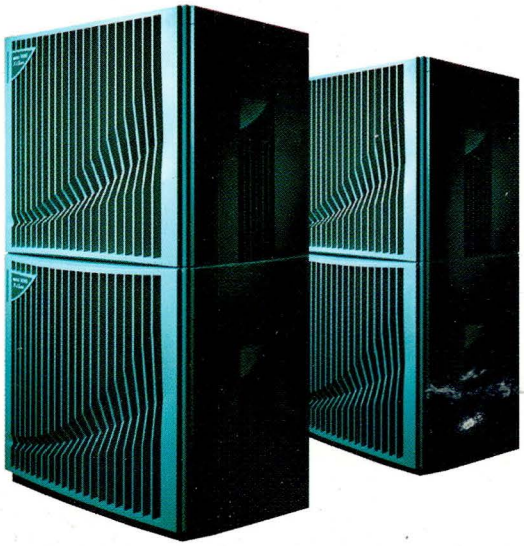
HEWLETT® PACKARD

Exemplar
S-Class and
X-Class Servers



PCI Ultra SCSI Installation and Service Guide

First Edition

Hewlett-Packard Company
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United States of America

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Exemplar S-Class and X-Class Servers

A4716-90011

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January 1997

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PCI Ultra SCSI Installation and Service Guide

Exemplar S-Class and X-Class Servers

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First	A4716-90011	Initial release January 1997.

Contents

Figures

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Preface

Purpose and audience

The *PCI Ultra SCSI Installation and Service Guide* provides information for installing and maintaining a PCI Ultra SCSI controller in Hewlett-Packard Exemplar S-Class and X-Class Technical Servers. It is intended for anyone installing or servicing the PCI Ultra SCSI controller, including:

- Hewlett-Packard customers
- Hewlett-Packard Customer Engineers
- Hewlett-Packard CXD TAC

Notational conventions

This section discusses notational conventions used in this book.

`Bold monospace`

In command examples, text shown in **`bold monospace`** identifies user input that must be typed exactly as shown.

`Monospace`

In paragraph text, `monospace` identifies command names.

In command examples, `monospace` identifies command output, including error messages.

In command syntax diagrams, text shown in `monospace` must be typed exactly as shown.

Italic

In paragraph text, *italic* identifies new and important terms and titles of documents.

In command syntax diagrams, *italic* identifies variables that must be supplied by the user.

Notes and cautions

This document presents notes and cautions in the following formats.

Note

A Note highlights supplemental information.

Caution

A Caution highlights information necessary to avoid damage to the system.

Associated documents

For more information on Exemplar S-Class and X-Class Technical Servers and SCSI devices, you can order these books from Hewlett-Packard:

- *Embedded Disk Installation and Service Guide: Exemplar X-Class and S-Class Servers* (A4716-90009). This book provides information on installing and servicing the Embedded disk drive.
- *Barracuda 9 Installation and Service Guide: Exemplar S-Class and X-Class Servers* (A4716-90008). This book provides information on installing and servicing the Barracuda 9 disk drive.
- *DDS-2 DAT Installation and Service Guide: Exemplar S-Class and X-Class Servers* (A4716-90014). This book describes how to install and service the DDS-2 Digital Audio Tape (DAT) drive.
- *Digital Tape Autoloader Installation and Service Guide: Exemplar S-Class and X-Class Servers* (A4716-90013). This book describes how to install the DLT4700 tape system mini-library.
- *Exemplar Site Preparation Guide: S-Class Servers* (A4716-90005). This book provides technical information needed to prepare a site for the installation of an Exemplar S-Class Server.
- *Exemplar Installation Guide: S-Class Servers* (A4716-90003). This book provides technical information and detailed procedures needed to install an Exemplar S-Class Server.
- *Exemplar Diagnostics Guide: S-Class and X-Class Servers* (A4716-90002). This book provides a roadmap to all diagnostic programs. It also provides the user with definitive descriptions of the purpose of each test and defines minimum hardware configurations required for testing.
- *Exemplar Maintenance Guide: S-Class and X-Class Servers* (A4716-90004). This book is intended as a reference for system support engineers and manufacturing test personnel, as well as those customers who perform their own system maintenance.

