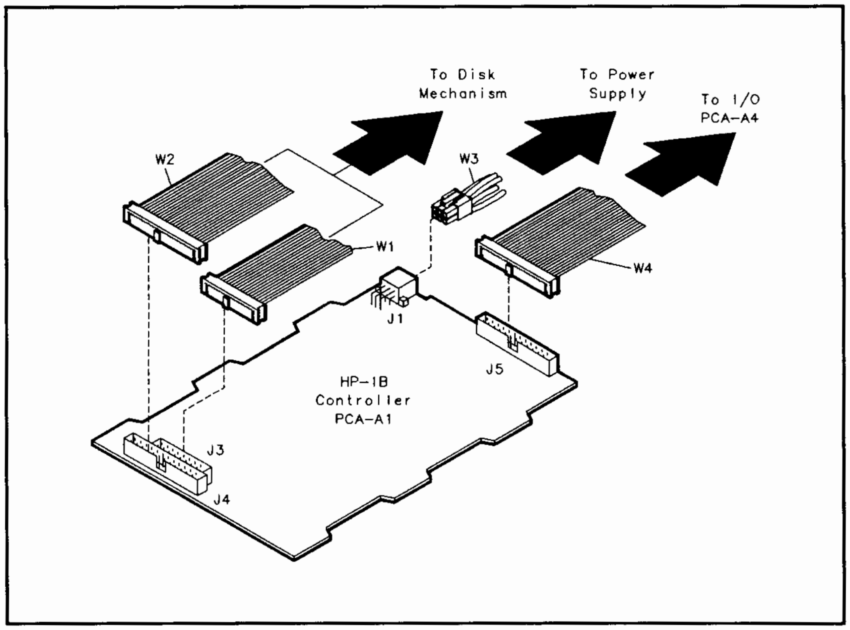


Figure 4-7. HP-IB Controller PCA Layout

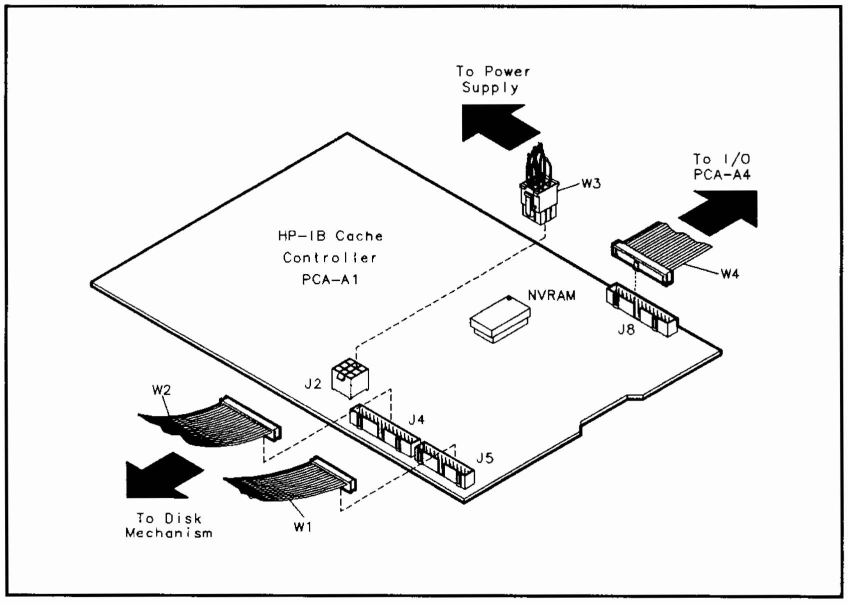


Figure 4-8. HP-IB Cache Controller PCA Layout

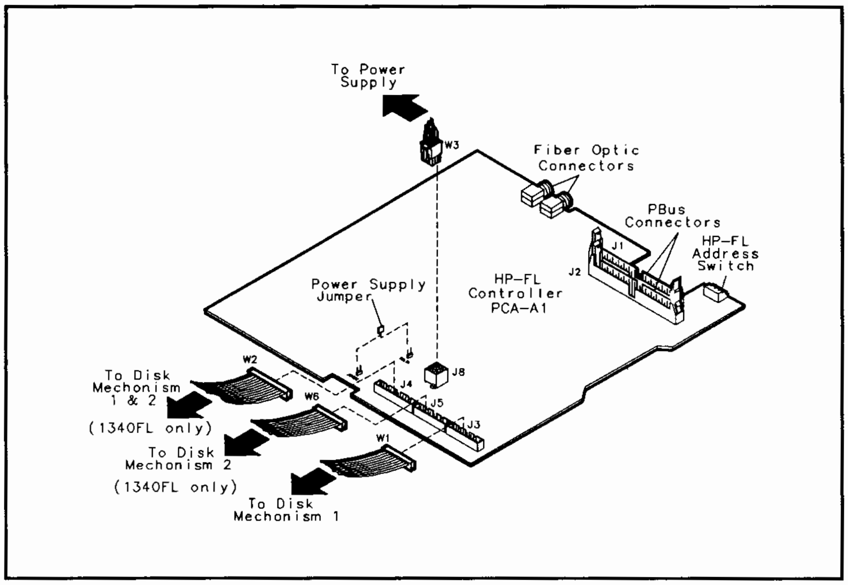
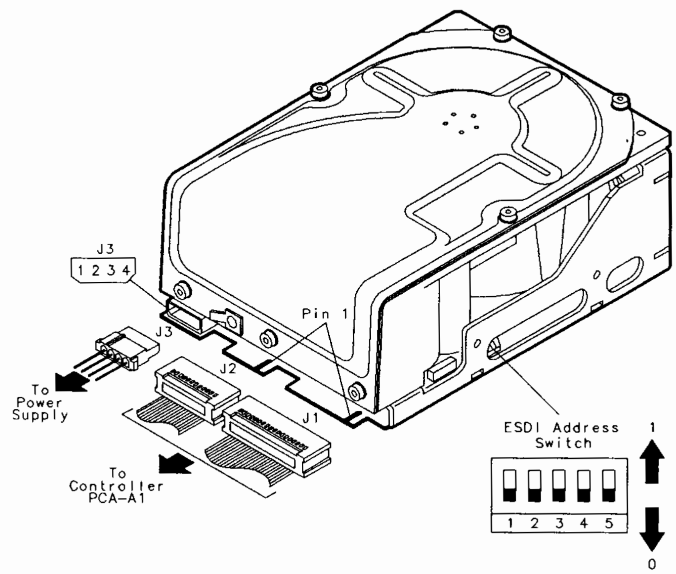


Figure 4-9. HP-FL Controller PCA Layout



ESDI Address Setting

Disk Mechanism	Switch Segments				
	1	2	3	4	5
1	0	0	0	0	1
2	0	0	0	1	0

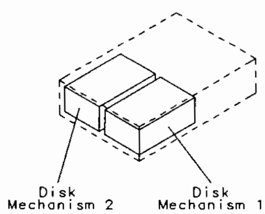
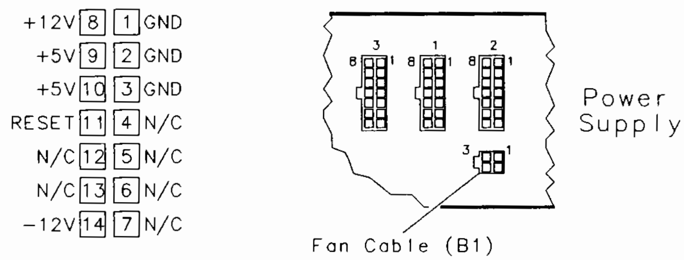


Figure 4-10. Disk Mechanism Layout



Voltage	Maximum	Minimum
+5.0	5.15	4.85
+12.0	12.6	11.4
-12.0	-11.4	-12.6

Figure 4-11. Power Supply Connector Pinout

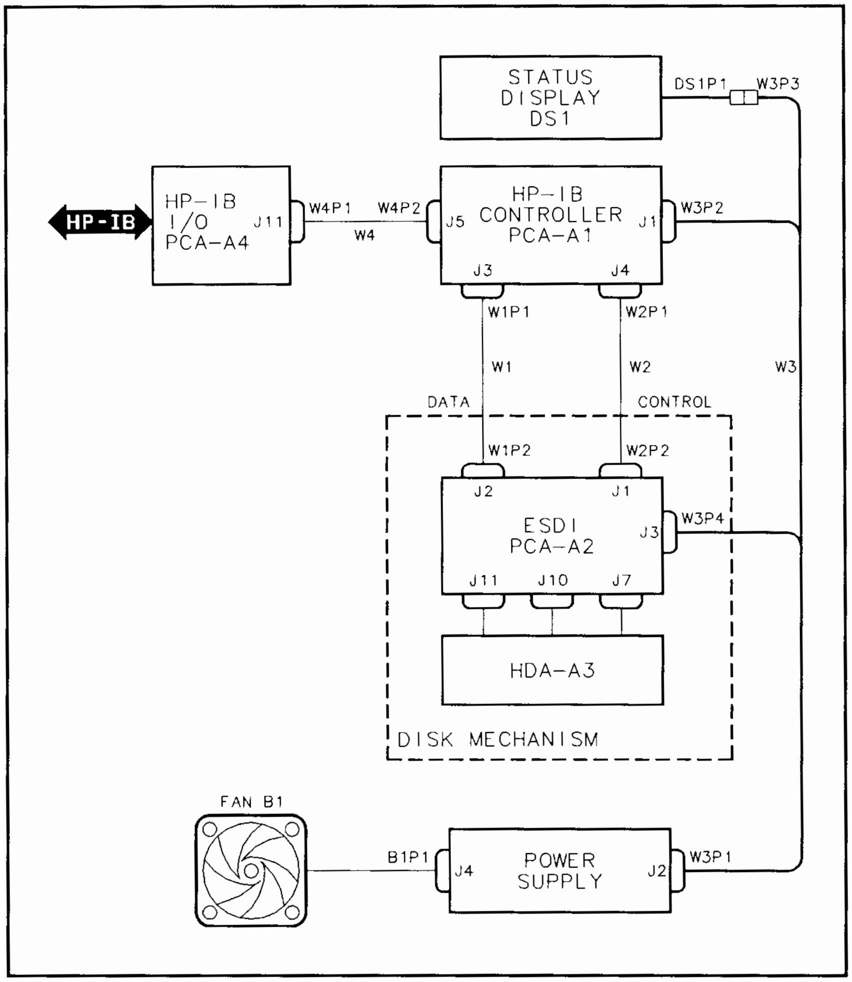


Figure 4-12. 335H and 670H Cabling

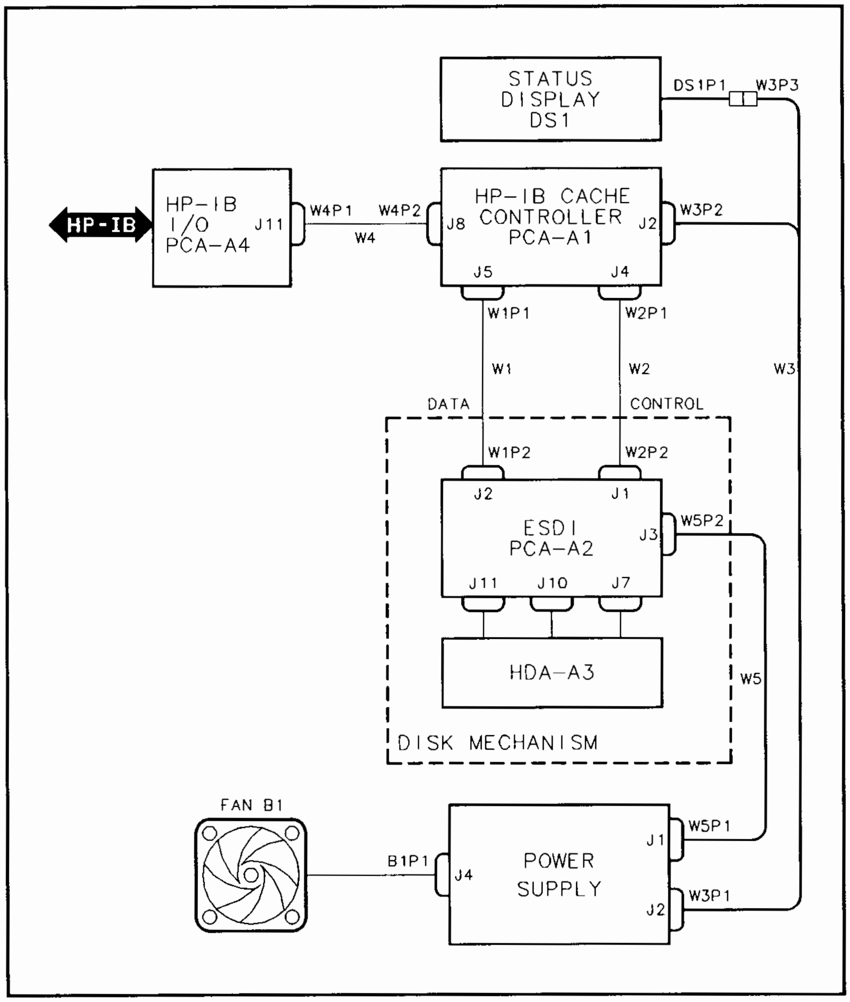


Figure 4-13. 670XP Cabling

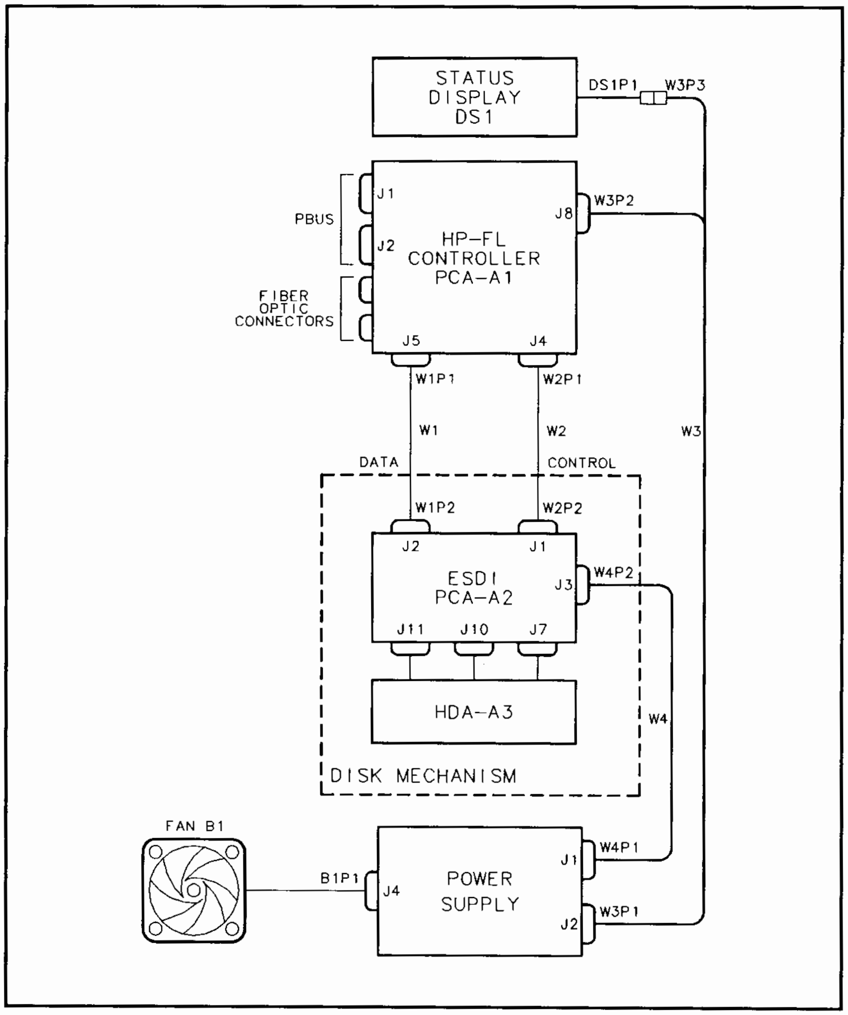


Figure 4-14. 670FL Cabling

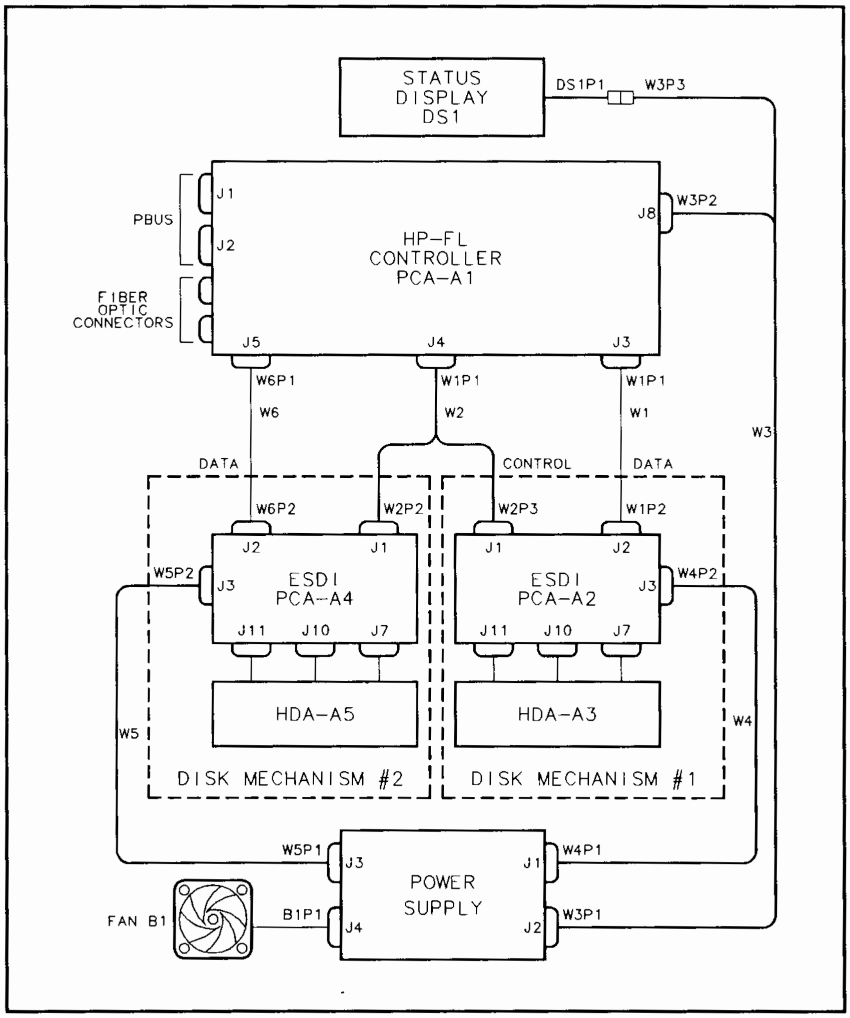


Figure 4-15. 1.34FL Cabling

5

Diagnostics

Introduction

For disk storage system problems that cannot be isolated by the power-on self-test, the CS80DISK diagnostic program provides additional troubleshooting capability. This chapter explains how the CS80DISK program can be used to isolate and correct disk storage system problems.

In addition to CS80DISK, there are also system-level diagnostic programs available for troubleshooting the disk storage system. Refer to the appropriate system diagnostic manual for information on using these system-level diagnostic programs.

CS80DISK Diagnostic Program

Note

FL-model disk storage systems are not supported by the CS80DISK program. The system-level diagnostic program FLEXDIAG is used to troubleshoot FL-model disk storage systems. Refer to the appropriate system documentation for information on running FLEXDIAG.

An important diagnostic tool for troubleshooting and isolating disk storage system failures is the CS80DISK program, which acts as an interpreter linking the disk storage system internal diagnostic utilities to a service-trained person.

CS80DISK can be used to test the disk storage system hardware by selectively initiating desired portions of the self-test diagnostic. The diagnostic results can then be retrieved and analyzed to aid in isolating the problem.

Media integrity can be established and maintained using the CS80DISK program. Error rate tests (ERTs) are used to identify areas of defective media. When defective media is located, sparing operations are performed to move the data to another area of the media. It is possible to reformat the entire disk media using initialization routines.

CS80DISK provides access to the disk storage system fault and error logs. Accessing and interpreting the contents of these logs is vital in isolating disk storage system problems. The content and structure of these logs is covered in detail later in this chapter. The CS/80 status message returned when using CS80DISK also provides valuable information about disk problems.

All CS80DISK commands supported by the disk storage system, including any product-specific information, are listed in Table 5-1. For detailed information about the operation of the external exerciser program, refer to the *CS80DISK Diagnostic Reference Manual,* part no. 5960-0153.

Table 5-1. CS80DISK Commands

COMMAND	DETAILS
BATCH	No device-specific information.
CACHEOFF	Model 670XP only. Turns off both read cache and write cache.
CACHEON	Model 670XP only. Turns both read cache and write cache on.
CACHE LOG	Model 670XP only. Returns number of correctable and uncorrectable data errors detected during power-on diagnostic. Correctable errors are defined as a single-bit error in a byte of the cache memory. An uncorrectable error is a double-bit error in a byte of cache memory.
CACHE STATS	Model 670XP only. Returns read cache and write cache statistics.
CANCEL	No device-specific information.
CHANNEL	No device-specific information.
CICLEAR	No device-specific information.
CLEAR LOGS	When clearing disk logs, all associated entries currently in RAM are also cleared. Used to clear the cache log on model 670XP disk storage systems.
CONFIGURE	No device-specific information.

Table 5-1. CS80DISK Commands (continued)

COMMAND	DETAILS
DESCRIBE	The disk storage system returns the following information: Model: 2200, 2202, or 2203 Unit: 0 Type: DISK Max Cylinder Address: 1448 Max Head Address: 7 (2200) 15 (2202/2203) Max Sector Address: 112 Max Block Address: 1,309,895 (2200) 2,619,791 (2202/2203) Current Interleave: 1
DEVICE	No device-specific information.
DIAG	H-model disk storage systems execute only the power-on diagnostic (number 0). The duration of the diagnostic is approximately 40 seconds. The 670XP executes two diagnostics: diagnostic 0 performs the power-on self-test but does not test cache memory. Diagnostic 1 adds the cache memory test to the routines performed by diagnostic 0. The times for diagnostics 0 and 1 are approximately 40 seconds and 60 seconds, respectively.
ERT LOG	Each head returns up to 106 entries. The format for the Error Code Byte returned with each log entry is shown in Figure 5-1.
EXIT	No device-specific information.

Table 5-1. CS80DISK Commands (continued)

COMMAND	DETAILS
FAULT LOG	The disk fault log contains up to 44 entries, is not read destructive, and upon being read may include up to 30 entries contained in controller RAM. TERROR/DERROR codes returned can be decoded using Table 5-2. The Hardware Fault Register (HFR) bits are decoded as follows: BIT ERROR 0 Spindle speed error (ESDI) 1 Data path fault (Ctrl) 2 Seek fault (ESDI) 3 Write protect (ESDI) 4 Write fault (ESDI) 5 Command/status ESDI fault 6 Command/status ctrl fault 7 Data clock fault (Ctrl) The significance of the Activity Number field is defined as follows: ACTIVITY NUMBER — NUMBER OF SEEKS 0 none 1-4 1-4 5 5 to 7 (1 second) 6 8 to 200 (1-30 seconds) 7 201 to 2,000 (30 seconds-5 minutes) 8 2,001 to 12,000 (5-30 minutes) 9 12,001 to 25,000 (30-60 minutes) 10 25,000 to 150,000 (1-6 hours) 11 150,000 to 600,000 (6-24 hours) 12 600,000 to 4,000,000 (1-7 days) 13 4,000,000 to 16,000,000 (1-4 weeks) 14 16,000,000 to 100,000,000 (1-6 months) 15 >100,000,000 (>6 months)

Table 5-1. CS80DISK Commands (continued)

COMMAND	DETAILS
HELP	No device-specific information.
INIT MEDIA	This utility destroys all user data. When executed, a format data pattern (22 hex) is written in the data field of all of the user sectors, and all preambles and postambles are rewritten. The postamble reflects a CRC/ECC pattern matching the header pattern plus format pattern. Options allow the user to retain only primary spares (P), retain primary and secondary spares (A), or initialize only the maintenance tracks (M). All disk logs are cleared when performing an INIT MEDIA operation.
PRESET	No device-specific information.
PROCESS	No device-specific information.
READ	No device-specific information.
READCACHEOFF	Model 670XP only. Turns off read cache. Write cache must be disabled first.
READCACHEON	Model 670XP only. Turns on read cache.
RF SECTOR	Returns all of the data in a sector including the 6 header bytes, 2 CRC bytes, and 12 ECC bytes. The sector address value used when executing this command represents a *physical* sector address. If the track on which the specified sector resides has undergone a sparing operation, the logical and physical sector addresses may not correspond.

Table 5-1. CS80DISK Commands (continued)

COMMAND	DETAILS
REQSTAT	Field replaceable assemblies (FRA) are coded as follows: 0 = none (unable to isolate assembly) 1 = Controller PCA 2 = ESDI PCA or Disk mechanism 3 = Power supply
RESET STATS	Clears cache table on the 670XP.
REV	No device-specific information.
RO ERT	Retrys are not performed during an ERT. No offset is allowed when performing an ERT. The format for the printed error information is defined in the details for the ERT LOG command.
RUN LOG	Each head returns up to 106 entries. The format for the Error Code Byte returned with each log entry is shown in Figure 5-2.
SDCLEAR	No device-specific information.
SERVO TEST	No device-specific information.
SPARE	**WARNING:** The SPARE command will cause some data loss. All attempts should be made to retain the data before the SPARE command is used.

Table 5-1. CS80DISK Commands (continued)

COMMAND	DETAILS
SPARE TABLE	The spare table is generated at power-on and stored in controller RAM. Any spares added since power-on are included in the table. Because the spare table is volatile, the disk storage system always returns zero as the "number of secondary spares" value, and as a result the secondary spares are not printed.
TABLES	All disk storage systems support the spare track table.
UNIT	The disk storage system is addressed as unit 0. The controller is individually addressable as unit 15.
UNIVERSAL CLEAR	No device-specific information.
VERSION	No device-specific information.
WRITECACHEOFF	Model 670XP only. Turns off write cache.
WRITECACHEON	Model 670XP only. Turns on write cache. Read cache must be on to enable write cache.
WRT ERT	No offset is allowed when performing a WTR ERT. The format for the printed error information is defined in the details for the ERT LOG command.

Error Logs

The disk storage system maintains three internal logs used to record error information. The contents of these logs is accessed using system-level diagnostics or the CS80DISK program. The logs reside on the disk storage system maintenance tracks. The physical locations of the maintenance tracks on the disk media are shown in Figure 10-6.

The logs contain valuable information for troubleshooting the disk storage system. It is important that you know what information each log contains and how to accurately interpret the information. This will help you quickly determine which logs to read and how to use the log contents to identify problems.

Note

When using the FLEXDIAG diagnostic program to read the logs on a model 1.34FL disk storage system, the logs for both mechanisms are returned when operating at the unit level. When operating at the mechanism level, only the logs for the currently selected mechanism are returned.

The disk storage system uses the ERT log and run-time log to record data errors, and the fault log to record other types of problems.

ERT Log

This log contains data errors detected during an error rate test (ERT). A separate ERT log is maintained for each data head. Each ERT log can accommodate up to 106 entries: 5 in controller RAM, and 101 on the outer-diameter (OD) maintenance track on the disk media.

ERT data errors are initially entered in controller RAM. The entries are transferred from RAM to the disk media after five data errors have accumulated, or at the conclusion of an ERT. Both RAM and disk media entries are returned when the ERT log is read.

During an ERT, retrys are not attempted to recover data. Thus, only two types of data errors are recorded in the ERT log: correctables, which the ECC was able to correct; and uncorrectables, which the ECC was unable to correct.

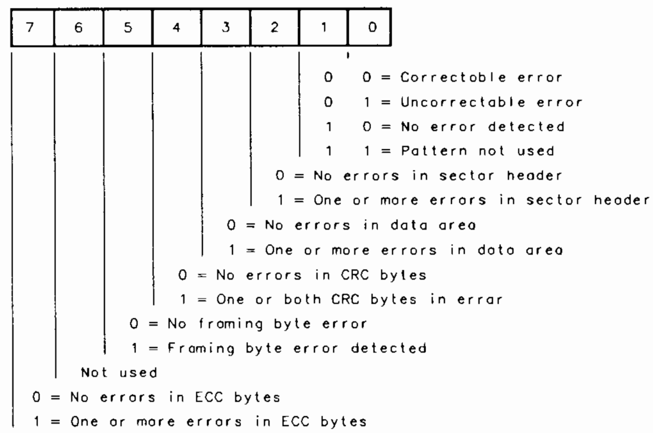
The structure of each ERT log includes a header followed by individual data error entries. The log header includes data error counters, which are incremented for each error, even if the error occurs repeatedly on the same sector. The ERT log header includes the following information:

- Total number of data error entries in the log.
- Number of sectors transferred by the corresponding head.
- Number of correctable data errors.
- Number of uncorrectable data errors.

Following the header information, there is an entry for each sector that experienced one or more errors during the ERT. If there were multiple errors on the same sector, the information in the Error Code Byte represents an accumulation of the various types of errors that occurred.

Each ERT data error entry includes the following information:

- Logical 3-vector address (cylinder, head, and sector) of the sector experiencing the error.
- Error Code Byte. This byte is defined in Figure 5-1.
- Error type (correctable or uncorrectable).
- Occurrence count indicating the number of times the sector experienced a data error.



* A parity error in the ERT log does not necessarily result in a data error. This bit can only be set if enabled during an ERT executed using an early version of the external exerciser. If the parity option is included, it should be set to "DISABLE" when running an ERT. This "parity" option is not included in later versions of the exerciser.

Figure 5-1. Contents of ERT Error Code Byte

Run-Time Log

The run-time log contains data errors detected during routine operation of the disk storage system, not during testing. The structure and handling of the run-time log is identical to that of the ERT log. However, there are important differences in the significance of some of the data fields. These differences are summarized below:

- The "number of correctable data errors" field in the run-time log header indicates the number of times a single retry was required to recover data. Data errors corrected solely by ECC (no retry required) are ignored. Although counted in the log header, correctable error addresses are *not* entered in the run-time log.
- The "number of uncorrectable data errors" field in the run-time log header indicates the number of times two or more retrys were required to recover data. Whether or not the data was ultimately recovered is indicated by the Error Code Byte in the data error entry. All uncorrectable data error addresses are entered in the run-time log.
- The run-time log data error entries include only *uncorrectable* errors. The significance of the Error Code Byte returned with each run-time log entry is shown in Figure 5-2.

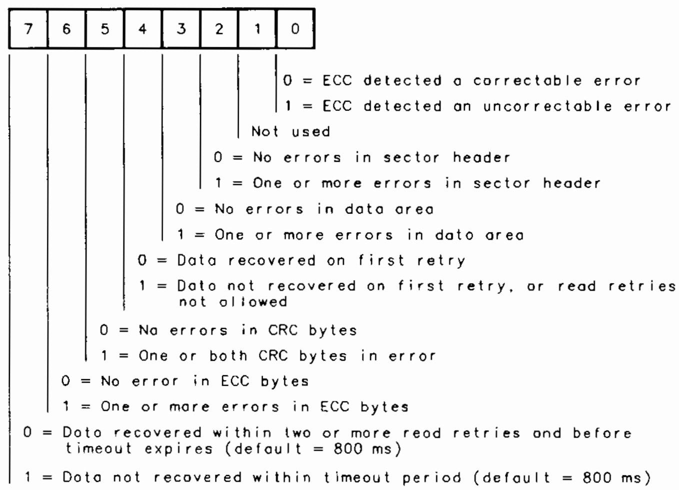


Figure 5-2. Contents of Run-Time Error Code Byte

Fault Log

All abnormal conditions that occur during operation of the disk storage system, excluding data errors, are recorded in the fault log. The disk storage system maintains a single fault log that can accommodate up to 74 entries: 30 in controller RAM, and 44 on the outside-diameter maintenance track on surface 0 of the disk media.

Fault log entries are initially entered in controller RAM and then periodically transferred to the disk media. Both RAM and disk media entries are returned when the fault log is read.

The entries in the fault log are divided into two categories: events and faults. The distinction between an event and a fault is related to their impact on command execution. An event is a condition from which the disk storage system can recover and still complete the current transaction. Events are retried by the disk storage system in an attempt to continue the transaction. A fault is a condition that causes the current transaction to terminate. A fault represents a situation from which the disk storage system cannot recover, consequently the failed operation is not retried.

During routine operation of the disk storage system, all faults are entered in the fault log. In addition, up to five events associated with each fault are also entered. Events that are retried successfully and do not lead to a fault are not entered in the fault log. For example, if an offtrack condition (an event) is detected, the disk storage system attempts to reposition the heads back on track. If the attempt is successful, the offtrack event is not entered in the fault log. However, if the disk storage system tries repeatedly without success to properly position the heads, the operation is terminated and a servo fault is entered in the fault log. Up to five of the offtrack events associated with the fault are also entered.

When executing an ERT, the fault log entries are handled differently. During an ERT, *all* events and faults that occur are entered in the fault log. An event does not have to be associated with a fault to be entered during an ERT.

Each entry in the fault log contains the following information:

- Current 3-vector address (cylinder, head, and sector). This is the last address at which the disk storage system was able to successfully position the data heads.
- Target address (cylinder, head, and sector). This is the address the disk storage system was attempting to access when the error occurred.
- Hardware Fault Register. This byte is a collection of status bits from the controller PCA and the disk mechanism. The purpose of this register is to provide additional information when a fault in the data path occurs. The significance of the individual register bits is defined in Table 5-1.
- Error Code. This is the TERROR/DERROR. Error codes are discussed in the following section and listed in Table 5-2.
- Activity Number. This number represents the number of seeks that occurred between faults. The range of seeks represented by each number is listed in Table 5-1. The time values included in the table are approximations of the time that would have elapsed between faults if the disk storage system was operating on a "typical" host system under "normal" activity.

Error Codes

The disk storage system encodes internal error conditions into 2-digit error codes. These codes, which are entered in both the disk storage system CS/80 status bytes and the fault log, can be retrieved using system-level diagnostics or the CS80DISK program.

A complete list of the error codes is contained in Table 5-2. The table lists each error code in both decimal and hexadecimal format. If the error applies only to a specific controller PCA, the affected controller is indicated. The error code is followed by a description which also identifies each error as a fault or event. Errors which could cause data corruption are identified.

The table includes a list of assemblies most likely to cause the associated error. The suspect assemblies are listed in order of descending probability. In some cases a corrective action rather than an assembly is indicated.

Note

When the the suspect assembly is identified as "ESDI PCA or disk mechanism", the ESDI should be replaced first, followed by the entire disk mechanism. For information on isolating disk mechanism failures, refer to "Disk Mechanism Troubleshooting" in Chapter 4.

The disk storage system errors are divided into two categories: test errors (TERROR) and disk system errors (DERROR). The classification of each error is determined by when the error occurred.

TERRORS

A TERROR is an error that occurs during execution of the disk storage system internal self-test diagnostic. When retrieving disk storage system status following a self-test diagnostic failure, each TERROR will be accompanied by a field replaceable assembly (FRA) code. The FRA code identifies the most likely cause of the failure. The FRA codes correspond to the disk storage system hardware assemblies as follows:

FRA	ASSEMBLY
0	None - disk storage system is unable to isolate assembly
1	Controller PCA
2	ESDI PCA or disk mechanism
3	Power supply

DERRORS

An error that occurs during any disk storage system activity other than the self-test diagnostic is classified as a DERROR. The DERROR code defines a specific malfunction that occurred during routine disk storage system operation. If the same malfunction occurred during the self-test diagnostic, it would be classified as a TERROR; consequently, certain error codes may fall into either category.

Data Errors

All data read from the disk media is checked for errors before being transferred to the host. When an error is detected, the disk storage system attempts to correct the data using two techniques: error correction code (ECC) and read retrys.

The first attempt at data correction is made using the ECC included in each sector. If the high-speed ECC circuits can correct the data, the transfer of data to the host is not interrupted.

If the data cannot be corrected using ECC, the disk storage system begins read retrys to recover the data. The disk storage system performs up to 40 read retrys in an attempt to recover the data. If the data cannot be recovered within the 40-retry limit, the data is declared unrecoverable.

Note During an ERT, read retrys are not implemented. Only ECC is used to correct errors detected during an ERT.

Data Error Classifications

Data errors fall into one of four different classifications, depending upon the action required to correct the data:

- Correctable - an error that was corrected using only ECC.
- Uncorrectable - an error that could not be corrected using only ECC. During routine operation, the disk storage system will automatically begin read retrys if the error is uncorrectable. However, during an ERT the disk storage system does not perform read retrys, so the error remains uncorrectable.
- Recoverable - an error that was corrected using one or more read retrys.
- Unrecoverable - an error that could not be corrected within the limit of 40 read retrys.

Data Error Troubleshooting

The first step in determining the cause of data errors is to identify the nature of the data error. Read the contents of the ERT log and run time log and analyze the information. The formats for both logs are discussed earlier in this chapter. The exact interpretation of these logs differs, so make sure you remember which log you are reading when you examine the data.

The next step is to determine whether the error is "hard" or "soft". Hard errors are repeatable at a given address and indicate a media defect or a sector that was written improperly. Soft errors occur randomly and are much less severe because they do not result in data loss. In fact, soft errors may be ignored if they occur infrequently.

After noting the error entries, a Read-Only (RO) ERT should be performed on, and possibly around, the suspect sector(s). The results of the ERT should then be compared with the original log entries to determine if the error is hard or soft. In the latter case, the error may be gone.

If the error is hard, it may indicate a media defect that must be spared. This can be determined by performing a Write-Then-Read (WTR) ERT on the suspect media. This test will destroy any data on the tested portion of the media, so back up any required data before proceeding. If the WTR ERT reveals that the defect is still present, then the media is most likely at fault and a sparing operation should be performed.

If a hard error disappears after performing the WTR ERT, the media is not likely at fault, and suspicion shifts to the mechanism electronics. Frequent soft errors may also indicate a problem with the electronics.

Another source of soft errors is problems with the disk storage system environment. Do not overlook possible problems with primary input power, or RFI and ESD levels.

Table 5-2.

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
3/3	SERVO TIMEOUT. (Event) The servo system did not respond to a command before the expiration of the watchdog timer on the controller PCA. When a command is sent to the servo system by the controller, a timer is started to monitor the time taken by the servo system to complete the command. This error is reported if the timer expires before the servo system responds. For most cases the time allotted is the maximum allowed time for the servo to complete the command. However, for some commands a lesser time value is used if there is a limited time available to complete the command. For example, during fault recovery, a transaction is time limited by the channel timer monitoring retry time and access time.	1.Internal cabling 2.ESDI PCA or disk mechanism 3.Controller PCA
4/4	INVALID CONTROLLER EVENT. (Fault) An invalid executive program event value was detected during the execution of a controller program task. The executive program will signal the occurrence of an event to a task program using an enumerated value representing the event. This error indicates that a task program detected an event value that it did not recognize.	1.No action required unless error is recurring. 2.Controller PCA

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
5/5 (HP-IB)	CHANNEL TIMEOUT. (Fault) The channel program has aborted a transaction because the channel byte timer has expired. During the execution message of a transaction a timer is kept that monitors the duration that has expired since the channel has become impeded and unable to transfer data. This occurs when the disk program is unable to sink or source data by accessing the media, such as during fault recovery. The duration of the channel byte timer is specified by the CS80 Retry Time complementary value programmed by the host. For simplicity in implementation the timer also specifies the Access Time defined under CS80 protocol.	1.Interface cabling 2.Host computer 3.Controller PCA
7/7[1]	MARGINAL DATA. Data was recovered with difficulty. This is a status condition and should not be entered in the drive logs.	1.Sparing advised.
8/8[1]	UNRECOVERABLE DATA. (Fault). Data at the specified block address was unrecoverable. During a disk read a block of data was determined to contain uncorrectable data errors during at least one read attempt of the data. The actual number of read attempts is determined by the available retry time as programmed by the host. Read retries are attempted as long as sufficient time is available to accomplish the retry.	Refer to data error troubleshooting.
9/9[1]	UNRECOVERABLE DATA OVERFLOW. (Fault). The previous transaction contained more than one unrecoverable data block.	1.Sparing advised.

[1]Error could involve data corruption.

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
B/11[1]	UNRECOVERABLE DATA DURING VERIFY. (Fault). During the previous Locate And Verify command at least one block of data was unrecoverable.	1.Sparing advised.
17/23	BAD SPARE AT POWER-ON. (Fault) During the power-on sequence, the mapping of a spare track could not be determined. During power on initialization the disk storage system attempts to read the tracks reserved on the media for spare tracks to determine the address information on them. In this manner the spare track address mapping table is reconstructed. If one of the tracks reserved for spares cannot be read, the reconstruction of the spare table is incomplete and an address ambiguity may exist. This error is reported to indicate this failure. NOTE: This error will cause the controller to write protect the unit.	1.Perform logical reformat of media. 2.ESDI PCA or disk mechanism
18/24	BAD SECTOR MARK TIMER. (Fault) During power-on diagnostics, the signal timer in the controller was unable to interrupt or count correctly.	1.Internal cabling 2.ESDI PCA or disk mechanism 3. Controller PCA
19/25	SERVO RECALIBRATE TIMEOUT. (Event) While monitoring a servo recalibration command, the watchdog timer on the controller PCA expired before the servo system responded with command status. This may occur if the servo system takes longer than the Retry Time specified for this disk storage system during recalibration.	1.No action required unless error is recurring. 2.ESDI PCA or disk mechanism

[1] Error could involve data corruption.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
1A/26	SERVO RECALIBRATE FAULT. (Fault) Too many error events occurred during attempts to recalibrate the servo, or insufficient channel time was available to start servo recalibration. During fault recovery multiple attempts are made to recalibrate the servo system, provided there is sufficient time to do so. If an attempt fails because of a hardware event, the event is logged and additional attempts are made. This error is logged when no further recovery attempts are made.	1.No action required unless error is recurring. 2.ESDI PCA or disk mechanism
1B/27	ILLEGAL PRIMARY SPARE. (Fault). Secondary (field) track sparing has already occurred on this unit, which prevents the primary (factory) spare command from being executed. The spare algorithm on this product assumes a specific allocation sequence for the spare tracks when determining the current address mapping of the unit. It is necessary to require that all primary (factory) track spare mapping occurs prior to any secondary (field) spare track remapping in order to retain correct address remapping. Should there be any secondary track mapping at the time a Spare Block command is issued (with the Primary option) the command will fail with this DERROR. In the factory, it is possible that this condition may result because of maintenance/log track auto-sparing. To clear this condition, the Initialize Media command (using Retain No Spares option) should be issued (possibly re-issued).	1.No action required.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
1C/28	POSSIBLE SPARE LOSS. (Fault). During an Initialize Media command, the spare information on a track could not be recovered. Default spare status was used, meaning the possible loss of previous spare address mapping. The Initialize Media command (retaining all spares or retaining primary spares options) will read and write each track to obtain the spare and allocation status of the track. Should this information be irretrievable, the default status is used. This means that locations that were once spared may not be spared. This DERROR is logged as a warning so that appropriate action may be taken; that is, an error rate test of the offending track.	1.Run ERT on suspect track.
1D/29	TRACK MAP ERROR. (Fault). A spare track address remapping was not verified. During an Initialize Media command or a Spare Block command, spare tracks are rewritten to show they are: (1) unused, (2) in use, or (3) retired. If unable to verify that the track remapping from one of these states to another state is successful, then the current internal address mapping of the disk storage system (as seen by the controller) MAY not be consistent with the actual mapping of the tracks. This inconsistency could lead to future data loss if not resolved. It should NOT be considered a fatal error and may not indicate a broken disk storage system - this error is provided as a means of data recovery.	1.No action required.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
1D/29 (cont)	If this error occurs during a Spare Block command while using the Retain No Data option, the disk storage system can be safely power-cycled or cleared in an attempt to reset the address map. If this is successful, no adverse affects should remain; however, the success or failure of the Spare Block command that led to the error is not known. If this error should occur during a Spare Block command while using the Retain Data option, the possibility of loss of data exists. The operator should immediately backup the device WITHOUT clearing or power-cycling to save the data on the track containing the target block address of the Spare Block command. After the data has been successfully backed up, the disk storage system may be reset or cleared to reset the address map. Should this error occur during an Initialize Media command, there will be no loss of data. However, the disk storage system should be power-cycled or cleared, and the Initialize Media command repeated.	
1E/30	BAD SPARE OR MAINTENANCE TRACK. (Fault). During an Initialize Media retaining spares, the controller was unable to verify any sector on a spare track or maintenance track.	1.Repeat Initialize Media command. No action required unless error recurs. 2.ESDI PCA or disk mechanism 3. Controller PCA

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
1F/31	WRITE FAILURE. (Fault) During diagnostic functional testing, a disk write was not successfully completed on a reserved self-test data track.	1.Cycle power and repeat test. No action required unless error recurs. 2.ESDI PCA or disk mechanism 3. Controller PCA
20/32	READ FAILURE. (Fault) During diagnostic functional testing, a disk read was not successfully completed on a reserved self-test data track.	1.Cycle power and repeat test. No action required unless error recurs. 2.ESDI PCA or disk mechanism 3. Controller PCA
21/33[1]	CAN'T DETECT DATA ERROR. (Fault) During diagnostic function testing, an uncorrectable data error could not be detected by the controller ECC circuit during a disk read of the reserved self-test data track. The diagnostic test writes a known uncorrectable sector pattern on the self-test track and then attempts to read the sector. If the ECC circuit fails to detect the data error, this error is reported.	1. Controller PCA

[1]Error could involve data corruption.

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
23/35[1]	EMPTY DATA BUFFER NOT DETECTED. (Fault) The controller DMA circuit did not interrupt, indicating a DMA RAM buffer empty condition. During the diagnostic test a disk write was initiated at a sector on the maintenance track with no data contained in the DMA RAM buffer. The test expects to receive an interrupt from the controller DMA circuit indicating the buffer empty condition.	1. Controller PCA
24/36	TRACK SKIPPED DURING FORMAT. (Fault) During media initialization using the Initialize Media command, each track is rewritten with a formal data pattern. If fault conditions occur which prevent the track from being rewritten (either partially or entirely), further attempts to rewrite the track are aborted and this DERROR is logged. The Initialize Media command continues with the next track until completion, or 10 tracks are skipped, in which case a DERROR 40 (28_{16}) is logged and the command is aborted. The user should note the addresses which are associated with this error in the fault log and attempt to spare those addresses. The Initialize Media command should then be repeated. This sequence should be repeated until the Initialize Media command completes with no errors. A unit which has reported this error should not be used until all fault conditions have been resolved. Tracks which have not been completely formatted may have inconsistent header information which could lead to improper addressing.	1.See description for action.