Ordering documents

To order additional copies of this document or other documents listed in "Associated documents," send requests to:

Hewlett-Packard Company
Convex Division
Customer Service
P.O. Box 833851
Richardson TX 75083-3851 USA

Please include the order number (xxxxx-9xxxx number) or the exact title of the document.

Technical assistance

If you have questions that are not answered in this book, contact the Hewlett-Packard Convex Technical Assistance Center (TAC) at the following locations:

Within the continental U.S., call 1 (800) 952-0379.

From Canada, call 1 (800) 345-2384.

All other locations, contact your local Hewlett-Packard office.

You can also use the `contact` utility, if you would like to report any problems you may have with the PCI Ultra SCSI controller or its associated documentation.

FCC notice

This equipment generates, uses, and can radiate radio frequency energy. If the equipment is not installed and used in strict accordance with the instruction manual, it may cause interference to radio communications.

This equipment has been tested and found to comply with 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 equipment is operated in a commercial environment.

When this equipment is operated in a residential area, it is likely to cause interference. In this case, the interference must be corrected at the operator's expense.

Do not connect external equipment to the utility outlets in the Hewlett-Packard Exemplar S-Class and X-Class Technical Server. Unauthorized connection voids all agencies' emissions certification.

Description and specifications

1

Product type: **PCI Ultra SCSI controller**
Marketing number: **SCU2000**
Part number: **220-000058-201**

This chapter introduces the PCI Ultra SCSI controller and describes the components and characteristics of the board. Physical and environmental specifications are also included.

Description

The PCI Ultra SCSI controller is an intelligent, high-performance, direct memory access (DMA) bus master SCSI host adapter for Hewlett-Packard Exemplar S-Class and X-Class Technical Servers. The controller combines a powerful RISC processor, a SCSI executive processor, and a PCI Local Bus interface in a single chip solution. The controller supports bootable devices and can be used with hard drives, tape drives, and other SCSI devices. The controller is packaged as a single-slot, short card with a direct interface to the 32-bit PCI Local Bus.

The features of the PCI Ultra SCSI controller are listed below.

- Compliance with Intel PCI Local Bus Rev. 2.0 specification
- Compliance with ANSI X3.131-1994 SCSI-2 standard
- Compliance with ANSI X3T10/1071D SCSI-3 Fast-20 standard (Ultra SCSI)
- Supports asynchronous and synchronous transfer modes

- Synchronous SCSI data transfer rates:
  - Wide and Ultra SCSI (40 Mbytes/sec)
  - Ultra SCSI (20 Mbytes/sec)
  - Wide and Fast SCSI (20 Mbytes/sec)
  - Fast SCSI (10 Mbytes/sec)
  - Normal (5 Mbytes/sec)
- Supports differential mode
- Supports up to 15 SCSI devices
- Supports logical unit numbers (LUNs) 0-7
- Supports bus master DMA
- Single-chip, high performance SCSI RISC processor
- 68-pin, high density SCSI connector

Specifications

Table 1 shows the physical size, power requirements, and recommended operating environment for the PCI Ultra SCSI controller.

Table 1 Specifications

Characteristic	Value
Form factor	17.78 cm x 10.67 cm (7.0 in x 4.2 in)
Operating power	5 volts @ 1 ampere
Operating temperature	0 to 55 degrees C (32 to 158 degrees F)
Storage temperature	-20 to 70 degrees C (-4 to 158 degrees F)
Relative humidity	10% to 90% (noncondensing)
Storage humidity	5% to 95% (noncondensing)

The PCI Ultra SCSI controller supports differential SCSI connections only. Internal cables for interconnection with the Embedded Disk and DAT tape drive are provided in the system.