[1]Error could involve data corruption.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
26/38	UTILITY END. (Event). This event is logged at the end of a utility as a dummy error. The action of logging this event will cause any events which occurred during the utility to be copied from the event log into the fault log.	1.No action required.
27/39	TOO MANY SERVO EVENTS. (Fault). Insufficient fault recovery time exists, or the maximum number of allowable hardware events has occurred during recovery. Fault recovery is invoked whenever a servo command fails. If there is insufficient time remaining to complete the necessary fault recovery, or the maximum allowed number of events has occurred, this error is logged to indicate no further fault recovery attempts are made. This is a terminator error for other events.	1.If error recurs, sparing is advised. 2.ESDI PCA or disk mechanism 3. Controller PCA
28/40	TOO MANY DISK EVENTS. (Fault). Insufficient fault recovery time exists or the maximum number of allowable hardware events has occurred during fault recovery. Fault recovery is invoked whenever a disk command fails. If there is insufficient time remaining to complete the necessary fault recovery, or the maximum allowed number of events has occurred during attempted recovery, this error is logged to indicate that no further fault recovery attempts are made.	1.If error recurs, sparing is advised. 2.ESDI PCA or disk mechanism 3. Controller PCA

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
29/41	NO INDEX PULSE. (Fault) The once-around, or index mark, signal could not be detected during a format operation. During media formatting, the sector address counter is synchronized with the index mark signal so that the media is consistently addressed, or "hard sectored" each time a format operation is done. The synchronization process involves initializing the sector counter to specific value during the sector in which the Index Mark signal occurs. If the index mark is not detected at a particular cylinder address, a search of a portion of the entire disk volume is made to locate a cylinder address at which the Index Mark can be detected. If no index mark can be detected within the search address space, this error is logged.	1.Internal cabling 2.ESDI PCA or disk mechanism 3.Controller PCA
2B/43 (HP-IB)	CHANNEL INTERFACE FAULT. (Fault) A diagnostic test of the host channel interface circuit in the controller failed.	1. Controller PCA

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
2D/45	VERIFY FAILURE DURING SPARE BLOCK. (Fault). Unrecoverable data, other than the target block address, was detected during a sparing operation. During a spare block command the entire track of data on which the target address block is located must be read and then rewritten with a revised header address. If a block of data other than the target address is unrecoverable, this error is reported to alert the user that the Spare Block operation cannot be performed without loss of user data. It is assumed that the target block address may contain unrecoverable data, thus necessitating the sparing operation. The target block address is not read during sparing and any data it contains is lost.	1.Perform spare, not retaining data.
2E/46	FAULT DURING SPARE. (Fault). A hardware fault occurred while verifying the data track containing the target address.	1.ESDI PCA or disk mechanism 2.Controller PCA

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
2F/47	FAULT DURING AVAILABLE SPARE SEARCH. (Fault). A hardware fault occurred while verifying the next available spare data track for use in media sparing.	1.Repeat spare operation. 2.Controller PCA 3.ESDI PCA or disk mechanism
30/48	FAULT IN SPARE OR MAINTENANCE TRACK FORMAT. (Fault). A hardware fault occurred while formatting the spare data tracks or the maintenance tracks.	1. Initialize media (maintenance track only) 2.ESDI PCA or disk mechanism
31/49	READ DISK LOGS FAULT. (Event). The disk logs were not readable during a Read Logs command. The returned data is only the content of the RAM logs.	Undetermined. No action required.
32/50[1]	RAM BUFFER EMPTY FAULT. (Fault) The controller did not detect a RAM buffer empty condition during a disk write diagnostic test. The diagnostic program starts a disk write after emptying the DMA RAM buffer which would normally contain data to be written. If the hardware system does not report that a RAM buffer empty condition was detected, this fault is reported.	1. Controller PCA
40/64 (HP-FL)	INTERLOCK ERROR. (Event) The disk storage system is in an interlock state and must be soft cleared.	1.The host should reset the disk storage system using a Configure Clear message.

[1]Error could involve data corruption.

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
41/65 (HP-IB)	LOOPBACK PARITY ERROR. (Fault). A parity error occurred during a channel loopback command.	1.Interface cabling 2.Host computer 3.Controller PCA
41/65 (HP-FL)	UNKNOWN DMA INTERRUPT. (Fault) The disk storage system received what it thought was a DMA interrupt, but it was illegal.	1.No action required unless error is recurring. 2. Controller PCA
42/66 (HP-FL)	INVALID PuP COMMAND. (Fault) Received an invalid PuP command.	1.No action required unless error is recurring. 2. Controller PCA
43/67[2] (HP-FL)	BAD TRANSPARENT. (Fault). An illegal transparent message was received.	1.Host computer 2.Interface cabling 3.Controller PCA
44/68[2] (HP-FL)	COMMAND PARITY ERROR. (Fault). The controller DMA reported a parity error in the command phase of a transaction.	1. Interface Cabling 2. Controller PCA 3. Host Computer
45/69[2] (HP-IB)	CHANNEL PARITY ERROR. (Fault) HP-IB interface circuit detected a parity error.	1. Interface Cabling 2. Host Computer 3. Controller PCA
45/69[1, 2] (HP-FL)	EXECUTION MESSAGE PARITY ERROR. (Fault) The controller DMA reported a parity error during the execution message phase of a transaction.	1. Interface Cabling 2. Controller PCA 3. Host Computer

[1]Error could involve data corruption.

[2]Ignore hardware fault register contents returned with this error.

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
46/70[2] (HP-IB)	INBOUND BYTE FAULT. (Fault) The controller detected a bad hardware state of the HP-IB channel interface circuit while decoding a received message byte.	1. Controller PCA
46/70[2] (HP-FL)	HOST MESSAGE PARITY ERROR. (Fault). The controller DMA reported a parity error for a host message.	1. Interface Cabling 2. Controller PCA 3. Host Computer
47/71[2] (HP-FL)	LONG HOST MESSAGE PARITY ERROR. (Fault). The controller DMA reported a parity error for a long host message.	1. Interface Cabling 2. Controller PCA
48/72[2] (HP-FL)	TRANSPARENT MESSAGE PARITY ERROR. (Fault). The controller DMA reported a parity error for a transparent message.	1. Interface Cabling 2. Controller PCA
49/73[2] (HP-FL)	LOOPBACK PARITY ERROR. (Fault). The controller DMA detected a parity error for a loopback message.	1. Interface Cabling 2. Controller PCA
4B/75[2] (HP-FL)	COMMAND LENGTH ERROR. (Fault). There was an underrun/overrun of command data to the disk storage system.	1. Host Computer 2. Controller PCA 3. Interface Cabling
4C/76[2] (HP-FL)	EXECUTION LENGTH ERROR. (Fault). Incorrect length received for the execution phase.	1. Host Computer 2. Controller PCA 3. Interface Cabling
4D/77[2] (HP-IB)	HP-IB INTERFACE FAULT. (Fault) A hardware fault was detected in the HP-IB interface circuit of the controller.	1. Controller PCA

[2]Ignore hardware fault register contents returned with this error.

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
4D/77[2] (HP-FL)	HOST MESSAGE LENGTH ERROR. (Fault). Incorrect length received on a host message.	1. Host Computer 2. Controller PCA 3. Interface Cabling
4E/78[1, 2] (HP-IB)	COMPLETION FAULT. (Fault) The channel message did not complete. Channel messages are transferred by programming the controller channel hardware to begin a DMA transfer of data between the channel interface and the data buffer RAM memory. If this DMA transfer does not complete successfully, this error is reported. During data transfers from the controller to the host the integrity of the data is monitored by generating a two byte Cyclic Redundancy Check (CRC) value for each 256 bytes of the message. As the data leaves the channel, the CRC value is compared against a value computed for the data at the time it was written on the disk. Should a miscompare occur, the message transfer is terminated and a completion fault reported. A CRC miscompare indicates either a hardware failure of the controller Error Correction Code (ECC) circuit or the controller RAM buffer memory. If data contained in the controller RAM buffer memory was corrupted prior to a disk write, the data written on the disk will be corrupt since the CRC is not checked as the data is written on the disk. In this case, all subsequent attempts to read this data will result in this error. It is necessary to rewrite the offending sector(s) to correct the problem and prevent future occurrences of this error.	1.Locate and rewrite the offending sector. 2. Controller PCA

[1]Error could involve data corruption.

[2]Ignore hardware fault register contents returned with this error.

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
4E/78 (cont)	NOTES. The address information associated with this error in the fault log does not accurately reflect the actual disk address of the corrupted data. Neither a Locate And Verify command nor an ERT will detect a sector with corrupted CRC; only a Locate And Read command will detect CRC faults.	
4E/78[2] (HP-FL)	LONG HOST MESSAGE LENGTH ERROR. (Fault). Incorrect length received on a long host message.	1. Host Computer 2. Controller PCA 3.Interface cabling
4F/79[2] (HP-FL)	LOOPBACK LENGTH ERROR. (Fault). Incorrect length received on a loopback message.	1.Host Computer 2.Controller PCA
50/80[2] (HP-FL)	TRANSPARENT LENGTH ERROR. (Fault). Incorrect length received on a transparent message.	1. Host Computer 2.Controller PCA
52/82 (HP-FL)	CRC MESSAGE ERROR. (Fault) The controller DMA reported a CRC error on the last message sent.	1. Controller PCA 2.Controller PCA
54/84[2] (HP-FL)	PuP HOST TIMEOUT. (Fault) PuP reported a host that did not respond in time. The disk storage system sending the message reports this error. NOTE. This error may be caused by power interruption on the disk storage system or host.	1. Interface Cabling 2. Host Computer 3. Environment
55/85[2] (HP-FL)	DMA TIMER TIMEOUT. (Fault). The host did not respond in time for the message in the controller DMA.	1. Host Computer 2. Interface Cabling 3. Controller PCA

[2]Ignore hardware fault register contents returned with this error.

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
57/87[2] (HP-FL)	ILLEGAL LOOPBACK MESSAGE LENGTH. (Fault). The host requested an illegal loopback message length.	1. Host Computer 2. Interface Cabling
58/88[2] (HP-FL)	ILLEGAL HOST MESSAGE LENGTH. (Fault). The host requested an illegal host message length.	1. Host Computer 2. Interface Cabling
5A/90[1] (HP-FL)	PuP CONTROLLER ERROR. (Fault) The controller firmware in the PuP processor experienced an illegal condition.	1.Controller PCA 2.Host Computer
60/96	CONTROLLER KERNEL FAILURE. (Fault) A controller fault condition was detected which required resetting the disk storage system. During operation, certain faults can occur for which no soft recovery mechanism is possible. Such faults are illegal controller program states or unmaskable controller processor interrupts which are caused by temporary or permanent hardware failures. In case the failure is temporary, the disk storage system is reset by executing the power-on program, which re-initializes the disk storage system. If the disk storage system is able to recover by re-initialization, the power-on status is reported to the host to indicate that the state of the disk storage system at the time of the failure has been lost.	1.Perform a reset. No action required unless error is recurring. 2.Controller PCA
61/97	CONTROLLER FAULT. (Fault) Data error detection fault.	1. Controller PCA

[1]Error could involve data corruption.

[2]Ignore hardware fault register contents returned with this error.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
62/98	ILLEGAL ESDI UNIT CONFIGURATION. (Fault) The ESDI switches on the disk mechanism are in an illegal state. Each ESDI unit connected on the ESDI bus has a DIP select switch which is used to select the address on the bus to which the ESDI unit will respond, as well as enabling or disabling certain options. These switches must be set to certain positions for proper operation. For single unit configurations, the address must be set to select unit address 1. The options switches must be set as follows: (1) Auto spinup : Enabled or Disabled (x) (2) Aggressive Seeks : Disabled (0)	1. Set ESDI switches to proper positions. 2.ESDI PCA or disk mechanism
63/99	NO ESDI UNITS. (Fault) During initialization of the controller, no disk mechanism was found on the ESDI bus. At power-on initialization all addresses of the ESDI bus are checked to determine how many ESDI units are attached to the controller. If no ESDI units respond to selection, this error is reported.	1.Internal cabling 2.Set ESDI switches to proper positions. 3.ESDI PCA or disk mechanism

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
64/100	UNSUPPORTED CONFIGURATION. (Fault) The type of disk mechanism connected to the controller PCA is not a supported model, or the type is not recognized. During initialization, an ESDI Request Configuration command is issued to each of the ESDI units attached to the ESDI bus. This information is used for configuring the units within the controller. If the model is not recognized by the controller, then the configuration may not be correct for proper operation. This is particularly true for multi-unit configurations.	1.Internal cabling 2.ESDI PCA or disk mechanism
65/101	SELECT FAULT. (Fault) A disk mechanism did not select properly. During initialization each ESDI address is checked for the presence of ESDI units. Once a unit is found, this address is considered available for use. If this ESDI unit cannot be reselected at some time after initialization and after being deselected, this fault is reported. Check ESDI unit address/option DIP switch settings.	1.Internal cabling 2.Set ESDI switches to proper positions. 3.ESDI PCA or disk mechanism

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
66/102	UNIT BUSY TIMEOUT. (Fault). A timeout occurred while attempting to use the disk mechanism because it was busy processing a command. An ESDI unit indicates "busy" status when it is processing a command, or during power-on initialization. A timer is started when the controller wishes to access the ESDI unit. This fault is logged if the timer expires prior to the unit becoming available. The ESDI unit indicates it is busy by deasserting the COMMAND COMPLETE status line on the ESDI interface.	1.Internal cabling 2.ESDI PCA or disk mechanism
67/103	OFFSET FAULTS. (Event). The controller attempted to write while either track offset or sector window offset was in use. The controller may use head positioning offsets in an attempt to read data from the disk when data errors are detected. These offsets must be reset prior to writing on the disk. This error indicates that the controller must reset offsets prior to doing the write. NOTE: Offsets are currently not used on the controllers used in these products.	1.ESDI PCA or disk mechanism
68/104	POWER FAIL. (Event) The controller detected a power fail status. A power-down condition was indicated by the power supply.	1.Environment 2.Power supply

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
69/105	WRITE PROTECT. (Fault) The disk mechanism(s) have been write protected due to a previously detected fault condition. After detection of a fault condition which indicates a problem with either the controller or the ESDI unit, a flag is set to prevent any further writes to that disk. This is done to protect the unit from loss of data. Power cycle will reset the unit.	Undetermined. No action required.
6A/106	AGGRESSIVE SEEK FAULT. (Event). A seek fault was reported when a write was attempted during position settling of the heads. The HP ESDI mechanisms provide a feature which causes the ESDI unit to report that a seek or head switch has completed, even though the heads have not completely fine settled into position. If the controller attempts to write when the heads have not settled, the unit will block the write and indicate this fault. This feature may be defeated by using either the configuration switch on the unit or a ESDI configuration command from the controller. NOTE: The controllers used in these products cannot successfully use this feature. The feature should not be used. Check ESDI option switch settings to disable the feature.	1.No action required.
6B/107	DATA ERROR QUEUE FULL. (Event). The queue for the data error correction program was full, preventing the start of a disk read. During disk reads, a buffer queue is used to queue information for in correcting data errors with the Error Correction Code (ECC). If this queue is full, the disk read will not be started. This prevent the disk read from overflowing the error correction program.	This error indicates an excessive error rate at the address indicated. Sparing should be considered.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
6C/108	UNAVAILABLE UNIT. (Event). A disk mechanism could not be accessed in time because it was unavailable during the time window of required access. If a unit is "busy" (either processing a fault condition or a previous command) it is unavailable to accept new commands. A timer is used to monitor the time that has elapsed since the unit was determined busy. If this timer expires during an allotted time window, this fault condition is reported. If an absolute maximum time has expired, then DERROR 102 (66_{16}) is reported. Note that this error does not necessarily indicate any type of failure. If the controller has issued a command to the ESDI unit and the host CPU cancels the transaction which initiated the command, then a new transaction may begin prior to completion of the first command. If the time window for responding to the new transaction is small, it may not be possible for the command to complete.	1.No action required.
6D/109 (HP-FL)	ESDI MECHANISM 1 ABSENT. (Fault) At power-on initialization, the controller was expecting a two-drive configuration, but was unable to select ESDI mechanism 1.	1.Set ESDI switches to proper positions. 2.Internal cabling 3.ESDI PCA or disk mechanism

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
6E/110 (HP-FL)	ESDI MECHANISM 2 ABSENT. (Fault) At power-on initialization, the controller was expecting a two-drive configuration, but was unable to select ESDI mechanism 2.	1.Set ESDI switches to proper positions. 2.Internal cabling 3.ESDI PCA or disk mechanism
6F/111	CONTROLLER COUNTER FAULT. (Fault) The diagnostic which tests the sector timing mark counter in the controller failed. The controller sector timing mark counter is used to count a programmed number of sector timing marks and then cause a controller program interrupt. The interrupt service program then programs the disk hardware for operation during the following sector. The diagnostic programs the timer to interrupt after a certain number of sectors have passed. If the sector address counter in the controller DMA circuit does not have the correct count, or the interrupt does not occur within a reasonable time period, this error is logged.	1. Controller PCA

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
72/114	DATA ERROR QUEUE OVERFLOW. (Event). A disk read has been disabled because the data error buffer queue has filled. During disk reads, the disk hardware will automatically disable a disk read if the buffer for the data error correction program becomes full. Information necessary for data error correction using the Error Correction Code (ECC) is stored in the buffer. The hardware will be disabled to prevent a buffer overflow. A queue overflow indicates an excessive error rate at the current track. Sparing should be considered.	Indicates an excessive error rate at the address indicated. Sparing should be considered.
73/115	COMMAND SENT STATUS. (Event). The controller/disk mechanism interface indicated Command Sent status. The controller/ESDI interface will interrupt the controller when all 17 bits of an ESDI command have been sent over the interface to the ESDI unit. This status is normally processed, but if sent when the controller has not issued a command, this fault is reported.	1. Controller PCA
75/117 (HP-FL)	DIFFERENT ESDI MECHANISMS. (Fault) During initialization of the controller, two types of ESDI mechanisms were on the ESDI bus. In a two-mechanism configuration, both ESDI mechanisms must be identical. If they are not, this error is reported.	1.ESDI PCA or disk mechanism

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
7C/124[1]	ERROR CORRECTION HEADER MISCOMPARE. (Fault) After successful data error correction, the header field read from the disk did not match the target header. During disk reads the controller hardware will automatically compare the sector header read from the disk with a reference header that is determined during the position verification. If a header miscompare occurs with no detected ECC error, a fault is reported. See ERROR 142 ($8E_{16}$). However, if ECC errors are detected in the sector, the header comparison is not valid and comparison must be deferred until the data error correction program has completed correction of the sector.	1. Controller PCA 2.ESDI PCA or disk mechanism
7D/125	HEADER MISCOMPARE FAULT. (Fault) The Header Miscompare error status is set in the controller DMA. No other hardware error status is set. The header miscompare error status is normally masked and should not be seen. If it does occur, this indicates a controller fault.	1. Controller PCA
7E/126	SECTOR FRAME WORD ERROR. (Event). The controller has detected an error in the frame word of the sector. Each sector on the disk has a framing word which is used for synchronizing the controller to the data pattern read from the disk. The framing word is 8 bits in length. A framing word error is indicated whenever two or more bits are in error from the pattern used (0FE) to indicate the frame word. This information is normally masked and is only unmasked optionally during Error Rate Tests.	1. Controller PCA

[1] Error could involve data corruption.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
80/128	ESDI STATUS MESSAGE PARITY ERROR. (Event). The controller detected a parity error in the data/status message received from the disk mechanism. Each ESDI message received by the controller from the selected ESDI unit has a parity bit to detect odd bit errors in the 16-bit message.	1.Internal cabling 2.Controller PCA 3.ESDI PCA or disk mechanism
81/129	ESDI COMMAND TIMEOUT. (Event). The controller/ESDI interface indicated an ESDI command has timed out. The ESDI specification requires that the ESDI device handshake each bit of a 17-bit command or 17-bit status message within 10 ms. The hardware timer in the controller that monitors this time has expired.	1.Internal cabling 2.Controller PCA 3.ESDI PCA or disk mechanism
82/130	ESDI ATTENTION BEFORE COMMAND. (Event). The selected disk mechanism asserted attention immediately prior to issuing an ESDI command, causing the ESDI command to be aborted.	1.No action required.
83/131	UNKNOWN ESDI COMMAND FAULT. (Fault). A fault condition was detected while the controller was issuing an ESDI command which could not be decoded.	1.Internal cabling 2.Controller PCA 3.ESDI PCA or disk mechanism
86/134	POSITION VERIFY FAILED. (Event). Position verification has failed on a track due to header miscompares of either the head address or cylinder address fields.	2.ESDI PCA or disk mechanism

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
87/135[1]	VERIFY FAILED. (Event). A position verification has failed due to unreadable sectors. After moving the heads to a desired track, the positioning is verified by reading sectors from the track. The verify will continue to read sectors if ECC errors are detected. If no sector is readable without ECC errors after some limited number of sectors have been read, the verify will terminate and this error is reported. The limit number is set in excess of the number of sectors on the track to allow sufficient time for the read-write circuit to lock to the data on the track.	1.Sparing advised. 2.Disk mechanism
88/136[1]	VERIFY FAULT. (Fault). The controller has detected a head miscompare with no ECC data errors while reading from a track on which a successful verify has already completed. During disk reads, the controller hardware automatically compares the header field with a reference header value which is initialized during position verification. If a header miscompare occurs without the presence of an ECC data error, this error is reported. The error indicates either that the current track is not formatted correctly, or that the controller hardware has malfunctioned.	1.Sparing advised. 2.Disk mechanism
89/137	HEAD POSITION FAULT. (Event) The wrong head has been selected.	1.Internal cabling 2.Controller PCA 3.ESDI PCA or disk mechanism

[1]Error could involve data corruption.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
8E/142	READ SECTOR ADDRESS FAULT. (Fault) The controller sector address counter had the wrong value during a disk read. During a disk read the controller processor uses interrupt service programs during each sector to program the disk hardware. If the controller sector address counter has the wrong address during the interrupt service routine, this error is reported.	1. Controller PCA
8F/143	WRITE SECTOR ADDRESS FAULT. (Fault) The controller sector address counter had the wrong value during a disk write. During a disk write, the read-write system hardware is programmed for each sector in which the write must occur. Interrupt service programs are used to accomplish this. If an interrupt occurs and the sector address counter does not contain the address at which the interrupt was intended to occur, this error is reported.	1. Controller PCA
90/144	READ DMA DISK ERROR. (Event). The controller disk DMA has the disk error status bit set. No other hardware status is indicated. The controller disk DMA circuit will set the Disk Error status bit for several reasons. When it is set with no other status bits set, it indicates signal timing errors on the ESDI. The status bit is set for the following conditions: (1) The sector timing mark signal was not framed correctly within required time window for the DMA circuit. (2) The Data Strobe signal from the Read-Write system was not framed correctly or did not occur within the timing mark window frame.	1.Sparing advised. 2.ESDI PCA or disk mechanism

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
91/145	WRITE DMA DISK ERROR. (Event). The controller disk DMA has the disk error status during a write.	1.Sparing advised. 2.ESDI PCA or disk mechanism
92/146	READ ECC TIMING FAULT. (Event). During a read, the ECC circuit in the controller had the Timing Fault status bit set. No other hardware status was indicated. The ECC asserts the Timing Fault status bit for a number of conditions. When set with no other status, it usually indicates that the ECC was programmed to be active during a sector and signals on the ESDI did not occur. The status bit can be set for the following conditions: (1) The sector timing mark did not occur within the correct time frame. (2) The Data strobe signal from the Read-Write system did not occur or was not framed correctly within the sector timing mark signal time window.	1.Sparing advised. 2.Controller PCA
93/147	WRITE ECC TIMING FAULT. (Fault). During a write, the ECC circuit in the controller had the Timing Fault status bit set. No other hardware status was indicated.	1.ESDI PCA or disk mechanism 2.Controller PCA

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
94/148	SECTOR WINDOW FAULT. (Event). The sector time counter in the controller timed out while attempting to synchronize the controller with the sector timing mark. During initialization of disk hardware control programs, the controller processor must synchronize the control program to the occurrence of the sector timing mark signal. If the signal does not occur within a specified time window, this error is reported. The sector timing mark signal is generated by the servo system electronics and can be shut off by the servo system if servo system errors occur. This error can occur if servo recalibration is required.	1. Disk mechanism 2.Controller PCA
95/149	MISSING HEADER AVAILABLE. (Fault) The Header Available status bit in the controller was not set during a position verify. During position verification, the header portion of a sector is read to compare the header address with the desired target address. The controller hardware will set the Header Available status bit when the header bytes (the first six bytes of the sector) have been read. If for some reason the sector could not be read, this bit will not be set. However, other error status information should be reported instead to indicate the reason for the read failure.	1. Controller PCA

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
96/150	READ SIGNAL FAULT. (Event). The controller circuits indicated an error during a disk read. The controller DMA circuit asserted the Disk Error status bit and the ECC has asserted the Timing Fault status bit. The read/write system has no error status indicated. The Disk Error and Timing Fault status are set for several conditions. When no other status is set, this indicates timing errors with the signals on the ESDI. Specifically, these errors are set for the following conditions: (1) The sector timing mark signal did not occur in the required time frames when the controller was programmed for a read disk transfer. (2) The Data Strobe signal from the read/write system was absent or did not occur in the proper time frame during a sector in which the controller was programmed for a disk read.	1.Sparing advised. 2.ESDI PCA or disk mechanism
97/151	WRITE SIGNAL FAULT. (Fault). The controller circuits indicated an error during a disk write.	1.ESDI PCA or disk mechanism 2.Controller PCA
9C/156	READ DMA BUFFER POINTER FAULT. (Fault) The controller DMA RAM address pointer had the wrong value at the completion of a disk read segment. During a disk read, the controller DMA hardware will automatically increment a RAM address pointer as the read progresses. At the completion of a disk read segment on the current track, the pointer value is compared with the value it should contain if the correct number of sectors were read. If the pointer is not correct, this error is reported.	1. Controller PCA