One shielded SCSI ribbon cable is provided with each controller for connection to a disk tray A or B port. The standard length of this cable is 13 inches, although 10-inch and 18-inch cables can be specified. Part numbers for the shielded SCSI ribbon cables are listed in Table 2.

For further information on connecting the controller to internal disk and tape devices, refer to the appropriate disk drive or tape drive product manual.

Table 2 Shielded SCSI ribbon cables

Description	Part number
10-inch SCSI shielded cable with back shell	612-000019-001
13-inch SCSI shielded cable with back shell	612-000019-002
18-inch SCSI shielded cable with back shell	612-000019-003

For connection to external SCSI devices, you must provide a differential SCSI cable. Table 3 shows the Hewlett-Packard differential SCSI cables and their part numbers.

Table 3 Differential SCSI cables

Description	Part number
10 ft. differential SCSI cable	604-680003-201
30 ft. differential SCSI cable	604-680003-202
60 ft. differential SCSI cable (special order only)	604-680003-203
14 ft. differential SCSI cable	604-680003-204

Unpacking and inspection 2

This chapter describes how to inspect and unpack the PCI Ultra SCSI controller from its shipping container and what to do if equipment is damaged.

Inspection

All shipping containers are designed to protect their components under normal shipping conditions. Carefully inspect each carton for signs of shipping damage *before* it is unpacked. If damage is found after visual inspection, document the damage with photographs and contact the transport carrier immediately.

Unpacking

Your bill of materials lists all equipment shipped from Hewlett-Packard. Use it as a checklist to ensure that all equipment has arrived.

Use the following procedure to unpack the shipping container:

Step 1 Remove each item from its shipping container.

Step 2 Inspect each item as it is unpacked for any signs of shipping damage.

Step 3 If equipment damage is found, document the damage, and proceed to the next section.

Save all packing material until after operational checkout of the equipment. This enables equipment to be returned safely to Hewlett-Packard if required.

Damage claims

If the equipment is damaged, complete a damage claim form and give it to the shipping representative. Claim forms are normally obtained from the shipping representative.

Installation

3

This chapter describes how to install the PCI Ultra SCSI controller and connect it to an internal or external SCSI device.

Precautions

Protect personnel and equipment when installing any Hewlett-Packard product by always taking proper precautions.

Electrostatic discharge (ESD)

The PCI Ultra SCSI controller, as well as all other circuit boards, is highly susceptible to damage by electrostatic discharge during installation and routine maintenance procedures.

Caution

Do not handle circuit boards without a grounded wrist strap fastened to a good earth ground or to the system chassis.

Antistatic packaging

Circuit boards arrive in a specially designed bag that dissipates static electricity and serves as a shield against electrostatic fields while the board is in transit. Retain this bag and use it to store the circuit board if you remove it from the system for any reason.

The bag is not designed for use as a static dissipating mat. Do not use the antistatic bag for any other purpose than to enclose a circuit board. Holes in the bag render it useless as an antistatic measure. Therefore, it should always be completely closed and sealed when it contains a circuit board. Immediately discard and replace any bag that shows damage or wear.

Preparation

Prepare an ESD safe work surface large enough to accommodate the EIOB assembly.

Preinstallation requirements

Before beginning the installation, make sure there is an Exemplar I/O Board (EIOB) with an available PCI slot in the system. You can determine how many PCI slots are occupied and unoccupied by observing the Power On Self Test (POST) messages during the boot process. You can install the PCI Ultra SCSI controller in any available PCI slot, within any available EIOB.

If you intend to connect the PCI Ultra SCSI controller to an external SCSI device, you need to supply a differential SCSI cable that is long enough to reach the device. Part numbers for several different cable lengths are listed in the "Specifications" section in Chapter 1.

To install the PCI Ultra SCSI controller, you need a #2 Phillips screwdriver.

Overview of installation

Installing a PCI Ultra SCSI controller involves some minor disassembly of system assemblies. The following list provides a summary of the steps involved in the installation process.

Note

This list is intended for summary purposes only; detailed installation instructions are presented in the sections that follow.

Step 1 Shut down the system.

Step 2 Remove side skins and Electromagnetic Interference (EMI) panels.

Step 3 Unplug EIOB power cable.

Step 4 Disconnect all SCSI and network cables attached to controllers in this EIOB. Mark or chart the connections for easy connection later.

Step 5 Remove EIOB.

Step 6 Remove the bracket on top of the PCI card cage.

Step 7 Install the controller.

Step 8 Reinstall the bracket on top of the PCI card cage.

Step 9 Reinstall EIOB.

Step 10 Plug in the EIOB power cable.

Step 11 Reattach all SCSI and network cables to the proper controller.

Step 12 Attach the new SCSI cable. If it is an external cable, route the cable through the cable channel.

Step 13 Reinstall EMI panels and side skins.

Step 14 Reboot the system.

Detailed installation instructions

The following sections provide detailed instructions on installing the PCI Ultra SCSI controller.

Removing the EIOB

To remove the EIOB, perform the following steps:

Step 1 Shut down the system with the `/etc/shutdown` command.

```
/etc/shutdown -h <time>
```

The *time* argument can be used to schedule a timed shutdown or the keyword "`now`" can be used to shut down the system immediately. Refer to the *SPP UX System Administrator's Guide* or the `shutdown` man page for more information on `/etc/shutdown`.

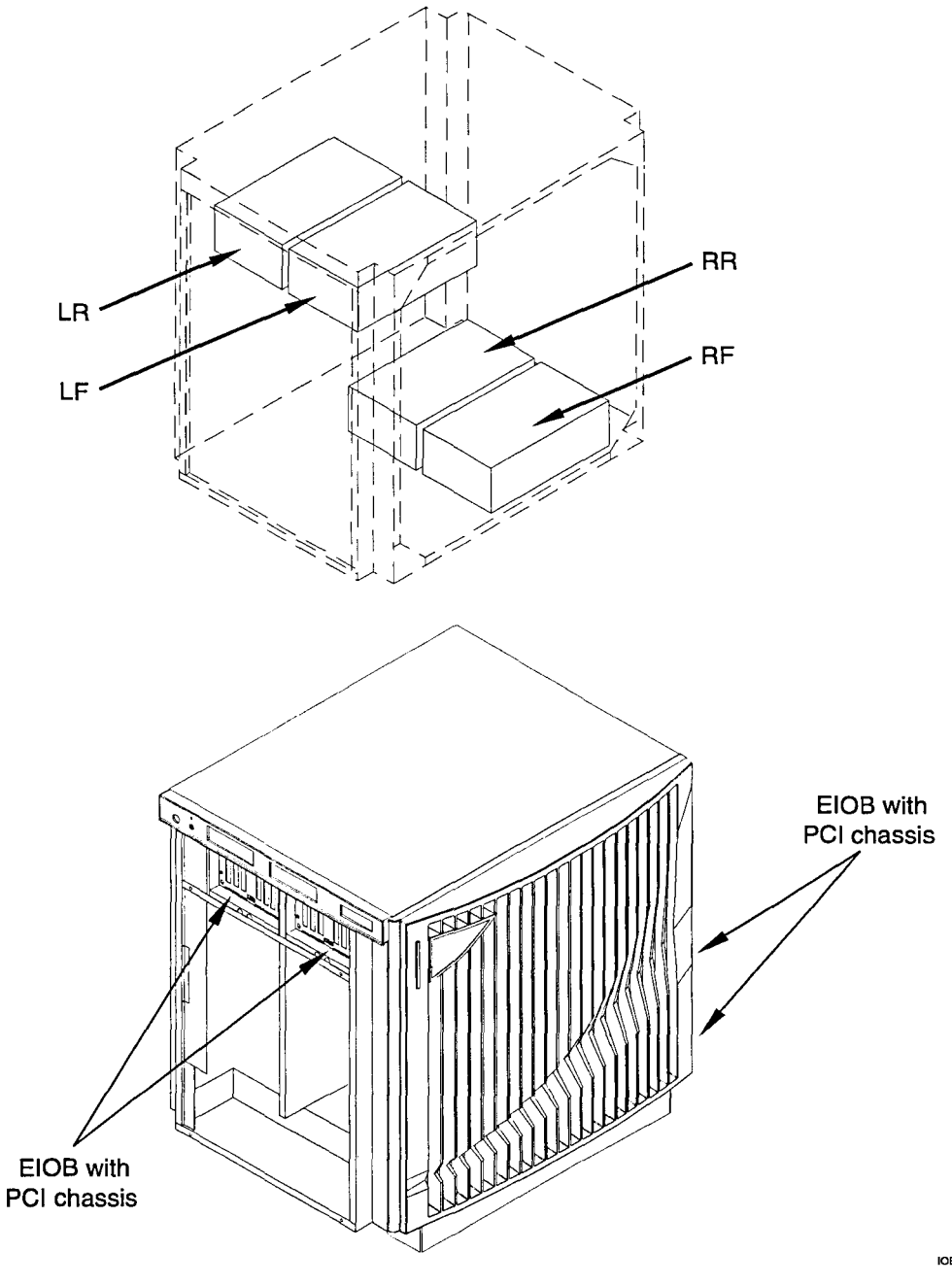
Step 2 Terminate power to the system by turning the keyswitch on the operator panel to the OFF position.