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
9D/157	WRITE DMA BUFFER POINTER FAULT. (Fault) The controller DMA RAM address pointer had the wrong value at the completion of a disk write segment. During a disk write the controller DMA hardware will automatically increment a RAM address pointer as the write progresses. At the completion of a disk write segment on the current track, the pointer value is compared with the value it should contain if the correct number of sectors were written. If the pointer is not correct, this error is reported.	1. Controller PCA
9E/158	UNRECOGNIZED UNIT FAULT. (Fault) A disk hardware control interrupt could not be decoded. The controller uses interrupts to bring attention to error conditions during disk transfers. An interrupt has occurred from the disk hardware which could not be decoded. This interrupt can be from the controller, the ESDI PCA, or the power supply.	1.ESDI PCA or disk mechanism 2.Controller PCA
A1/161	WRITE FAULT. (Fault). The disk mechanism reported a write fault.	1.ESDI PCA or disk mechanism

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
A2/162	UNDEFINED VENDOR STATUS FAULT. (Fault) During an ESDI Request Vendor Status command, the disk mechanism responded with an unrecognized value.	1.Internal cabling 2.ESDI PCA or disk mechanism 3.Controller PCA
A3/163	WRITE WITH POSITION OFFSET. (Fault) The disk mechanism reported that a write occurred with position offset. The ESDI disk units can be commanded to position the heads slightly offset from the center of track (track offset) or to offset the start of the sector window (window offset) for purposes of recovering data which otherwise is unreadable. This offset must be reset by the controller prior to the controller causing a write to occur. If this is not done, the ESDI unit will report the condition. NOTE: Position offset is not currently implemented on the controllers used in these products.	1.Internal cabling 2.ESDI PCA or disk mechanism 3.Controller PCA
A4/164	SEEK FAULT. (Event). The disk mechanism reported a seek fault condition.	1.ESDI PCA or disk mechanism
A5/165	INVALID OR UNSUPPORTED ESDI COMMAND. (Event). The disk mechanism has decoded a command from the controller which is invalid or not supported.	1.No action required.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
A6/166	ESDI COMMAND INTERFACE FAULT. (Event). The disk mechanism did not correctly handshake the 17-bit command from the controller within the allotted time.	1.Internal cabling
A7/167	ESDI COMMAND PARITY FAULT. (Event). The disk mechanism detected a parity error on the last controller command.	1.Internal cabling
A8/168	ESDI UNIT POWER-ON CONDITION. (Event). The disk mechanism reported that it has reinitialized and is in its power-on state. The ESDI unit indicates a power-on status whenever it is in its power-on state. This occurs when power is disrupted to the ESDI unit. This could occur (under suspicious conditions) without power disruption to the controller. The controller must sense that the ESDI unit is no longer in its configured state and must be reconfigured.	1.Internal cabling 2.ESDI PCA or disk mechanism
A9/169	ESDI UNIT HAS SPINDLE STOPPED. (Event). The disk mechanism has reported that its spindle motor has not been started, or is failing to spin. The HP ESDI disk unit can optionally be configured to NOT start its spindle when it is powered up. This is set by the option switch on the ESDI mechanism.	1.No action required.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
AC/172	ESDI FIXED DISK WRITE PROTECT. (Fault) The disk mechanism has its write protect status set. The ESDI disk unit may write protect itself whenever it determines conditions exist which are risky to allow writes to the disk. The unit will set write protect and report to the controller with this status.	1.Internal cabling 2.ESDI PCA or disk mechanism
AF/175	INVALID ESDI STATUS. (Fault). The disk mechanism has reported a status message which has invalid status information. The ESDI status message received from the ESDI unit could not be decoded.	1.No action required.
B3/179	ESDI UNIT SPINDLE STUCK. (Fault) The signal from the sensors within the disk mechanism indicate the spindle is not spinning. The ESDI disk unit has reported that it is unable to cause the spindle to spin up.	1.Internal cabling 2.ESDI PCA or disk mechanism
B4/180	NO SPINDLE SPEED FAULT. (Fault) The disk mechanism spindle has begun spinning, but it cannot attain the proper speed.	1.Internal cabling 2.ESDI PCA or disk mechanism
B5/181	NO SPINDLE LOCK. (Fault) The disk mechanism was able to attain proper spindle speed, but cannot maintain proper speed.	1.Internal cabling 2.ESDI PCA or disk mechanism
B7/183	WRITE OFF TRACK. (Fault). The disk mechanism reported that a write occurred while the heads were off track.	1.Internal cabling 2.ESDI PCA or disk mechanism
B8/184	WRITE OFF SPEED. (Fault). The disk mechanism reported that a write occurred while the spindle was not locked to its proper speed.	1.Internal cabling 2.ESDI PCA or disk mechanism

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
B9/185	WRITE SKIPPED. (Fault). During a write operation, the disk mechanism missed detection of two consecutive sector timing pulses.	1.Internal cabling 2.ESDI PCA or disk mechanism
BA/186	WRITE WITH ILLEGAL HEAD. (Fault). The disk mechanism reported that a write occurred while an illegal head address was selected.	1.Internal cabling 2.ESDI PCA or disk mechanism
BB/187	ESDI TIMEOUT. (Event) The disk mechanism reported that a handshake of status or data did not occur within the required 10 ms time window.	1.Internal cabling 2.ESDI PCA or disk mechanism
BC/188	SEEK BOUNDS ERROR. (Event). The controller requested a seek to an address which is beyond the physical bounds of the disk mechanism.	1.No action required.
BD/189	SECTORS SKIPPED. (Event). The disk mechanism reported consecutive sectors skipped while seeking or track following.	1.No action required.
BE/190	GRAY CODE ERROR. (Event). The disk mechanism servo interrupt timed out while waiting to obtain a valid gray code.	1.No action required.
BF/191	SERVO TIMEOUT. (Event) The disk mechanism servo system was unable to position the head in the fine-settle window within time limits.	1.Internal cabling 2.ESDI PCA or disk mechanism
C0/192	GROSS SETTLING. (Event) The disk mechanism servo system was unable to position the head to within one-half track of its target.	1.Internal cabling 2.ESDI PCA or disk mechanism

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
C1/193	ESDI UNIT INTERRUPT FAULT. (Fault) The servo program of the disk mechanism servo system timed out while waiting for a servo interrupt.	1.Internal cabling 2.ESDI PCA or disk mechanism
C2/194	SEEK WHILE SHUT DOWN. (Event). The controller has commanded a seek while a seek fault is pending.	1.No action required.
C3/195	ESDI WRITE PROTECT. (Fault) A write operation was attempted while the disk mechanism had set its write protect.	1.Internal cabling 2.ESDI PCA or disk mechanism
C4/196	MECHANISM ARM STUCK DURING POWER-ON. (Event). The head armature will not move from the inner diameter landing zone at power-on.	1.Internal cabling 2.ESDI PCA or disk mechanism
C5/197	WRITE AND OFFTRACK. (Event). The disk mechanism write-protected the media due to an offtrack condition. Aggressive seek feature is enabled.	1.Internal cabling 2.ESDI PCA or disk mechanism
C6/198	WRITE WITH OFFTRACK CONDITION. (Event). The disk mechanism write-protected the media due to an offtrack condition. Aggressive seek feature is disabled.	1.Internal cabling 2.ESDI PCA or disk mechanism
C7/199	CAN'T LOCATE MIDDLE OF DISK SERVO SAMPLES. (Event) The disk mechanism servo system cannot or could no longer detect gray code samples at the middle of the disk media.	1.Internal cabling 2.ESDI PCA or disk mechanism
C8/200	LOST SERVO SYSTEM GRAY CODE SAMPLES. (Event)	1.Internal cabling 2.ESDI PCA or disk mechanism

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
D0/208 (HP-FL)	HEADER PARITY ERROR. (Fault) There was a parity error on an ALINK header. No error message is returned since the source is unknown.	1. Controller PCA
D1/209 (XP Only)	POWER-ON WRITE UPDATE CRC FAULT. (Fault) Write update data in NVRAM failed CRC check at power-on. Read and write cache disabled. During power-on initialization, a check is made to see if any writes were accepted into the non-volatile RAM but not written to disk. If so, a CRC check is made of the RAM buffer in which the data is contained. If the CRC check fails, this indicates that user data has been lost and that the data on the disk is not coherent. The cache is disabled to prevent further data loss.	1.NVRAM 2. Controller PCA
D1/209 (HP-FL)	TOO MANY ALINK TRANSACTIONS. (Fault) A particular source of transactions exceeded the allowable limit of active transactions.	1.Host computer 2.Controller PCA
D2/210 (XP Only)	POWER-ON WRITE UPDATE FAILURE. (Fault) Write update failed at power-on. Read and write cache disabled. During power-on initialization, a check is made to see if any writes were accepted into the nonvolatile RAM, but not written to disk. If so, this data is written to disk at this time, provided the data passes a check of the CRC code. If the write fails for any reason, this DERROR is returned. No retries are attempted. The cache is disabled to prevent possible loss of user data.	1.If this error occurs by itself, the likely cause is the controller PCA 2.If there are other events associated with this error, the likely cause is the ESDI PCA or disk mechanism

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
D2/210 (HP-FL)	TOO MANY ALINK HEADERS. (Fault) The number of unprocessed headers exceeded the allowable number. NOTE. Occurrences of this error should be reported to Disk Storage System (DSS).	1. Controller PCA
D3/211 (XP Only)	READING WRITE UPDATE FAILED DATA. (Fault). The host has accessed data which previously failed a write update. When a write update fails, valid user data may or may not be contained within the controller nonvolatile RAM. If the host processor ignores a write update failure error and attempts to read any of this data, this DERROR is returned to warn the host that the data is probably invalid. It is likely the host will attempt to spare the location, however only a Spare-Not-Retaining-Data will eliminate the invalid data.	1.No action required.
D3/211 (HP-FL)	PBUS TIMEOUT. (Fault) A transaction exceeded the allowable time on the PBus on the link disk storage system.	1.Host computer 2.Interface cabling 3.Environment 4.Controller PCA

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
D4/212 (XP Only)	RUNTIME WRITE UPDATE FAILURE. (Fault) During run time operation, a write to disk failed after the write was reported complete to the host. Write I/Os are buffered in a nonvolatile RAM buffer in the controller. When the last byte of a write execution message is received, the write is reported complete to the host, even though the data has not been written onto the disk. If the write fails, this error is logged to indicate that data which must be written to disk is still resident within the nonvolatile buffer. One retry is attempted prior to logging this error. Each try will continue to attempt the write until one fault or five events occur. The cache is disabled to prevent any (further) loss of user data.	1.If this error occurs by itself, the likely cause is the controller PCA 2.If there are other events associated with this error, the likely cause is the ESDI PCA or disk mechanism
D4/212 (HP-FL)	ALINK IER. (Fault) The HP-FL interface detected a parity error in the disk-to-host connection. This error is reported by the link drive. A parity error was detected by the link drive when transferring data from a disk to the host.	1.No action required unless error is recurring. 2.Controller PCA (on either the selected drive or the drive connected to the host) 3.Interface cabling

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
D5/213[1] (XP Only)	INVALID NVRAM FORMAT DETECTED. (Fault) The data pattern contained within the NVRAM was not the expected pattern. Read and write cache disabled. The non-volatile RAM is formatted with a pattern key word at the factory. This keyword is checked during power-on, prior to checking if data exists in the buffer to be written to disk. The keyword pattern should be present at all times if the non- volatile RAM is functioning correctly and the battery for the RAM data retention is functioning properly. If this pattern is not found correct, it indicates that the data contents of the RAM are probably invalid. The cache is disabled when this occurs. The controller board should be replaced for this failure. If for some reason it is not desirable to replace the board, the RAM can be reformatted by placing the disk storage system in self-test mode and setting the remaining address switches to address 5. This will erase any data remaining in the RAM and reformat the keyword patterns. Note that if the data retention battery is weak or a component failure exists, the data integrity problem will not be alleviated.	1.NVRAM 2.Controller PCA
D5/213 (HP-FL)	ALINK PER. (Fault) The HP-FL interface detected an illegal protocol frame from the fiber optic interface chips, which perform the receive and transmit interface functions.	1.No action required unless error is recurring. 2.Controller PCA 3.Interface cabling 4.Host interface (fiber optic cable)

[1]Error could involve data corruption.

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
D6/214 (XP Only)	THREE CONSECUTIVE DRAM ERRORS. (Fault) Three consecutive uncorrectable ECC errors were detected in the controller DRAM. The dynamic RAM on the controller PCA is protected by ECC code. During three consecutive accesses of the DRAM, ECC errors were detected. (This occurs during three host transactions). This error indicates that the DRAM of the controller is probably faulty. The fault logs will contain two DERROR 214s, followed by a DERROR 216. A single DERROR 216 is not cause to replace the controller board if it is not followed by an additional DERROR 216 and DERROR 214. The cache function has been disabled to protect data integrity.	1. Controller PCA
D7/215 (XP Only)	THREE DRAM ERRORS WITH CACHE DISABLED. (Fault) Three consecutive uncorrectable ECC errors were detected in the controller DRAM with the cache disabled. The cache has either been disabled by the host or has been disabled because of detected fault conditions. Three consecutive accesses of the controller DRAM have resulted in uncorrectable ECC errors. The disk storage system will be write protected to prevent corruption of any user data on the disk.	1. Controller PCA

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
D8/216 (XP Only)	UNCORRECTABLE DRAM ECC ERROR. (Fault) An uncorrectable (2 or more bits) ECC error was detected in the controller RAM. The dynamic RAM of the controller is protected by ECC code which can correct 1-bit errors and detect 2-bit errors (or more). An uncorrectable (2 or more bits) ECC error was detected. This fault is noteworthy but should not cause the controller FRA to be replaced unless accompanied by DERRORs 216, 215, or 214.	1. Controller PCA
DA/218[1] (XP Only)	DRAM TEST FAILED. (Fault) A diagnostic test of the volatile DRAM failed. The volatile DRAM portion of the controller memory is tested for addressing and data content problems which may exist. The test is kept simple to keep the execution time of the test short. (There are 2 megabytes of DRAM to test.) The composite test includes the following checks: - Data pattern test of 0s pattern to all locations. - Data pattern test of 1s pattern (0FF hex) to all locations. - Every word of each 4 kilobyte page is filled with the page number starting at page 0 and ending with page 511. The pages are examined starting with page 511 and ending with page 0. - Every word of each 4 kilobyte page is filled with the page number starting at page 511 and ending with page 0 The pages are examined starting with page 0 and ending with page 511.	1. Controller PCA

[1] Error could involve data corruption.

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
DB/219[1] (XP Only)	NVRAM TEST FAILURE. (Fault) A diagnostic test of the nonvolatile buffer RAM failed. The nonvolatile RAM of the controller is connected in parallel with the volatile DRAM. A diagnostic test is performed which tests the following conditions: - Read from only the NVRAM - Write to only the NVRAM (Check DRAM for changes) - Read from NVRAM and associated DRAM - Write to DRAM (Check NVRAM for changes)	1.NVRAM 2.Controller PCA
E3/227[2] (HP-FL)	SPARING THRESHOLD REACHED (Event). More than ten spares were used since the disk storage system powered-on the last time.	1.No action required.
F1/241 (HP-FL)	PRONTO INITIALIZATION ERROR (Fault) During the loopback self-test, an error with the Pronto initialization or Pronto headers occurred. The Pronto chip is part of the HP-FL interface on the controller PCA.	1. Controller PCA

[1]Error could involve data corruption.

[2]Ignore hardware fault register contents returned with this error.

Table 5-2. DERROR and TERROR Codes (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
F2/242 (HP-FL)	DATA PATH SELF-TEST ERROR (Fault) During the loopback self-test, an error with the full data path occurred.	1. Controller PCA
F3/243 (HP-FL)	ODD NUMBER BYTE DATA PATH ERROR (Fault) During the loopback self-test, an error with an odd number of bytes in the data path occurred.	1. Controller PCA
F4/244 (HP-FL)	CHANNEL 1 OVERFLOW ERROR (Fault) During the loopback self-test, an error occurred when trying to force a channel 1 overflow.	1. Controller PCA
F5/245 (HP-FL)	CHANNEL 0 OVERFLOW ERROR (Fault) During the loopback self-test, an error occurred when trying to force a channel 0 overflow.	1. Controller PCA
F6/246 (HP-FL)	CHANNEL 1 DISABLE ERROR (Fault) During the loopback self-test, an error occurred when trying to force a channel 1 disable during a channel 1 write.	1. Controller PCA
F7/247 (HP-FL)	CHANNEL 1 WATCHDOG TIMER ERROR (Fault) During the loopback self-test, an error occurred when trying to create a watchdog timer during a channel 1 write.	1. Controller PCA
F8/248 (HP-FL)	PBUS MATCH ERROR (Fault) During the loopback self-test, an error with the match function of the PBus occurred.	1. Controller PCA
F9/249 (HP-FL)	CHANNEL SWITCH ERROR (Fault) During the loopback self-test, an error occurred when trying to test the switch from channel 1 to 0.	1. Controller PCA

Table 5-2. (continued)

NUMBER (hex/dec)	ERROR DESCRIPTION	SUSPECT ASSEMBLY
FA/250 (HP-FL)	PRONTO ERROR IN PARITY ERROR DETECTION (Fault) During the loopback self-test, an error occurred when checking the Pronto's ability to detect parity errors. The Pronto chip is part of the HP-FL interface on the controller PCA.	1. Controller PCA
FB/251 (HP-FL)	PI ERROR IN PARITY ERROR DETECTION (Fault) During the loopback self-test, an error occurred when checking the PI's (PBus interface) ability to detect parity errors.	1. Controller PCA
FC/252 (HP-FL)	DICE ERROR IN PARITY ERROR DETECTION (Fault) During the loopback self-test, an error occurred when checking the DMA's ability to detect parity errors.	1. Controller PCA
FD/253 (HP-FL)	WATCHDOG TIMER ERROR (Fault) During the loopback self-test, an error occurred when trying to force a watchdog timer.	1. Controller PCA

6

Adjustments

There are no operating or maintenance adjustments required.

7

Peripherals

This chapter does not apply to these products.

8

Replaceable Parts

Introduction

This chapter includes the following information:

- Removal and replacement procedures.
- Replaceable parts.
- Field stocking inventory.

Preparation For Service

Warning **To avoid the possibility of electric shock, always disconnect the disk storage system from ac power before performing any servicing procedures.**

Before working on the disk storage system, perform the following steps:

1. Switch off the disk storage system power.
2. Disconnect the ac power cord from the disk storage system.
3. Disconnect all interface cables from the disk storage system.
4. If necessary, move the disk storage system to a location where all surfaces, including the top, are easily accessible.
5. Make sure you and the disk storage system are properly grounded using an anti-static work station and wrist strap.

Removal and Replacement Procedures

Caution

The disk mechanism and controller PCA in the disk storage system are very susceptible to electrostatic damage. Use the field service grounding kit (p/n 9300-1155) to reduce the risk of electrostatic damage when servicing the disk storage system. Store static sensitive assemblies in an anti-static bag immediately after removing them.

The following paragraphs provide detailed instructions for removing and replacing the major disk storage system assemblies. The procedures are given in the order in which disassembly normally occurs. The order of disassembly is shown in Figure 8-3. To assist in the identification of the parts, references are made to the index numbers used in Figure 8-3 through Figure 8-7. The index numbers refer to Figure 8-3 unless specific reference is made to one of the other figures.

Unless noted, the assembly is installed by reversing the removal procedure.

Note

TORX hardware is used in the assembly of the disk storage system. This hardware requires the use of special drivers. In this manual, any reference to this type of hardware will be accompanied by the required driver size, for example, "T15"

Front Panel

1. Locate the two locking tabs on the underside of the front panel (Figure 8-3, 1).
2. Press in on the locking tabs and pull the lower edge of the front panel forward until the panel separates from the disk storage system chassis.

To install the front panel:

1. Insert the tabs along the upper edge of the front panel into the slots in the disk storage system chassis.
2. Lower the panel into position and press on the lower edge of the panel until the locking tabs snap into the disk storage system chassis .

Top Cover

1. Remove the front panel.
2. Remove the two T15 screws (Figure 8-3, 4) attaching the top cover (3) to the rear of the disk storage system.
3. Slide the top cover back and then lift it off.

To install the top cover:

1. Position the top cover so the tabs on the inside of the cover fit into the slots in the disk storage system chassis
2. Lower the top cover on to the disk storage system chassis and slide the cover forward into place.
3. Secure the panel using the two mounting screws.

HP-IB I/O Panel

The following procedure applies to models 335H, 670H, and 670XP disk storage systems.

1. Remove the front panel and top cover.
2. Disconnect the I/O cable (Figure 8-4, 3) from the HP-IB I/O panel (Figure 8-3, 5).
3. Remove the three T15 screws (6) attaching the HP-IB I/O panel to the rear of the disk storage system.
4. Remove the HP-IB I/O panel.

HP-FL I/O Panel

The following procedure applies to model 670FL and 1.34FL disk storage systems.

1. Remove the five T15 screws (Figure 8-3, 11) attaching the HP-FL I/O panel (10) to the rear of the disk storage system.
2. Carefully pull the I/O panel away from the disk storage system chassis until the PBus and fiber optic connectors on the HP-FL controller PCA (Figure 8-6, 1) are accessible.

3. Disconnect the PBus and/or fiber optic cables from the HP-FL controller PCA and remove the HP-FL I/O panel.

Front Insert Assembly

1. Remove the front panel and top cover.
2. Remove the T15 screw (Figure 8-3, 15) holding the front insert clip (14) in place.
3. Remove the front insert clip.
4. Pull the front insert assembly (16) away from the front of the disk storage system. The insert assembly is now held in place only by spring clips around its edges.

Disk Mechanism

Caution

- The disk mechanism is susceptible to mechanical shock and vibration. Be careful to avoid bumping or jarring the disk mechanism when removing or installing it. The disk mechanism should be placed on a padded surface while it is out of the disk storage system chassis.
- Avoid touching the surface of the ESDI controller PCA while handling the disk mechanism.

1. Remove the front panel, top cover, and front insert assembly.
2. Disconnect the three cables from the disk mechanism (Figure 8-3, 17). Press down on the connector lock (Figure 8-3, 24A) tab to disconnect the ESDI cables.
3. Remove the T20 screw (18) securing the disk mechanism to the disk storage system chassis.
4. Slide the disk mechanism toward the rear of the disk storage system until the mounting tabs on the disk mechanism disengage from the disk storage system chassis.
5. Carefully lift the disk mechanism out of the disk storage system.

6. If the disk mechanism is being replaced, remove the four T10 screws (20) securing the mounting bracket assembly (19) to the disk mechanism. Remove the bracket and install it on the new disk mechanism.

Before installing a new disk mechanism, make sure the ESDI address switch on the mechanism is set to the proper address. The location of the ESDI address switch and the proper address settings are shown in Figure 4-10. If the disk mechanism is set to an improper address, a disk mechanism fault will occur during self-test.

Note

When reinstalling a disk mechanism in a model 1.34FL, make sure the mechanism is installed in its original position. If both disk mechanisms have been removed, check the ESDI address switch settings on each mechanism to determine its proper position. Figure 4-10 shows the relationship between the ESDI address and disk mechanism position. The controller PCA associates a specific ESDI address with each position. If the disk mechanisms are installed in the wrong positions, the self-test will fail with a disk mechanism fault.

ESDI PCA

Caution

- The disk mechanism must be placed upside-down to remove the ESDI PCA. In this position, the disk mechanism is very susceptible to mechanical shock and vibration. Be extremely careful to avoid bumping or jarring the disk mechanism when replacing the ESDI PCA. Place the disk mechanism on a padded surface while removing the EDSI PCA.
- Make sure you observe the proper ESD precautions when removing the ESDI PCA. Handle the ESDI PCA only by its edges.

1. Remove the disk mechanism.
2. Carefully place the disk mechanism upside-down so the ESDI PCA (Figure 8-3, 22) is accessible. Place the disk mechanism on a padded surface.

3. Remove the four T10 screws (20) securing the mounting bracket assembly (19) to the disk mechanism. Remove the bracket.
4. Pull the connector lock (24A) off the ESDI PCA.
5. Remove the four T10 screws (23) securing the ESDI PCA to the disk mechanism. See Figure 8-1.

Note

Do not mistakenly remove the two T10 screws securing the heat sink to the ESDI PCA.

---

6. Carefully pull the ESDI PCA away from the disk mechanism until the three cables connecting the HDA to the ESDI PCA are accessible. The ESDI PCA will hinge to one side, providing easy access to the cable connectors. See Figure 8-1.
7. Disconnect the speed sense cable, the spindle drive cable, and the data cable from the ESDI PCA.

Note

Before installing a new ESDI PCA, make sure the ESDI address switch on the new ESDI PCA is set to the same address as that on the old ESDI PCA. The location of the ESDI address switch is shown in Figure 4-10. If the disk mechanism is set to an improper address, a disk mechanism fault will occur during self-test.

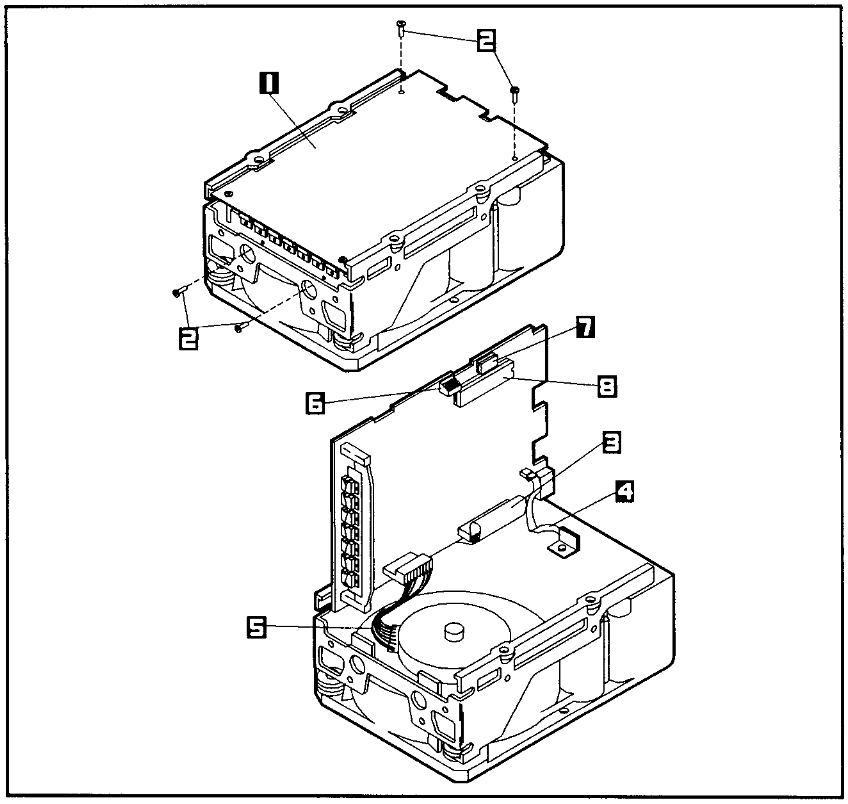


Figure 8-1. Removing the ESDI PCA

1. ESDI PCA
2. ESDI PCA mounting screws
3. Data cable
4. Speed sense cable
5. Spindle drive cable
6. ESDI address switch
7. Terminator resistor pack
8. EPROM

HP-IB Controller PCA

The following procedure applies to model 335H and 670H disk storage systems.

1. Remove the front panel and top cover.
2. Remove the disk mechanism.
3. Disconnect all cables from the HP-IB controller PCA (Figure 8-4, 1).
4. Remove the PCA holder (Figure 8-4, 2) holding the HP-IB controller PCA in place. To remove the PCA holder, press in on the holder and pull it out of the chassis.
5. Slide the HP-IB controller PCA toward the rear of the disk storage system until it can be lifted out of the disk storage system chassis.

HP-IB Cache Controller PCA

The following procedure applies to model 670XP disk storage systems.

1. Remove the front panel and top cover.
2. Remove the I/O panel.
3. Disconnect all cables from the HP-IB cache controller PCA (Figure 8-5, 1).
4. Remove the PCA holder (Figure 8-5, 3) holding the HP-IB cache controller PCA in place. To remove the PCA holder, press in on the holder and pull it out of the chassis.
5. Slide the HP-IB cache controller PCA out the rear of the disk storage system.

Caution

When replacing the HP-IB cache controller PCA, there is the possibility that the NVRAM (Figure 8-5, 2) on the old controller PCA contains data that has not yet been updated to the disk media. To avoid losing this data, the NVRAM should be removed from the old controller PCA and installed on the new PCA. This will allow the new controller PCA to update the disk when power is applied.

If the original NVRAM itself has failed, it should be removed from the new controller PCA and the new NVRAM installed.

When installing a cache controller PCA with new NVRAM, the cache should be initialized following the procedure in "Initializing 670XP Disk Storage System Cache Memory" in Chapter 2.

HP-FL Controller PCA

The following procedure applies to model 670FL and 1.34FL disk storage systems.

1. Remove the front panel and top cover.
2. Remove the I/O panel.
3. Disconnect all cables from the HP-FL controller PCA (Figure 8-6, 1).
4. Remove the PCA holder (Figure 8-6, 2) holding the HP-FL controller PCA in place. To remove the PCA holder, press in on the holder and pull it out of the chassis.
5. Slide the HP-FL controller PCA out the rear of the disk storage system.

Note

When installing an HP-FL controller PCA in a model 1.34FL, the ESDI data cables must be connected to the proper connectors on the controller PCA. Disk mechanism 1 must be connected to data port 1 (J3) on the HP-FL controller PCA, and disk mechanism 2 must be connected to data port 2 (J5). If the connectors are inadvertently swapped, self-test will fail with a disk mechanism fault.

Before installing a new HP-FL controller PCA, perform the following steps:

1. Determine whether an ASTEC or DELTA power supply is installed in the disk storage system. The ASTEC supply has a voltage selection switch and external fuse; the DELTA supply has neither.

Caution

Make sure the power supply jumper on the new HP-FL controller PCA is in the location corresponding to the type of power supply installed in the disk storage system. Operating the disk storage system with the jumper in the wrong location may damage the HP-FL controller PCA.

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2. Check the location of the power supply jumper on the new HP-FL controller PCA. See Figure 8-2. If the jumper is not on the connector corresponding to the type of power supply installed, move the jumper to the proper connector.

* *The ASTEC power supply is a product of ASTEC Europe Limited.*

** *The DELTA power supply is a product of DELTA Electronic Industries Co., Ltd.*

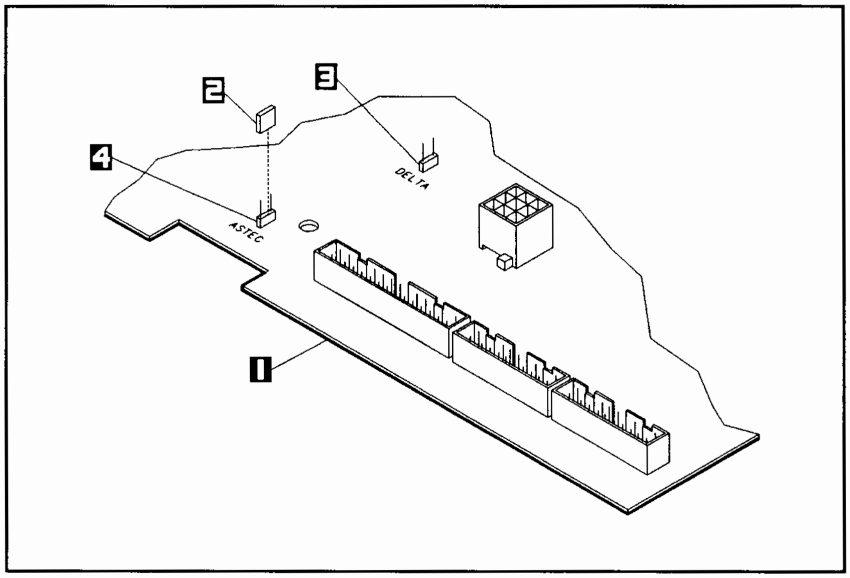

Figure 8-2. Checking the Power Supply Jumper

1. HP-FL controller PCA
2. Power supply jumper
3. DELTA connector
4. ASTEC connector

Power Supply

1. Remove the front panel and top cover.
2. Disconnect all cables from the power supply (Figure 8-3, 25).
3. Remove the T20 screws (26) mounting the power supply to the disk storage system chassis. The ASTEC supply is held in place with two screws, and the DELTA supply is held in place with four screws.
4. Slide the power supply toward the front of the disk storage system until the mounting tabs on the power supply disengage the slots in the disk storage system chassis.
5. Lift the power supply out of the disk storage system.

Before installing a new power supply, perform the following:

1. If the power supply being installed has a voltage selector switch, make sure the switch is set to the proper position before operating the disk storage system.

Caution When replacing the power supply on an FL-model disk storage system, make sure the power supply jumper on the HP-FL controller PCA is in the location corresponding to the type of power supply being installed. Operating the disk storage system with the jumper in the wrong location may damage the HP-FL controller PCA.

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2. When installing a new power supply in an FL-model disk storage system, check the location of the power supply jumper on the HP-FL controller PCA. See Figure 8-2. If the jumper is not on the connector corresponding to the type of power supply being installed, move the jumper to the proper connector.

Note The ASTEC supply has a voltage selection switch and external fuse; the DELTA supply has neither.

Fan

1. Remove the front panel and top cover.
2. Disconnect the fan cable from the power supply.
3. Pull the fan cable out of its plastic cable guides.
4. Remove the two screws (Figure 8-3, 33) mounting the fan (32) to the disk storage system chassis.
5. Remove the fan.

Status Display

1. Remove the front panel and top cover.
2. Remove the disk mechanism. On dual-mechanism models, only the disk mechanism directly behind the status display (Figure 8-3, 34) must be removed.
3. Disconnect the status display cable from the power supply cable.
4. Pull the status display cable out of its plastic cable guides.
5. Remove the status display by pulling in on the plastic tab mounting the status display to the disk storage system chassis.

Replaceable Parts

The field replaceable parts common to all models of the disk storage systems are listed in Table 8-1 and illustrated in Figure 8-3. Because the controller PCA and its associated cabling differ significantly between models, these parts are included in separate tables and figures. Also included is a list of cabinet and rack adapter parts used in mounting the disk storage system.

The parts are listed in order of disassembly. Attaching parts are listed immediately after the item they attach. Items in the DESCRIPTION column are indented to show their relationship to the next higher assembly. In addition, the symbol "- - - x - - -" follows the last attaching part for the item. Identification of the items and the labels is as follows:

Major Assembly

*Replaceable Assembly

*Attaching Part for Replaceable Assembly

**Subassembly or Component Part

**Attaching Part for Subassembly or Component Part

***Sub-subassembly or Component Part

***Attaching Parts for Sub-subassembly or Component Part

The replaceable parts listings provide the following information for each part:

a. FIG & INDEX NO. The figure and index number which indicates where the replaceable part is illustrated.

b. HP PART NO. The Hewlett-Packard number for each replaceable part.

c. DESCRIPTION. The description of each replaceable part. (Refer to table 8-2 for an explanation of the abbreviations used in the DESCRIPTION column.)

d. UNITS PER ASSEMBLY. The total quantity of each part used in the major assembly.

The items included in the parts list can be ordered through your local Hewlett-Packard Sales Office. Parts that can also be ordered directly from the manufacturer are identified in the description of the item. Common hardware can usually be purchased locally.

Ordering Information

To order replaceable parts for the disk storage system, address the order to your local Hewlett-Packard Sales Office. For the address of the nearest HP Sales Office, contact a Hewlett-Packard Headquarters Office. Headquarters Offices are listed at the rear of this manual. Specify the following information in each order:

a. Model number and full serial number.

b. Complete Hewlett-Packard part number.

c. Complete description of each part, as provided in the replaceable parts listing.

Service Kit Contents

To adequately support the disk storage systems, the following items are recommended for field service inventory:

PART NUMBER	DESCRIPTION
C2200-60013	Control Cable (335H, 670H)
C2201-60116	Control Cable (670FL, 670XP)
C2204-60421	Control Cable (1.34FL)
C2200-60013	Data Cable (335H, 670H)
C2201-60115	Data Cable (670FL, 670XP)
C2204-60420	Data Cable (1.34FL)
C2200-60001	Fan
07961-60004	I/O Cable (335H, 670H)
C2202-60209	I/O Cable (670XP)
07961-60014	I/O PCA (335H, 670XP, 670H)
C2200-60017	LED Cable
C2201-60122	Mechanism Power Cable (670FL, 670XP)
C2204-60412	Mechanism Power Cable (1.34FL)
C2201-60123	Controller Power Cable (670FL, 670XP, 1.34FL)
C2200-60020	Power Cable (335H, 670H)

Table 8-1. Disk Storage System Replaceable Parts

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	UNITS PER ASSY
8-3-	C2200A	DISK STORAGE SYSTEM, 335 Mbyte, HP-IB	REF
	C2201A	DISK STORAGE SYSTEM, 670 Mbyte, HP-FL	REF
	C2202A	DISK STORAGE SYSTEM, 670 Mbyte, HP-IB Cache	REF
	C2203A	DISK STORAGE SYSTEM, 670 Mbyte, HP-IB	REF
	C2204A	DISK STORAGE SYSTEM, 1.34 Gbyte, HP-FL	REF
1	C2200-60008	*FRONT PANEL	1
2	C2200-00002	*NAME PLATE, 335H	1
	C2201-00002	*NAME PLATE, 670FL	REF
	C2202-00002	*NAME PLATE, 670XP	REF
	C2203-00002	*NAME PLATE, 670H	REF
	C2204-00002	*NAME PLATE, 1.34FL	REF
3	C2200-60016	*TOP COVER	1
		(Attaching Parts)	
4[1]	0515-0390	*SCREW, T15, 6 mm, M4.0 by 0.7	2
		- - - X - - -	
		NOTE: Parts 5 through 9 are used on models 335H, 670H, and 670XP	
5	C2200-00009	*HP-IB I/O PANEL	1
		(Attaching Parts)	
6[1]	0515-0390	*SCREW, T15, 6 mm, M4.0 by 0.7	3
		- - - X - - -	
7	07961-60014	HP-IB I/O PCA	1
		(Attaching Parts)	
8	0380-1332	*HEX STANDOFF, 0.18 inch	2
9	2190-0074	*LOCK WASHER	2
		- - - X - - -	

[1]These parts may be obtained locally by their description.

Table 8-1. Disk Storage System Replaceable Parts (continued)

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	UNITS PER ASSY
		NOTE: Parts 10 through 13 are used on models 670FL and 1.34FL	
10	C2201-60025	*HP-FL I/O PANEL	1
		(Attaching Parts)	
11[1]	0515-0390	*SCREW, T15, 6 mm, M4.0 by 0.7	5
		- - - X - - -	
12	C2201-60027	*PBUS CLAMP	1
		(Attaching Parts)	
13[1]	0515-0433	*SCREW, T15, 8 mm, M4.0 by 0.7	2
		- - - X - - -	
14	C2200-00023	*CLIP	1
		(Attaching Parts)	
15[1]	0515-0433	*SCREW, T15, 8 mm, M4.0 by 0.7	1
		- - - X - - -	
16	C2200-60025	*FRONT INSERT ASSEMBLY	1
17	C2200-60051	*DISK MECHANISM, 335 megabyte (Used on model 335H only)	1
	C2201-60051	*DISK MECHANISM, 670 megabyte	REF
		(Attaching Parts)	
18[1]	2680-0309	*SCREW, TORX, T20, 10-24, 0.5 inch	1
		- - - X - - -	
19	C2200-60005	*MOUNTING BRACKET ASSEMBLY	2
		(Attaching Parts)	
20[1]	0515-2111	*SCREW, T10, 0.25 in., 6-32	4
		- - - X - - -	
21	1400-0977	**RFI CLIP	1

[1]These parts may be obtained locally by their description.

Table 8-1. Disk Storage System Replaceable Parts (continued)

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	UNITS PER ASSY
22	97548-60028	**ESDI PCA, original version	1
	97548-60128	**ESDI PCA, newer surface-mount version	REF
		(Attaching Parts)	
23[1]	0515-0372	**SCREW, T10, 8 mm, M3.0 by 0.50	4
		- - - X - - -	
24	1810-1176	***TERMINATOR RESISTOR PACK	1
24A	C2200-40012	*CONNECTOR LOCK	1
25	C2200-60044	*POWER SUPPLY, DELTA	1
	C2200-60024	*POWER SUPPLY, ASTEC (obsolete)	REF
		(Attaching Parts)	
26[1]	2680-0309	*SCREW, TORX, T20, 10-24, 0.5 inch (used with ASTEC supply)	2
	0515-0390	*SCREW, TORX, T15, 6 mm, M4.0 by 0.7 (used with DELTA supply)	4
		- - - X - - -	
27	2110-0010	**FUSE, 5A, 250V, non-time-delay (Used in ASTEC power supply only.)	1
28	07961-40004	*ROCKER ARM	1
29	07961-40003	*PUSH ROD	1
30	07961-60005	*PUSH BUTTON ASSEMBLY	1
31	1460-2216	**SPRING	1
32	C2200-60001	*FAN	1
		(Attaching Parts)	
33[1]	0624-0661	*SCREW, T20, 0.625 in., 10-14	2
		- - - X - - -	
34	C2200-60017	*STATUS DISPLAY	1
35	1400-1567	*CABLE CLIP	4
36	C2200-60014	*CHASSIS ASSEMBLY	1
37	C2201-80006	**RFI CLIP	6

[1]These parts may be obtained locally by their description.

Table 8-1. Disk Storage System Replaceable Parts (continued)

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	UNITS PER ASSY
38	8120-3445	*HP-IB CABLE, 1 meter (Model 10833A)	1
	5061-3174	*PBUS CABLE, 807-mm	REF
39	8120-2371	*POWER CORD, NEMA10A/CEE (903)	1
	8120-0698	*POWER CORD, NEMA15A/CEE (904)	REF
	8120-1351	*POWER CORD, BS 1363/CEE (900)	REF
	8120-1369	*POWER CORD, ASC 112/CEE (901)	REF
	8120-1689	*POWER CORD, GMBH/CEE (902)	REF
	8120-1860	*POWER CORD, CEE/CEE, 1.5 meter (905)	REF
	8120-2104	*POWER CORD, SEV/CEE (906)	REF
	8120-2956	*POWER CORD, MDPP/CEE (912)	REF
	8120-4211	*POWER CORD, SABS/CEE (917)	REF
	8120-4753	*POWER CORD, NEMA12A/CEE (918)	REF

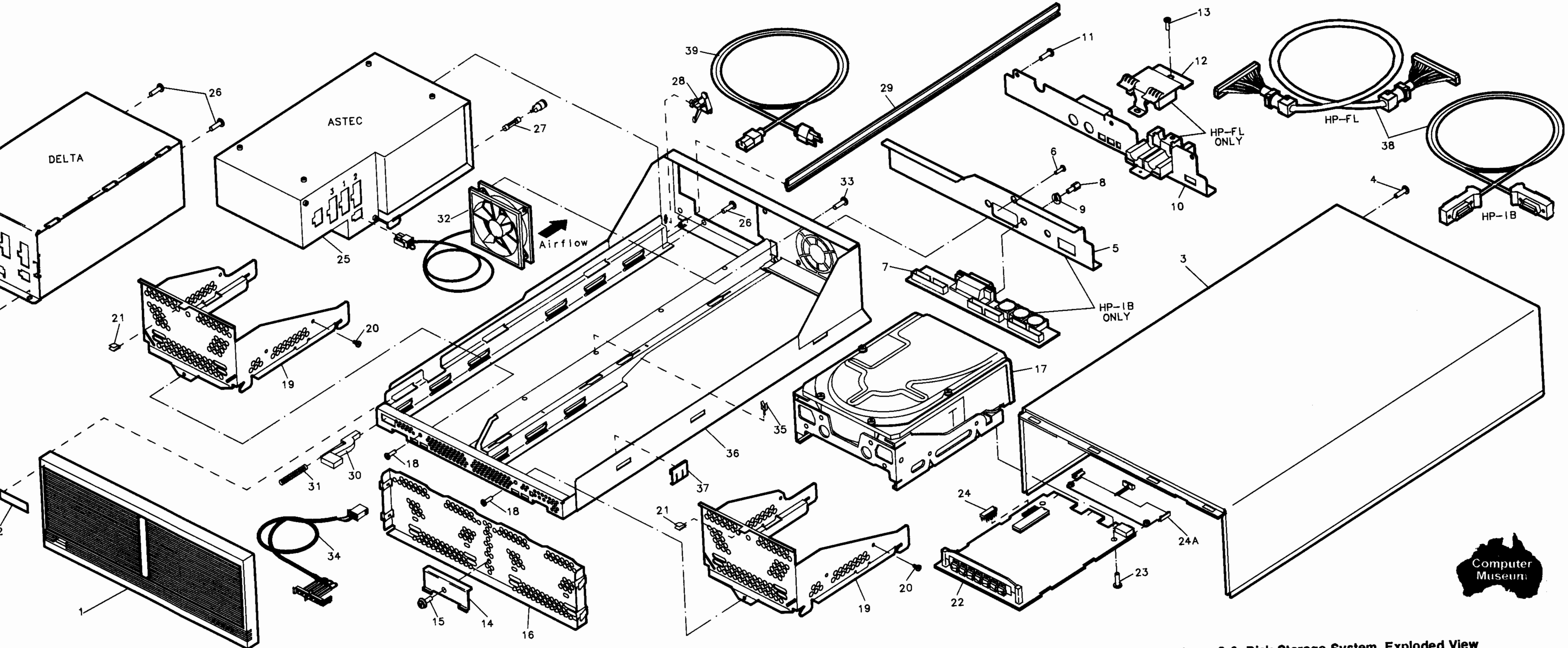
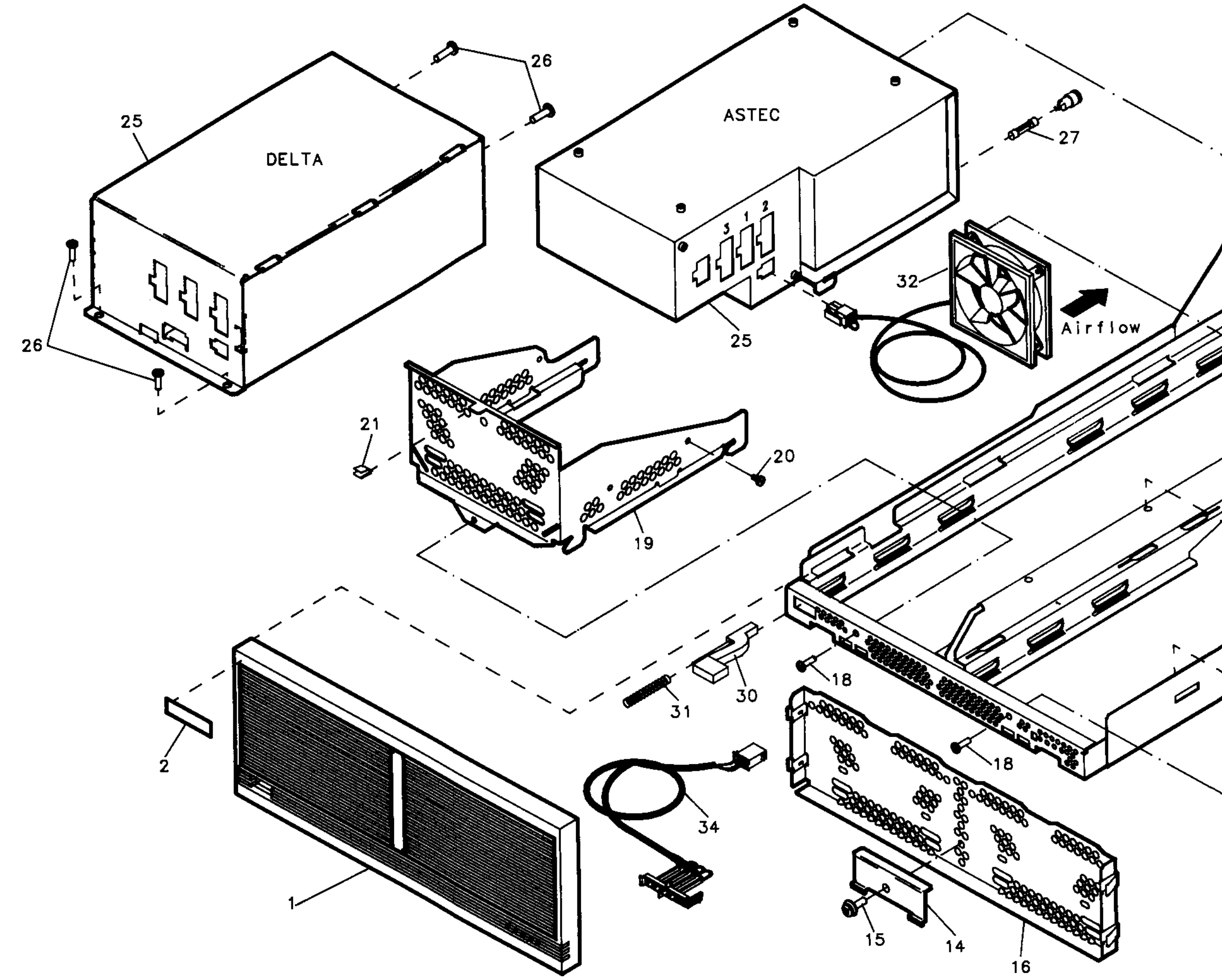