Caution

Do not remove the EIOB without first removing power to the system. Failure to remove power before removing the EIOB will damage electronic components on the board assembly.

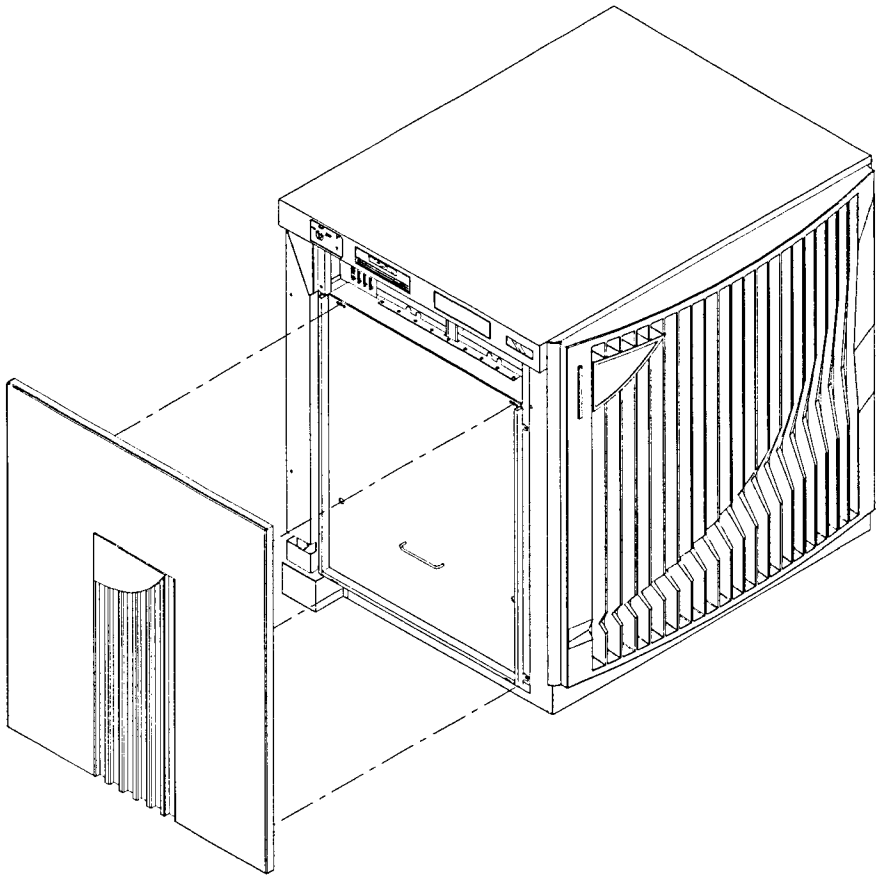
Step 3 Select the EIOB where you intend to install the controller. The chassis can contain from one to four EIOBs, depending on your system configuration. You can install the PCI Ultra SCSI controller in any EIOB. However, the EIOB you are targeting for installation determines which side skin you need to remove in Step 4. Figure 1 shows the four possible locations of an EIOB in the chassis.