Figure 8-3. Disk Storage System, Exploded View



DELTA
ASTEC
Airflow
3
1
2
25
26
27
32
25
26
21
20
19
2
1
31
30
18
18
34
15
14
16

Table 8-2. Model 335H and 670H Controller PCA and Cabling

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	UNITS PER ASSY
8-4-	C2200A	DISK STORAGE SYSTEM, 335 Mbyte, HP-IB	REF
	C2203A	DISK STORAGE SYSTEM, 670 Mbyte, HP-IB	REF
1	C2200-60037	*HP-IB CONTROLLER PCA	1
2	07961-40011	*PCA HOLDER	1
3	07961-60004	*I/O CABLE	1
4	C2200-60012	*DATA CABLE	1
5	C2200-60013	*CONTROL CABLE	1
6	C2200-60020	*POWER CABLE	1

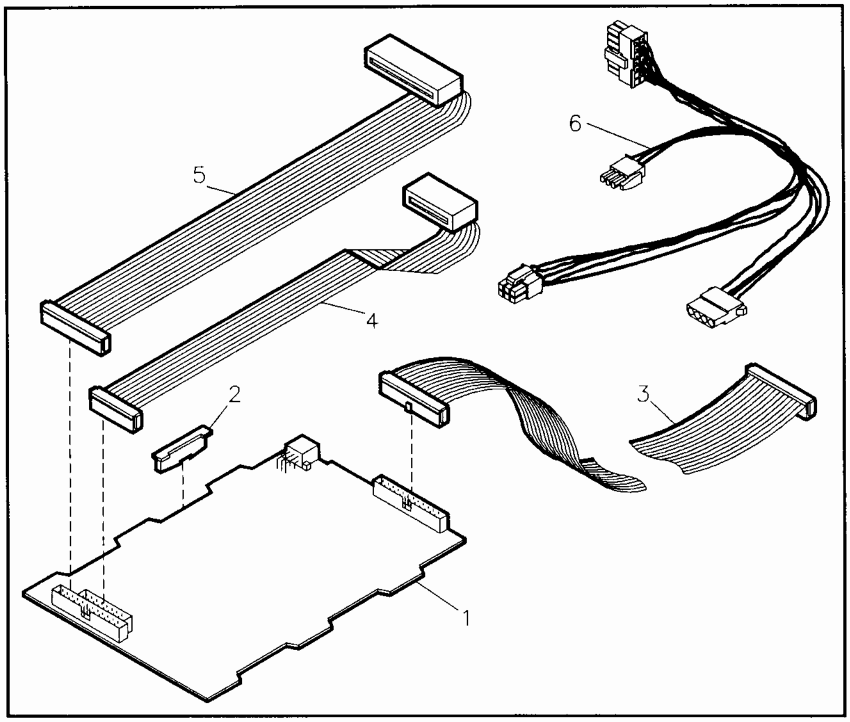


Figure 8-4. Models 335H and 670H Controller PCA and Cabling, Exploded View

Table 8-3. Model 670XP Controller PCA and Cabling

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	UNITS PER ASSY
8-5-	C2202A	DISK STORAGE SYSTEM, 670 Mbyte, HP-IB Cache	REF
1	C2202-60001	*HP-IB CACHE CONTROLLER PCA	1
2	1818-4531	**NON-VOLATILE RAM, write cache	1
3	07961-40011	*PCA HOLDER	1
4	C2202-60209	*I/O CABLE	1
5	C2201-60115	*DATA CABLE	1
6	C2201-60116	*CONTROL CABLE	1
7	C2201-60122	*MECHANISM POWER CABLE	1
8	C2201-60123	*CONTROLLER POWER CABLE	1

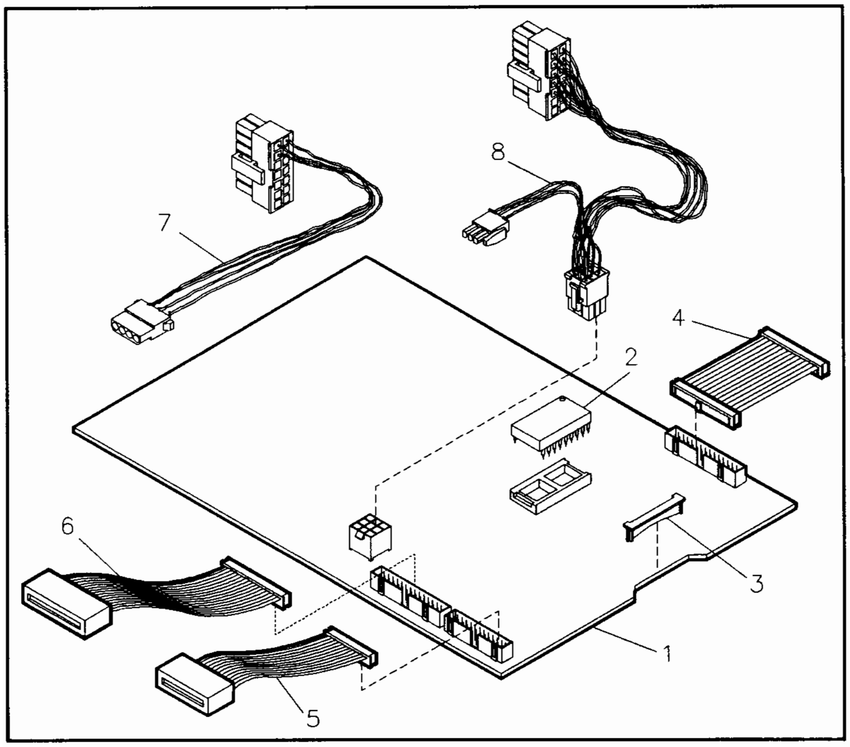


Figure 8-5. Model 670XP Controller PCA and Cabling, Exploded View

Table 8-4. Model 670FL Controller PCA and Cabling

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	UNITS PER ASSY
8-6-	C2201A	DISK STORAGE SYSTEM, 670 Mbyte, HP-FL	REF
1	C2201-60004	*HP-FL CONTROLLER PCA	1
	C2201-60005	*HP-FL CONTROLLER PCA, Option 1BG	REF
2	07961-40011	*PCA HOLDER	1
3	C2201-60115	*DATA CABLE	1
4	C2201-60116	*CONTROL CABLE	1
5	C2201-60122	*MECHANISM POWER CABLE	1
6	C2201-60123	*CONTROLLER POWER CABLE	1

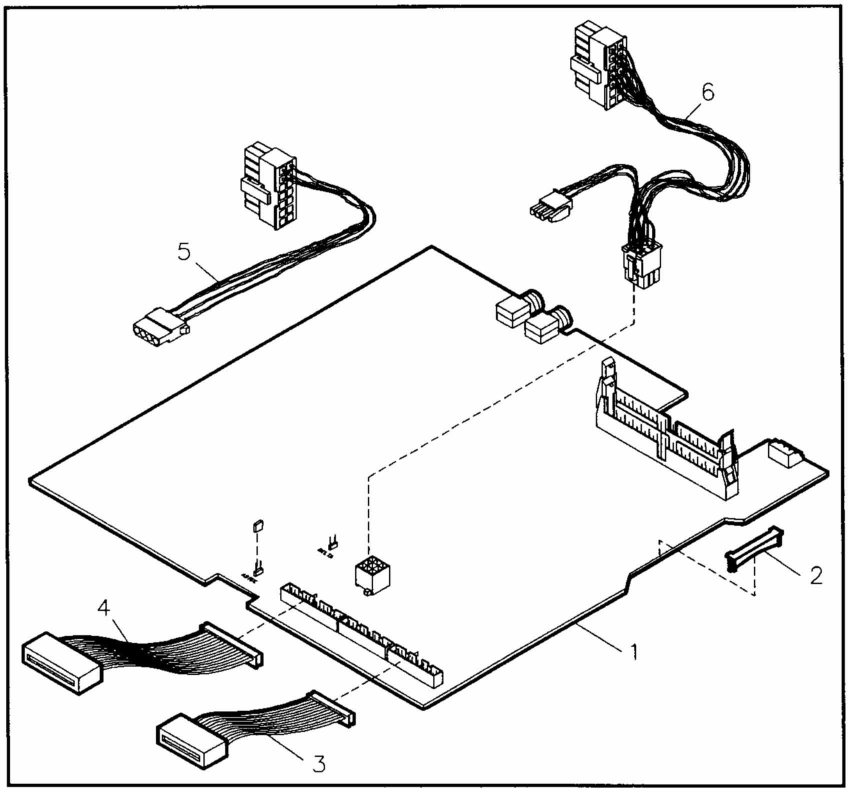


Figure 8-6. Model 670FL Controller PCA and Cabling, Exploded View

Table 8-5. Model 1.34FL Controller PCA and Cabling

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	UNITS PER ASSY
8-7-	C2204A	DISK STORAGE SYSTEM, 1.34 gigabyte, HP-FL	REF
1	C2201-60004	*HP-FL CONTROLLER PCA	1
	C2201-60005	*HP-FL CONTROLLER PCA, Option 1BG	REF
2	07961-40011	*PCA HOLDER	1
3	C2201-60124	*DATA CABLE, mechanism 1	1
4	C2204-60420	*DATA CABLE, mechanism 2	1
5	C2204-60421	*CONTROL CABLE	1
6	C2201-60123	*CONTROLLER POWER CABLE	1
7	C2201-60122	*POWER CABLE, mechanism 1	1
8	C2204-60412	*POWER CABLE, mechanism 2	1

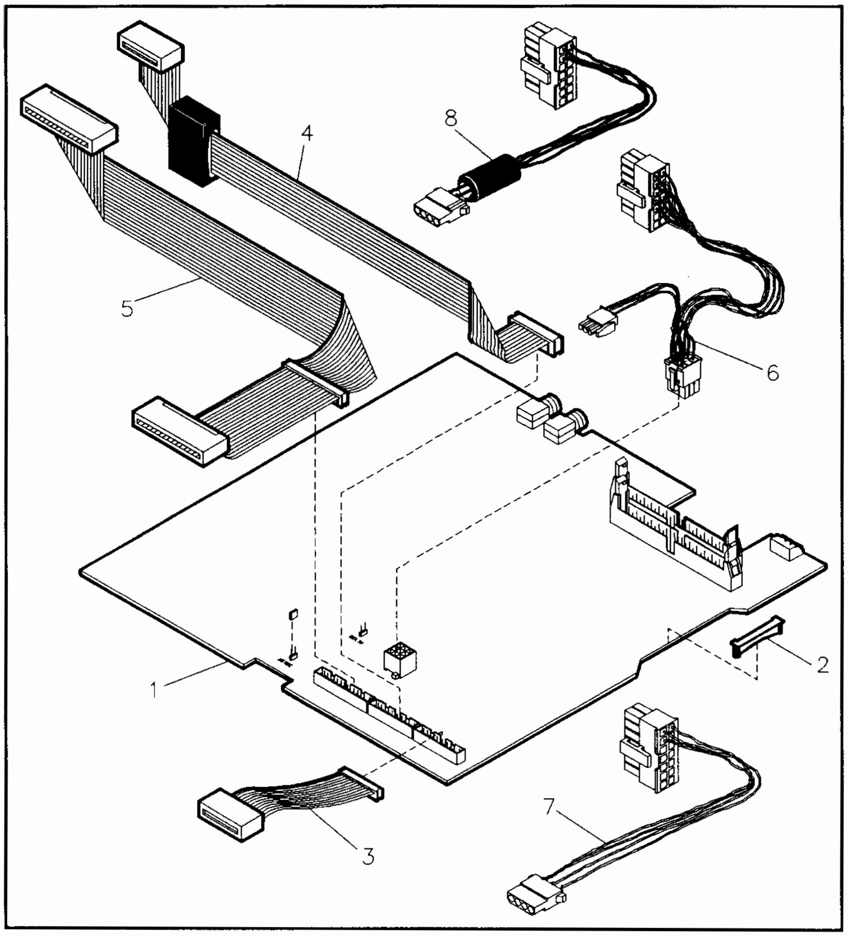


Figure 8-7. Model 1.34FL Controller PCA and Cabling, Exploded View

Table 8-6. Cabinet and Rack Adapter Parts

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	UNITS PER ASSY
	46299A	EIA CABINET	REF
	29453-60001	*EIA RACK	1
	5062-0268	*FRONT DOOR	1
	5062-0270	*REAR DOOR	1
	35199C	*EIA RACK ADAPTER KIT	8
		(See below for 35199C parts)	
	8120-1860	*POWER CORD	8
	5061-3171	*PDU	1
	5061-3172	*PDU POWER CORD	1
	92211Y	CABINET	REF
	92211S	*MOUNTING RAIL KIT	1
	92211T	*FILLER PANEL KIT	1
	92199E	*POWER STRIP	1
	8120-1575	*POWER CORD	4
	35199C	EIA RACK ADAPTER KIT	REF
	5001-3349	*ADAPTER TRAY	1
		(Attaching Parts)	
	0590-0804	*SHEETMETAL NUT, 10-32	4
	2680-0278	*SCREW, T25, 0.5 in., 10-32	4
		- - - X - - -	
	5001-3350	*MOUNTING FLANGE	2
		(Attaching Parts)	
	0590-0804	*SHEETMETAL NUT, 10-32	2
	0570-1366	*SCREW, 10-32, 0.625 in., Phillips	2
		- - - X - - -	

Table 8-6. Cabinet and Rack Adapter Parts (continued)

FIG.& INDEX NO.	HP PART NO.	DESCRIPTION	UNITS PER ASSY
	92211Q	RACK ADAPTER KIT (For HP 19514A Cabinet)	REF
	5061-3170	*ADAPTER TRAY	1
		(Attaching Parts)	
	0515-0433	*SCREW, T15, 8 mm, M4.0 by 0.7	
		- - - X - - -	

9

Diagrams

Introduction

This chapter includes the following figures:

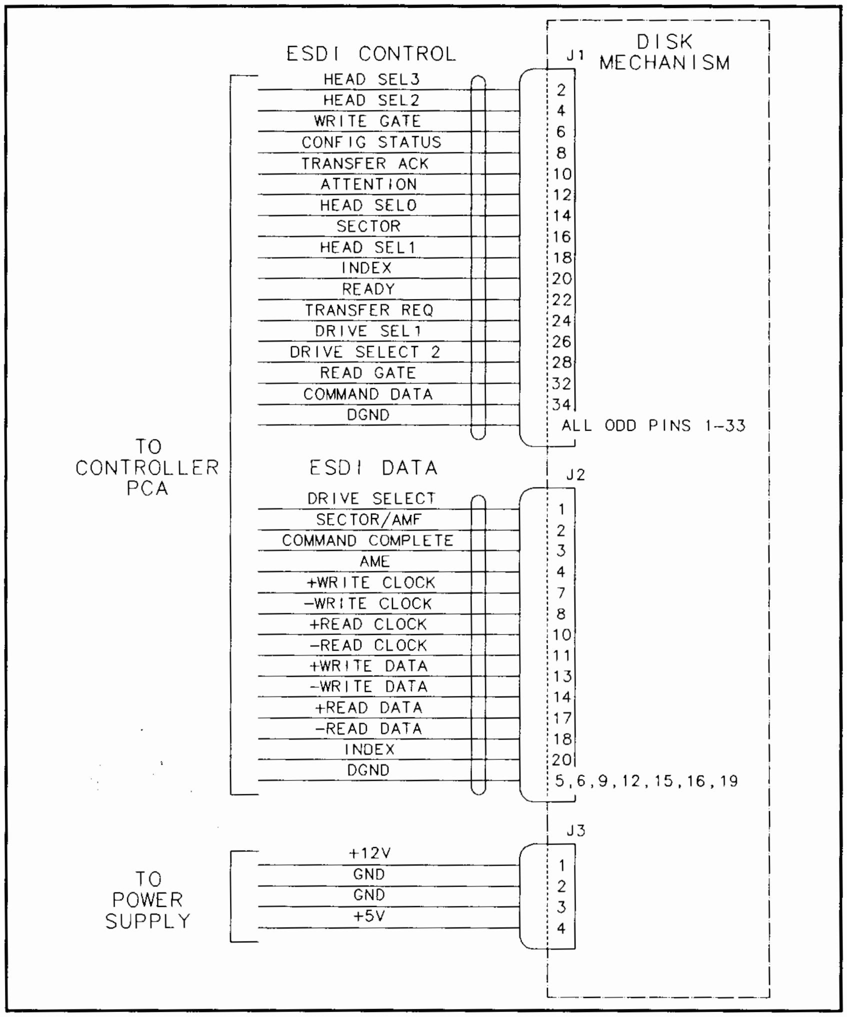


Figure 9-1. Disk Mechanism Signal Distribution

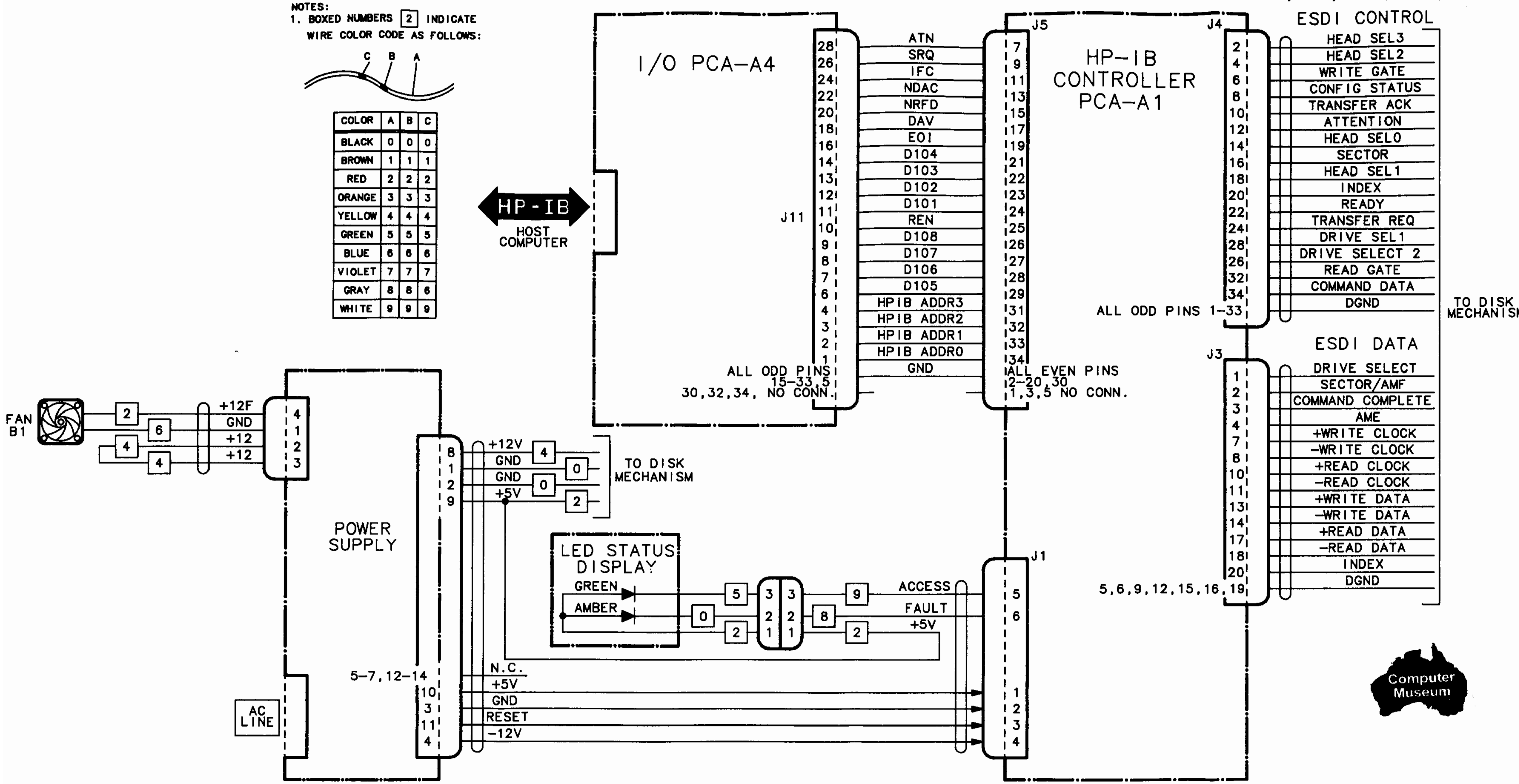


Figure 9-2. 335H and 670H Signal Distribution

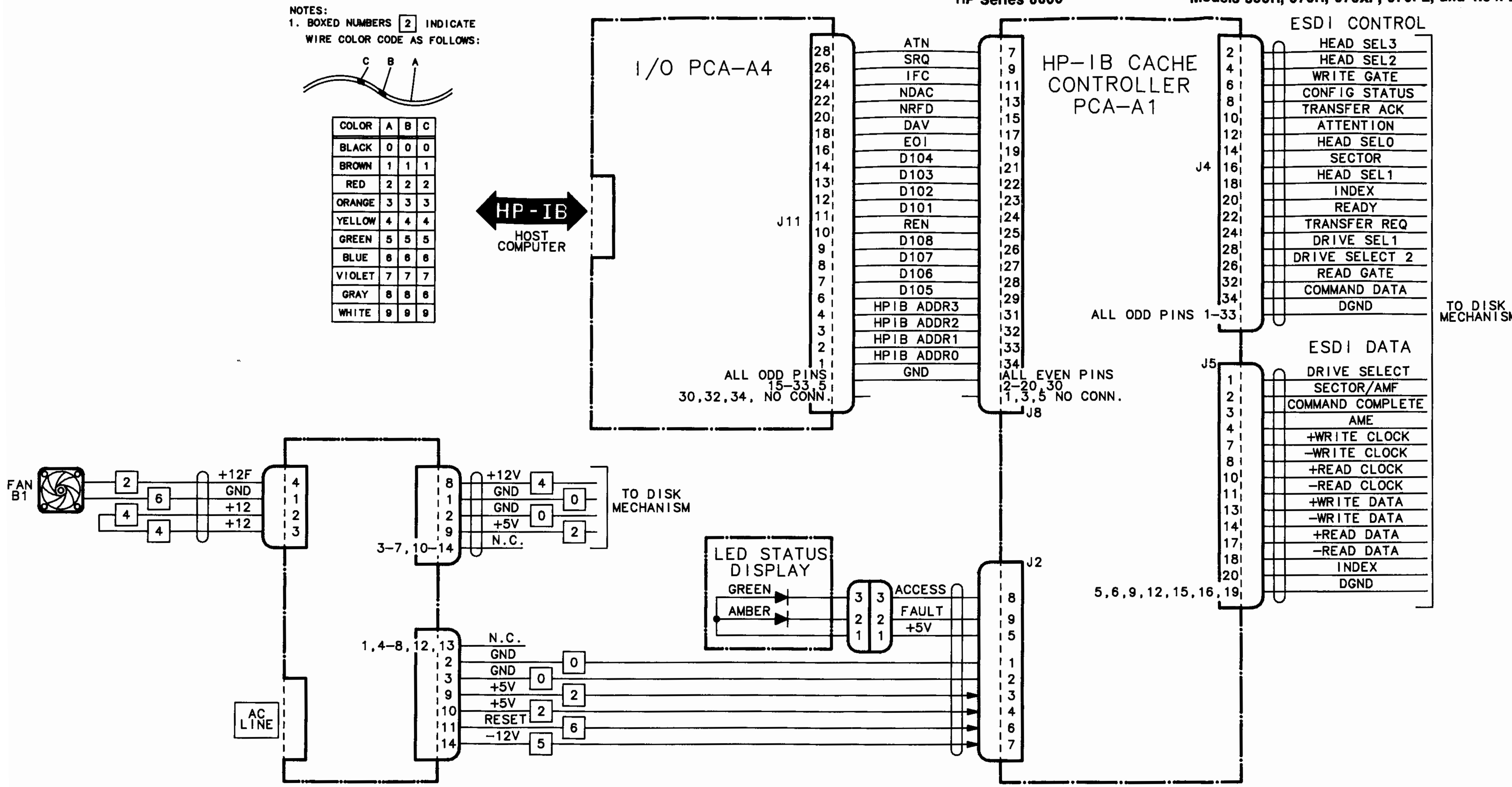


Figure 9-3. 670XP Signal Distribution

NOTES:
1. BOXED NUMBERS [2] INDICATE WIRE COLOR CODE AS FOLLOWS:

COLOR	A	B	C
BLACK	0	0	0
BROWN	1	1	1
RED	2	2	2
ORANGE	3	3	3
YELLOW	4	4	4
GREEN	5	5	5
BLUE	6	6	6
VIOLET	7	7	7
GRAY	8	8	8
WHITE	9	9	9

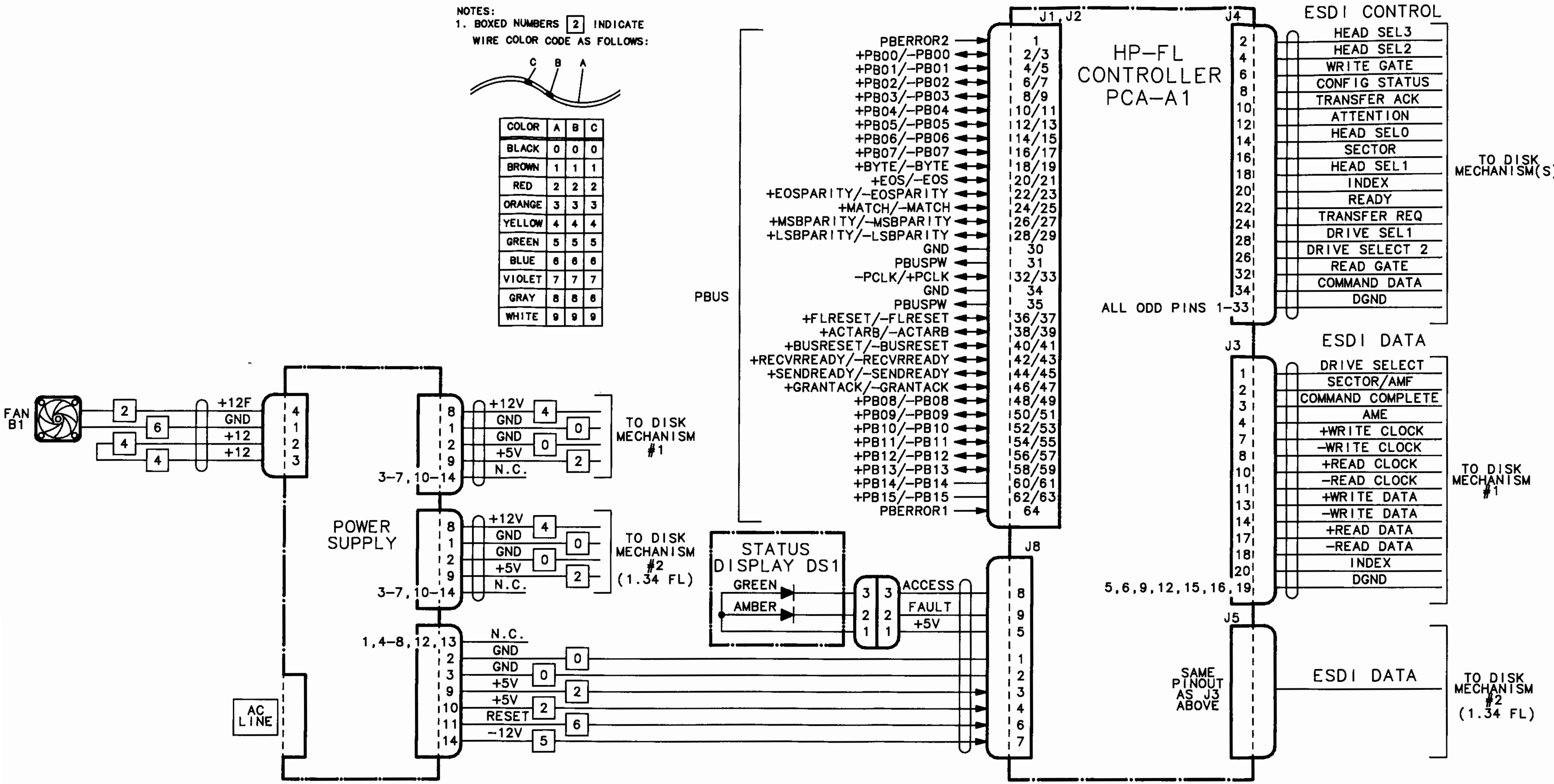


Figure 9-4. 670FL and 1.34FL Signal Distribution

10

Theory of Operation

Introduction

This chapter describes the operation of the disk storage system to the functional assembly level. The disk storage system can be broken down into the following major functional assemblies:

- HP-IB controller PCA or HP-FL controller PCA - manages the overall operation of the disk storage system. The controller PCA coordinates the flow of data between the host and the disk mechanism by programming the ESDI PCA to perform the necessary data transfer.
- ESDI PCA - initiates and controls data transfers to or from the disk media in the HDA. The ESDI PCA includes the servo and read/write circuits used to locate and transfer data.
- Head disk assembly (HDA) - contains the disk media, data heads, and other electro-mechanical assemblies used to store and retrieve information on the disk media. The HDA operates under the direct control of the ESDI PCA.
- Power supply - develops and distributes the dc operating voltages.

Each of the major assemblies are discussed in the following paragraphs. In addition, media format and the ESDI and HP-FL interfaces are also discussed in this chapter.

HP-IB Controller PCA

The HP-IB controller PCA manages the overall operation of the disk storage system. The HP-IB controller PCA performs such higher-level functions as target sector identification, disk sector formatting, sparing, data error correction, and self-test diagnostics. The controller PCA serves as the interface between the computer system HP-IB channel and the disk mechanism, interpreting the host CS/80 commands and generating the proper ESDI command to cause the disk mechanism to perform the data transfer.

The operations of the controller PCA are divided among six circuits:

- HP-IB interface
- DMA
- Processor control
- ECC
- ESDI interface
- Cache (670XP only)

These circuits are shown in Figure 10-1 and discussed in greater detail in the following paragraphs.

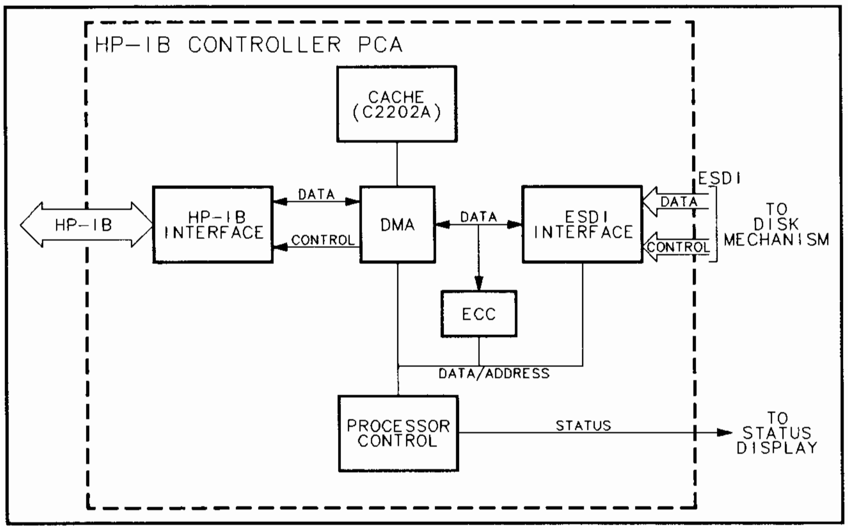


Figure 10-1. HP-IB Controller PCA Functional Diagram

HP-IB Interface

As its name implies, the primary function of the HP-IB interface is to implement the HP-IB channel protocol. This includes detection of all primary commands, parallel poll and identify response, and the transmission of data over the bus.

All data is transferred between the HP-IB interface and the DMA. The overall operation of the HP-IB interface is controlled by the DMA.

DMA

The DMA manages the transfer of all data between the host and the disk storage system. In its primary function, the DMA coordinates the flow of user data between the host and the disk media. The DMA also transfers CS/80 command and status data between the host and the processor control.

To manage the flow of data, the DMA uses two independent state machines. An I/O state machine coordinates the transfer of data between the HP-IB channel and the DMA buffer RAM. A disk state machine controls the transfer of user data between the DMA buffer RAM and the disk mechanism. The use of the two state machines and buffer RAM allow the DMA to match the different operating speeds of the HP-IB channel and the ESDI bus.

The operation of the DMA is controlled by the processor control. To initiate a data transfer, the DMA is programmed for the type (read or write) and length of the transfer. The DMA then uses its internal state machines to synchronize the flow of data between the host and the disk mechanism. The DMA passes all CS/80 command and status information between the host and the processor control.

The DMA also generates the CRC code, which it uses to detect the occurrence of data errors.

Processor Control

The overall operation of the HP-IB controller PCA is managed by the processor control. This circuitry contains a microprocessor and its supporting hardware circuitry, including the ROM used to store the controller operating system firmware.

The processor control implements its control through the use of various firmware tasks. These tasks include such operations as decoding CS/80 commands, transferring user data, allocating hardware resources, executing self-test diagnostics, correcting data errors, and detecting and reporting any problems to the host.

The processor control initiates the various tasks by passing commands to the other circuits on the HP-IB controller PCA. When a task is complete, status is passed back to the processor control indicating the success or failure of the operation.

The processor control communicates with the other circuits on the controller PCA over its address bus and data bus. The processor control also passes status information to the front panel LED status display during self-test.

ECC

The ECC improves data reliability by detecting and correcting data errors. It performs this function by monitoring all data transfers between the DMA and the disk mechanism, and using a special ECC code to detect and correct any data errors.

When data is written to the disk mechanism, the ECC generates 12 bytes of ECC code which are appended to the data field of each sector. When the data is read, the ECC uses the ECC bytes to detect the occurrence of any data errors. If an error is detected, the ECC alerts the microprocessor control, which performs the actual data correction. Up to six bytes in a sector can be corrected using ECC.

ESDI Interface

The ESDI interface provides the communication link between the HP-IB controller PCA and the disk mechanism. This circuitry is responsible for implementing the ESDI protocol required by the disk mechanism. All ESDI timing, selection, commands, status, and data transfers are controlled by this circuitry.

The ESDI interface includes two data ports, allowing up to two disk mechanisms to be connected to the ESDI. Each disk mechanism has its own dedicated ESDI data bus. The disk mechanisms share a common ESDI control bus.

All user data is transferred between the DMA and the disk mechanism through the ESDI interface. When writing data to the disk media, the ESDI interface converts the parallel data format used by the DMA into the serial data stream required for transmission over the ESDI data bus. When reading data from the disk, the ESDI interface converts the serial ESDI data stream into the parallel DMA format.

The ESDI interface uses status returned by the disk mechanism to detect disk mechanism problems, and reports these problems to the processor control.

Cache (670XP Only)

The cache contains the memory required to implement disk caching, which improves disk performance by reducing the number of disk accesses required to locate data.

The cache includes 2 megabytes of dynamic RAM used as read cache. The RAM can be organized by the host into pages of 4, 8, 16, or 32 kilobytes in length. The cache contains copies of the most recently accessed data. Before performing a read operation, the cache is searched to determine if the required data is in RAM. If it is, no disk access is required.

The cache also includes 4 kilobytes of NVRAM used during disk writes. When writing to the disk, the data is stored in RAM and the host is immediately informed that the write is complete. The data is then transferred to the disk media at the first opportunity. This “immediate write” feature improves system performance by quickly freeing up the host to perform other operations.

HP-FL Controller PCA

The HP-FL controller PCA performs the same function as the HP-IB controller PCA. As shown in Figure 10-2, many of the circuits are common to both PCAs. The primary difference between the two controllers lies in the host channel interface. Because most of the common controller circuits have already been discussed for the HP-IB controller PCA, the discussion here is limited to those circuits unique to the HP-FL controller PCA: the PBus interface, the fiber optic interface, and the protocol processor.

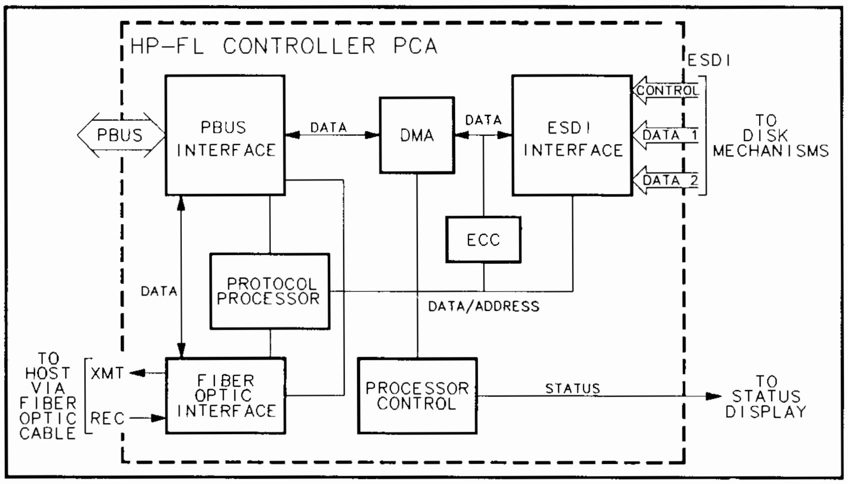


Figure 10-2. HP-FL Controller PCA Functional Diagram

PBus Interface

The PBus interface provides the HP-FL controller PCA access to the electrical PBus. The PBus interface implements the required protocol to communicate with other disk storage systems over the PBus. Bus arbitration, source and receiver selection, information transfer, and bus resets are all handled by the PBus interface. Under the direction of the protocol processor, the PBus interface coordinates the flow of all information across the PBus.

The PBus interface provides access to the PBus for the fiber optic interface, the DMA, and the protocol processor. Data transferred over the fiber optic link is routed between the fiber optic interface and the PBus through the PBus interface. The PBus interface routes segment header information between the PBus and the protocol processor. And FLEX messages are transferred between the PBus and the DMA through the PBus interface.

The PBus interface serves as the PBus source when it is writing data to the bus, and as the PBus receiver when it is reading data off the bus. The PBus interface can serve both functions simultaneously when it is transferring data between its own fiber optic interface and its protocol processor or DMA. It simply writes the data to the PBus and then reads it back in.

Included in the PBus interface are circuits which detect improper PBus cabling or termination. If the PBus is not configured properly, the PBus interface alerts the processor control, which passes the information to the PBus fault LEDs on the rear of the disk storage system.

Fiber Optic Interface

The fiber optic interface connects the HP-FL controller PCA to the fiber optic cable used to transfer data between the host and the disk storage system. This circuitry allows the remainder of the HP-FL controller PCA to communicate with the host over the fiber optic interface.

One of the primary functions of the fiber optic interface is to provide the fiber optic conversion. The receive data path converts incoming light energy to corresponding electrical signals, converts the serial data bits into parallel format, and sends the data to the PBus through the PBus interface. The transmit data path reverses the process for outgoing data. The fiber optic interface manages the flow of all data between the fiber optic channel and the PBus.

The fiber optic interface implements the fiber optic protocol, ensuring that all data being transferred over the link is formatted properly. It also checks for errors in the transmitted data and handles data retransmission if necessary.

The fiber optic interface detects the presence of host activity on the fiber optic cable and reports this information to the processor control for display on the HP-FL status LEDs. The fiber optic interface is inactive on any disk storage system not connected to the host via a fiber optic cable.

Protocol Processor

The protocol processor implements the higher levels of the HP-FL protocol. This includes sending, receiving, and interpreting message segment headers to manage the overall operation of the HP-FL interface.

At the direction of the processor control, the protocol processor can be programmed to perform such operations as receiving a command, sending or receiving an execution message, or sending a report. Once programmed, the protocol processor uses the PBus interface to perform the required transfer over the link.

As data is transferred between the fiber optic link and the PBus, the protocol processor uses the information in the segment headers to manage the operation of the link. The protocol processor monitors the progress of each transaction, sequencing the PBus interface through the proper steps to complete the operation. When the transfer is complete, the protocol processor informs the processor control.

The protocol processor also detects any problem with the HP-FL interface and reports these problems to the processor control.

ESDI PCA

The ESDI PCA controls the direct operation of the HDA. Spindle speed, head positioning, and data transfer, are all controlled by the ESDI PCA.

As shown in Figure 10-3, the ESDI PCA is divided into the following circuits:

- ESDI interface
- Microcontroller
- Disk controller
- Servo
- Read/write
- Spindle driver
- Actuator driver

ESDI Interface

The ESDI interface serves as the direct electrical interface between the controller PCA and the remainder of the ESDI PCA. This circuitry handles all ESDI timing and protocol, including disk mechanism and head selection decoding. The transfer of command, status, and configuration information is coordinated by the ESDI interface. Internal registers allow the microcontroller to program the operation of the interface and retrieve status information.

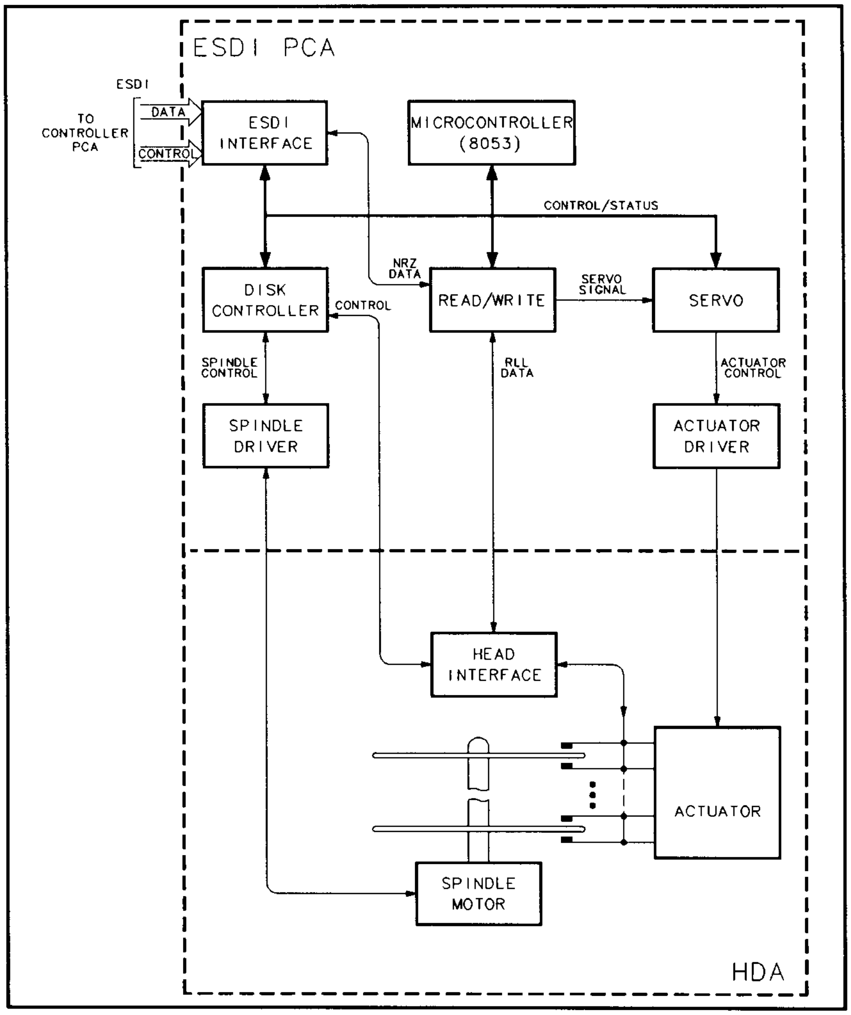


Figure 10-3. Disk Mechanism Functional Diagram

Microcontroller

The microcontroller manages the operation of the other ESDI PCA circuits. The program memory, which contains the operating system firmware, is internal to the microcontroller.

The microcontroller communicates with the rest of the circuits via four I/O ports. One of these ports serves as a combination address/data bus, providing the microcontroller access to the internal registers of the ESDI interface and disk controller. This allows the microcontroller to manage such functions as spindle startup, ESDI interface transfers, head selection, and servo and read/write timing. Incoming ESDI commands and outgoing status/configuration information are transferred between the microcontroller and the ESDI interface and disk controller through this port. The microcontroller uses the same port to pass acceleration and position information to the servo circuitry during seeks.

A second port is used to transfer control and timing signals to the servo and read/write circuits. The remaining ports monitor and control other ESDI PCA circuits.

The microcontroller coordinates the execution of the disk mechanism self-test executed at power-on. This self-test checks all aspects of disk mechanism operation. At the conclusion of the test, the microcontroller passes the results to the ESDI interface for transmission to the controller PCA.

Disk Controller

The disk controller performs several functions including servo timing and control, read/write timing and control, and spindle motor speed control. The overall operation of these circuits is controlled by the microcontroller via internal command and control registers. These registers allow the microcontroller to program the disk controller to perform the required operations.

The disk controller generates timing and control signals for both the servo and read/write circuits. These circuits detect and decode the servo information and synchronize all disk operations to these signals. The status of the mechanism hardware is collected and stored in an internal status register for use by the microcontroller.

The disk controller also maintains the proper spindle motor speed. Using a feedback signal from the HDA, the disk controller outputs control signals to the spindle driver to ensure that the proper spindle speed is maintained.

Servo

The servo circuitry establishes and maintains the proper position of the mechanism 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 circuitry, and then passed to the servo circuitry. Using this information, the servo 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 and control signals for the microcontroller and 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 disk operations. The microcontroller and disk controller generate control signals to initiate seeks, keep heads on track, and control the operation of the servo circuitry.

Read/Write

Under control of the microcontroller and disk controller, the read/write circuitry transfers data between the ESDI channel and the disk media. During write operations, the read/write circuitry accepts non-return-to-zero (NRZ) write data and its associated clock from the ESDI interface. The incoming NRZ data is encoded into 2-7 Run Length Limited (RLL) code, which is transferred to the head interface in the HDA to be written on the media.

During a read, the data is read from the disk and transferred through the head interface to the read/write circuitry. The read/write circuit translates the data back into NRZ format, recovers the read clock, then transfers both clock and data to the ESDI interface for transmission over the ESDI channel.

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

Actuator Driver

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

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 microcontroller. Once the motor is up to speed, the disk controller maintains the speed of the spindle.

Head/Disk Assembly

The head/disk assembly (HDA) 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 and is not field repairable or separately replaceable. The operation of the HDA is controlled by the ESDI PCA. The components of the HDA are shown in Figure 10-3.

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 four (C2200A) or eight (C2201A - C2204A) disks. Data is stored on both surfaces of each disk.

Media format is discussed later in this chapter.

Heads

There are eight (C2200A) or sixteen (C2201A - C2204A) data heads in the HDA which 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 a cushion of air.

Actuator Assembly

Mechanical positioning of the read/write heads is achieved using a 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 mechanism. This prevents the actuator from moving until power is applied to the disk mechanism. At power-on, the actuator driver releases the latch, allowing normal movement of the heads.

Head Interface

The head interface processes the data signals transferred between the read/write heads and the ESDI PCA. The head interface includes 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 circuitry on the ESDI PCA. Additional functions performed by the head interface include head selection and write control.

Spindle Assembly

The spindle assembly provides the mechanical mounting for the disks. The spindle rotates on a ball bearing system and is driven by a brushless DC motor attached to the HDA casting. The 3-phase drive current for the motor is provided by the spindle driver on the ESDI PCA. Three Hall-effect sensors, mounted on the spindle assembly, provide feedback signals to the spindle driver for proper commutation.

Power Supply

The power supply develops the dc operating voltages from the input ac line voltage and distributes these voltages to the other assemblies in the disk storage system. The dc voltages developed by the power supply are +5, +12, and -12 vdc. The output voltages are not adjustable.

In addition to the dc voltages, the power supply also outputs a RESET status signal, which is used by the controller PCA during power-on. At power-on, RESET remains deactivated (low) until the +5 volt output reaches +4.75 volts or higher, then RESET becomes active (high). RESET will be deactivated any time the +5 volt output drops below 4.75 volts.

The power supply is a self-contained switch-mode supply mounted in its own enclosure. An internal line filter reduces the level of line transients entering the power supply and the amount of switching noise leaving the supply. An internal fan provides cooling for the supply. A thermal protection circuit shuts down the outputs of the power supply if the temperature of the supply rises too high. When thermal shut down occurs, the supply must be turned off, allowed to cool down, and turned back on.

The controls on the power supply include an on/off switch, an ac line input connector, an external fuse, and a voltage selector switch. The dc voltages are output to the other assemblies through three connectors. The pinout is identical for each of these connectors. A fourth, smaller connector is used to provide +12 volts to the external cooling fan.

Some products may be equipped with an auto-ranging power supply. This type of supply automatically adjusts itself to the input voltage, eliminating the need for a voltage select switch and external fuse. The supply is fused internally, but this fuse should only fail if the power supply itself has failed.

An interlock circuit in the power supply detects the presence of the external fan. If the external fan fails or is not connected to the power supply properly, one of the following will occur:

- On an automatic ranging power supply, all output voltages will be disabled if the external fan is not connected properly. To correct the problem, switch the disk storage system power off, connect the external fan, and switch the power on again.

- On a standard power supply, the internal cooling fan in the power supply is disabled if the external fan is not connected properly. This will cause the operating temperature of the power supply to rise. If the supply temperature rises too high, the thermal protection circuit shuts down the outputs of the power supply. If thermal shut down occurs, switch the supply off and connect the external fan. When the supply has cooled, it can be switched back on.

Disk Media

The disk storage systems contain the following number of disks:

- HP 335H - 4 disks
- HP 670H, 670XP, 670FL - 8 disks
- HP 1.34FL - 16 disks (2 mechanisms, 8 disks per mechanism)

Both surfaces of each disk are used for data storage. Each data surface is accessed by a single data head.

Media Format

The surface of each disk is organized into a series of concentric tracks, with each track subdivided into sectors. Each disk surface contains 1457 tracks allocated as follows: 1449 user data tracks, 6 spare tracks, and 2 maintenance tracks. The physical layout of each disk surface is shown in Figure 10-6.

The ESDI format used on the disk media divides each track into 57 sectors of 512 bytes each. The disk storage system controller divides each of these sectors in half, creating 114 sectors each capable of storing 256 bytes of data. On each track, 113 sectors are used for data and 1 is reserved as a spare. Figure 10-4 illustrates how each 512-byte sector is divided into two 256-byte sectors.

The maintenance tracks are reserved for service purposes. They contain the disk storage system fault and error logs, as well as areas used to test the read/write circuitry during self-test. The format of the maintenance tracks is shown in Figure 10-5.

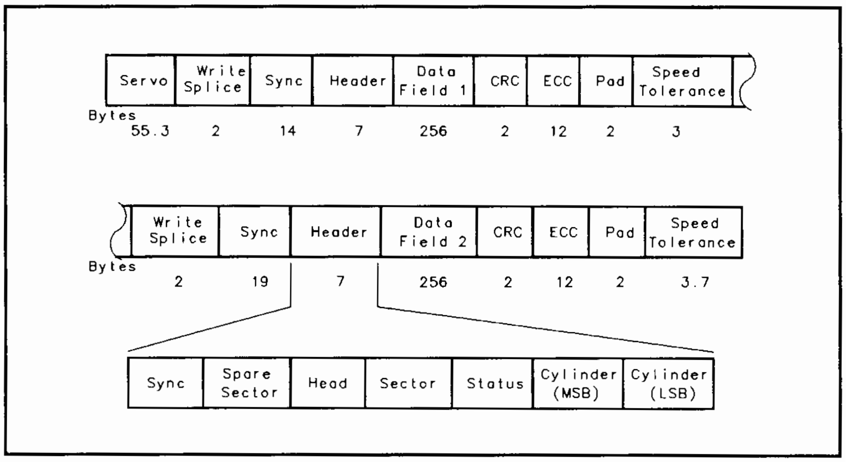


Figure 10-4. Sector Format

Field	Description
Servo	Inter-sector position information.
Write Splice	Provides time to enable the write circuits.
Sync	Synchronizes read circuits (all zeros).
Header	Status and address information.
Sync	Identifies beginning of header.
Spare sector	Physical address of spared sector on track (113 if no sector spare performed).
Head	Bits 0 - 3 contain logical head address. When set, bit 6 indicates primary retired spare, and bit 7 indicates secondary retired spare.
Sector	Physical sector address.
Status	Track status. When set, individual bits indicate status as follows: bit 7 - primary track spare; bit 6 - primary sector spare; bit 5 - secondary track spare; bit 4 - secondary sector spare.
Cylinder (MSB)	Logical cylinder address, most significant byte.
Cylinder (LSB)	Logical cylinder address least significant byte.
Data field	User data.
CRC	Cyclic Redundancy Check used for error checking.
ECC	Error Correction Code used for error detection and correction.
Pad	Pad bytes ensure proper recording and recovery of data.
Speed Tolerance	Speed tolerance bytes.

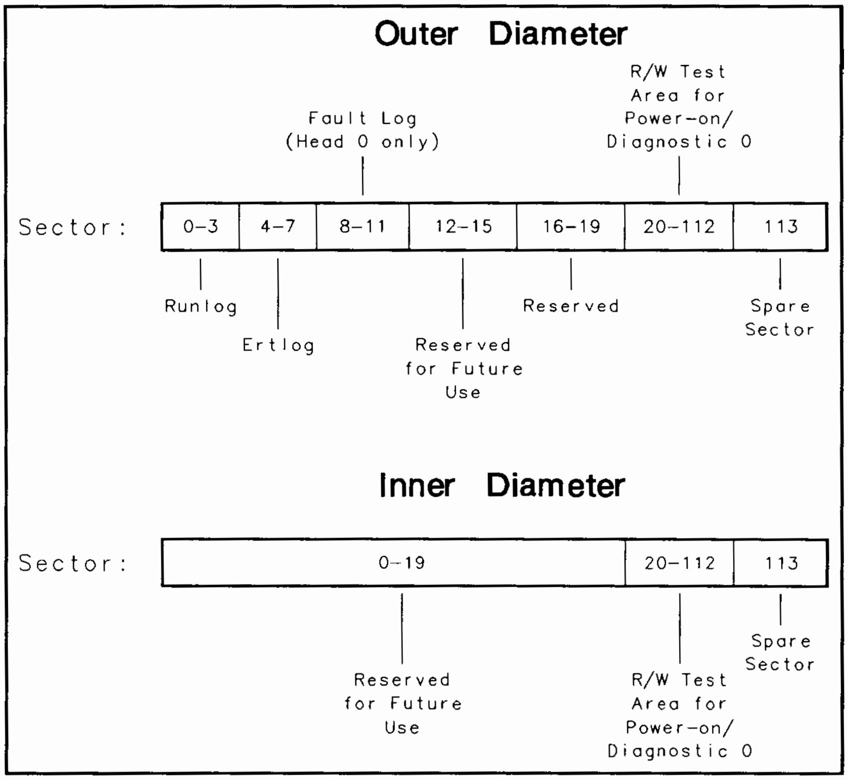


Figure 10-5. Maintenance Track Format

Media Addressing

Each data location on the disk media is identified by both a logical and physical address. The two addresses differ because physical addressing takes into account the presence of nondata tracks such as maintenance and spare tracks, and logical addressing does not. The relationship between logical and physical cylinder addresses for a single-mechanism disk storage system is shown in Figure 10-6, and for a dual-mechanism disk storage system in Figure 10-7.

The host uses logical addressing when communicating with the disk storage system. The disk storage system converts each logical address to its physical equivalent, reducing each data location to its three basic addressing components: cylinder, head, and sector. The conversion takes into account any sparing operations which may have moved the data to a new physical location on the disk media.

The addressing scheme used on the dual-mechanism model 1.34FL disk storage system involves an additional feature. In addition to identifying the cylinder, head, and sector, the disk storage system must also be able to identify which disk mechanism is being addressed. This is accomplished by doubling the range of cylinder addresses and dividing them between the two disk mechanisms. This allows the disk storage system to use the cylinder address to select the proper disk mechanism. As shown in Figure 10-7, cylinder addresses 0 through 1448 select disk mechanism 1, and cylinder addresses 1449 through 2897 select disk mechanism 2.

This division of logical addresses between the two disk mechanisms plays an important part when troubleshooting model 1.34FL disk storage systems. By knowing the cylinder address where an error or fault occurred, it can be determined which of the two disk mechanisms is faulty.

The FLEXDIAG diagnostic program allows testing a dual-mechanism 1.34FL disk storage system at the unit (disk storage system) or mechanism level. When performing tests on an individual mechanism, the addressing structure is identical to that for a single-mechanism disk storage system. See Figure 10-7. To properly interpret addresses when testing a dual-mechanism disk storage system, you must remember whether the testing is being performed at the unit or mechanism level.

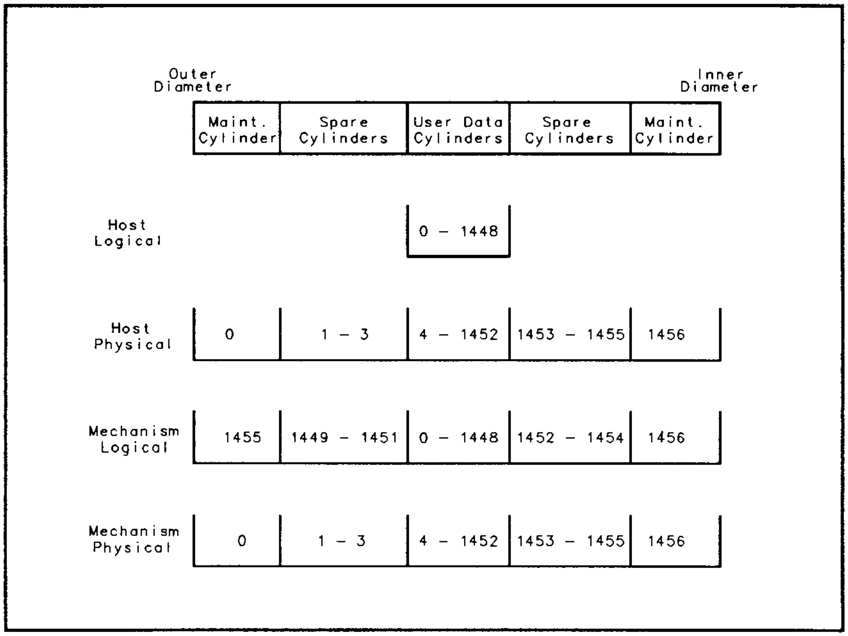


Figure 10-6. Single Mechanism Cylinder Addressing

Mechanism 1

	Outer Diameter				Inner Diameter
	Maint. Cylinder	Spare Cylinders	User Data Cylinders	Spare Cylinders	Maint. Cylinder
Host Logical			0 - 1448		
Host Physical	0	1 - 3	4 - 1452	1453 - 1455	1456
Mechanism Logical	1455	1449 - 1451	0 - 1448	1452 - 1454	1456
Mechanism Physical	0	1 - 3	4 - 1452	1453 - 1455	1456

Mechanism 2

	Maint. Cylinder	Spare Cylinders	User Data Cylinders	Spare Cylinders	Maint. Cylinder
Host Logical			1449 - 2897		
Host Physical	1457	1458 - 1460	1461 - 2909	2910 - 2912	2913
Mechanism Logical	1455	1449 - 1451	0 - 1448	1452 - 1454	1456
Mechanism Physical	0	1 - 3	4 - 1452	1453 - 1455	1456

Figure 10-7. Dual Mechanism Cylinder Addressing

Media Sparing

Each data surface contains six spare tracks, and each data track contains one spare sector. This spare media is used to relocate defective sectors discovered during data transfers and media testing. When sparing a defective sector, the disk storage system first attempts to use the spare sector on the data track. If the spare sector has already been used, the entire data track is spared.

All sparing is done at the direction of the host. When initiating a sparing operation, the host has the option of retaining all data on the track, excluding the defective sector. If data is not retained, all data on the track with the defective sector is lost.

Sector Sparing

When performing a sector sparing operation retaining data, the disk storage system temporarily copies the contents of the track, excluding the defective sector, to the nearest available spare track. The disk storage system reformats the original track, mapping out the bad sector and replacing it with the spare sector. The disk storage system then copies the data back to the reformatted track in the proper logical addressing sequence, skipping the bad sector. This reformatting technique avoids an additional latency when accessing a track containing a spared sector.

When reformatting the track, the disk storage system writes the physical address of the defective sector in the header of each sector on the track. This information allows the disk to skip the proper sector in subsequent accesses to the track. This header field contains the address of the spare sector (113) until a sparing operation is performed on the track.

Track Sparing

If the spare sector has been used, the disk storage system must move the entire track to an available spare track. Each data head has 6 spare tracks allocated for this purpose. To improve performance, the spare tracks are located in two areas: three at the inner diameter (ID) of the disk, and three at the outer diameter (OD). See Figure 10-6.

When sparing a track, the disk storage system selects the next available spare from the group that is closer to the defective track. This reduces the physical distance between the original track and the spare. If all of the spare tracks from the selected group have been used, the next available spare from the other group is used.

Defective maintenance tracks are spared automatically by the disk storage system. No host intervention is required when sparing a maintenance track.

Spare Track Table

The disk storage system uses a spare track table to determine which tracks have been spared. The spare track table is created during power on and stored in controller RAM. The disk storage system builds the table by accessing each group of spare tracks to determine which tracks have been used. If a spare track has been used, its logical address is entered in the spare track table. Before each subsequent seek, the disk storage system searches the table to determine if the target address has been reassigned to a spare track. If the target track has been spared, the disk storage system seeks directly to the new location.

ESDI

The controller PCA communicates with the disk mechanism over the ESDI interface. This industry standard interface allows up to seven disk mechanisms to be connected to a single controller. In these products up to two disk mechanisms can be connected to the ESDI interface.

ESDI comprises two separate busses: the control bus and the data bus. The control bus is used to transfer control information between the ESDI PCA and the controller PCA. Control signals perform such functions as mechanism selection, head selection, data transfer handshaking, command/status transfer, and read/write control. The control bus signals are multiplexed between disk mechanisms. A disk mechanism must be selected before it can receive or transmit information over the control bus. Only one disk mechanism can be selected at a time.

Data and timing signals are transferred over the ESDI data bus. Each disk mechanism has its own dedicated data bus. This allows the controller to monitor the data signals without selecting the corresponding disk mechanism. Data is transferred serially over the bus in differential NRZ format.

Descriptions of the ESDI control signals and data signals are contained in Table 10-1 and Table 10-2.

HP-FL

The HP-FL is a high-speed, serial, fiber optic interface. The interface comprises two parts: the fiber optic link transfers data between the host and the disk storage system, and the electrical PBus forms the communication network for up to eight disk storage systems. This configuration allows a host to communicate with up to eight disk storage systems over a single, thin fiber optic cable.

Data is transferred between the host and the disk storage system optically. At the disk storage system, the optical signals are converted to electrical levels and transferred to the PBus. Once on the PBus, the data is directed to the desired disk storage system.

Data transferred across the interface is organized into message segments. Each segment includes header information indicating the type and length of each segment. The segment header also contains addressing information for selecting the proper disk storage system on the PBus. The segment header information is stripped off by the fiber optic interface hardware on the controller PCA and used to manage the operation of the link. The data content of the segment is passed on to the remainder of the controller hardware for processing.

HP-FL uses the FLEX command set, which is an HP-FL implementation of the CS/80 Instruction Set. Once the HP-FL protocol and formatting information is stripped off, the disk storage system processes the message as it would any CS/80 command.

Fiber Optic Interface

The host is connected to the disk storage system using a duplex fiber optic cable. The cable contains two graded-index glass fibers: one for transmission, one for reception. Each fiber is terminated by a 905-type SMA connector. The maximum length of the fiber optic cable used for host/disk storage system connection is 500 meters.

Each standard disk storage system contains a fiber optic connection. (These connections are deleted on Option 1BG products.) Connection to the disk storage system is made via two SMA connectors on the HP-FL controller PCA. The fiber optic interface circuitry is active only if a fiber optic cable is connected to the HP-FL controller PCA.

Note Although it is physically possible to connect more than one host to a cluster of disk storage systems, multihost configurations are not supported.

PBus

The PBus is an electrical interface that works in concert with the HP-FL optical interface to transfer information between a host computer and a disk storage system or cluster of disk storage systems. Information is transferred optically between the host and the disk storage system HP-FL port, where it is converted to electrical signals. The PBus serves as the electrical interface between the link port and the disk storage system(s).

The PBus can be configured with up to eight disk storage systems. A host computer is connected to one of the disk storage systems via its HP-FL port. The PBus forms the connecting link between the disk storage systems, forming a network which allows the host to communicate with any disk storage system on the bus.

The PBus comprises a synchronous 16-bit data bus with parity, and associated control lines for managing the operation of the bus. The format of the information transferred over the data bus is an extension of the HP-FL message-level protocol. Additional addressing information is added to each message segment to manage the flow of information over the PBus.

Each disk storage system contains its own internal PBus, which interfaces to the external world via two parallel-wired connectors on the HP-FL controller PCA. These connectors are used to daisy-chain disk storage systems together, thus creating a common PBus for up to eight disk storage systems. The connections between disk storage systems are made using PBus cables. The total cable length of the bus must not exceed 6.4 meters.

The bus is terminated using special PBus terminators which are plugged into the unused connectors at each end of the disk storage system chain. Improper termination will render the entire HP-FL interface inoperative.

Electrically, the bus uses differential drivers and receivers for all data and control lines.The PBus signals and their functions are listed in Table 10-3. The bus signal lines include 16 data lines, 2 parity lines, and 11 control lines used to manage bus operation. Two additional lines detect improper bus termination.

Table 10-1. ESDI Control Signals

SIGNAL	DESCRIPTION
DRIVE SELECT 1, 2, 3.	The controller selects a disk mechanism by placing the binary address of the desired disk mechanism on these three lines. DRIVE SELECT 1 is the least-significant bit and DRIVE SELECT 3 is the most-significant bit.
HEAD SELECT 0, 1, 2, 3.	The controller selects a read/write head by placing the binary address of the desired head on these four lines. HEAD SELECT 0 is the least-significant bit of the address.
WRITE GATE.	When activated by the controller, this signal causes the data on the NRZ WRITE DATA lines to be written on the disk media.
READ GATE.	When activated by the controller, this signal causes data to be read from the disk media. The data is decoded and transferred over the NRZ READ DATA lines.
COMMAND DATA.	The controller sends command data to the disk mechanism over this line. Each command is sent in the form of 16 bits of serial data plus 1 bit of parity. The first 4 bits are the CMD Function, much like an Op Code. The next 12 bits, (the CMD Parameter Field), are parameters of that CMD Function. The final bit is used for odd parity. Commands include such operations as seek, recalibrate, request status, request configuration, and initiate diagnostics.

Table 10-1. ESDI Control Signals (continued)

SIGNAL	DESCRIPTION
TRANSFER REQUEST and TRANSFER ACKNOWLEDGE.	These two lines are used to handshake each bit of the serial data on the COMMAND DATA and CONFIG/STATUS DATA line. When the controller wishes to send a command to the mechanism, it places the first bit of the command on the COMMAND DATA line and enables the TRANSFER REQUEST line. When the mechanism has received the bit, it enables the TRANSFER ACKNOWLEDGE which signals the controller to move on to the next bit. When the mechanism sends back data on the CONFIG/STATUS DATA line, it puts the bit on the line and enables the TRANSFER ACKNOWLEDGE line. When the controller receives the bit, it enables the TRANSFER REQUEST line.
READY.	This signal indicates to the controller that the mechanism spindle motor is up to speed.
DRIVE SELECTED.	The mechanism activates this line when selected by the controller.
ATTENTION.	The disk mechanism uses this line to alert the controller that the mechanism has experienced a fault or change of status. In response to this signal, the controller should request status to determine what has occurred.
INDEX and SECTOR.	These are timing signals generated by the disk mechanism and used by the controller to synchronize read and write operations. The controller uses these signals to enable READ GATE or WRITE GATE at the proper times to read or write the desired sectors.

Table 10-2. ESDI Data Signals

SIGNAL	DESCRIPTION
NRZ WRITE DATA.	This differential pair is used by the controller to send data to the mechanism to be written on the disk media. The data transfer is synchronized with the WRITE CLOCK signal.
WRITE CLOCK.	This is the differential timing signal used by the mechanism when writing data on the disk media. The clock is generated by the controller.
NRZ READ DATA.	Data read from the disk is transferred to the controller over this differential pair. The read data is clocked by the READ CLOCK signal generated by the mechanism.
READ/REFERENCE CLOCK.	The differential clock signal transferred over this line is determined by the state of the READ GATE signal. When READ GATE is inactive, the signal on this line is the reference clock. When READ GATE is active, READ CLOCK is transferred on this line.
COMMAND COMPLETE.	When inactive, this signal indicates to the controller that the mechanism is busy performing an operation. When the mechanism is not busy, this signal is active.

Table 10-3. PBus Signals

SIGNAL	DESCRIPTION
PBus Data (PB00-PB15)	The 16-bit bidirectional data bus.
Parity (MSBPARITY, LSBPARITY)	Data bus parity lines used to ensure data integrity. MSBPARITY is associated with data lines PB08-PB15. LSBPARITY is associated with data lines PB00-PB07.
End Of Segment (EOS)	Asserted by source during information transfer to indicate that the last word of the message segment is on the data bus. Also used by bus arbiter during source selection to indicate that the new source address is available.
End Of Segment Parity (EOSPARITY)	Protects integrity of the EOS signal line. Always set to the opposite state of EOS, except during source selection. Also used during source selection to encode address bit 3.
Active Arbiter (ACTARB)	When asserted, indicates the presence of an active bus arbiter.
Grant Acknowledge (GRANTACK)	Asserted by the currently selected source unit to indicate that the bus is in use.
Send Ready (SENDREADY)	A data transfer handshake line asserted by the source when it has valid data for the receiver. Also used when selecting a receiver, and during source selection to encode address bit 0.
Receiver Ready (RECVRREADY)	A data transfer handshake line asserted by the receiver when it is ready to receive data from the source. Also used when selecting a receiver, and during source selection to encode address bit 1.
PBus Clock (PCLK)	The clock signal used to transfer data synchronously over the bus. Supplied by the active bus arbiter.
Match (MATCH)	When asserted, indicates that the data message segment just received from the host has the same virtual circuit number as the preceding segment. Also used during source selection to encode address bit 2.

Table 10-3. PBus Signals (continued)

SIGNAL	DESCRIPTION
PBus Error (PBERROR1, PBERROR2)	Two signal lines used to detect the integrity of the PBus. The voltage levels on these lines indicate if the PBus is properly cabled and terminated.
Byte (BYTE)	Indicates that an odd number of bytes are included in a message. Asserted coincident with EOS to indicate that the last (odd) byte of data is present on the most significant byte of the data bus.
Link Reset (FLRESET)	When asserted, forces all devices to disconnect from the PBus and enter their power-on initialization routines. Asserted in response to a Remote Link Reset command from the host.
Bus Reset (BUSRESET)	When asserted, resets the PBus. All devices disconnect from the bus.

11

Reference

Introduction

For more information, refer to the following manuals:

- *Disk Product Specifications and Site Environmental Requirements*, part number 5955-3456
- *HP Series 6000 Disk Storage Systems Owner's Manual, Models 335H, 670H, and 670XP*, part number C2200-90901 (English part number)
- *HP Series 6000 Disk Storage Systems Owner's Manual, Models 670FL and 1.34FL*, part number C2201-90901 (English part number)
- *HP Series 6000 Disk Storage Systems Installation Guide, Models 335H, 670H, and 670XP*, part number C2200-90902 (English part number)

12

Service Notes

Introduction

This chapter contains a listing of all service notes published for the disk storage systems. No service notes have been published at the time of this printing.

Index

Q

R

S

T

U

V

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Telephone: (52/5) 596 79 33

UNITED KINGDOM:
Hewlett-Packard Ltd.
Miller House
The Ring, Bracknell
Berkshire RG12 1XN, England
Telephone: (44/344) 424-898

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