Figure 1 EIOB locations



Step 4 Remove the left or right side cabinet skin by pulling from the top and bottom of the skin until it pops out. Each skin has a set of four catch pins that secure it to the chassis as shown in Figure 2.

Figure 2 Removing side skins



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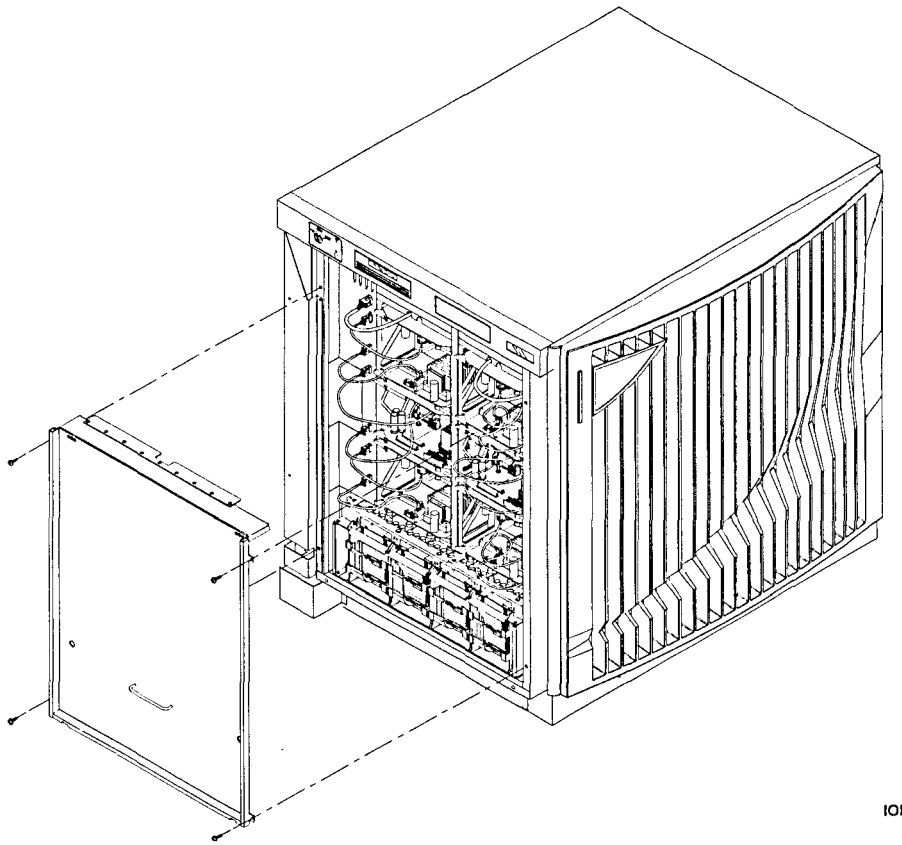
Step 5 Remove the EMI panel by removing the four screws that fasten the panel to the chassis as shown in Figure 3.

Figure 3 Removing EMI panels



Step 6 Unplug the power cable on the front of the target EIOB. The power connections are labeled on the chassis and are designated as follows:

IOLF I/O Left Front

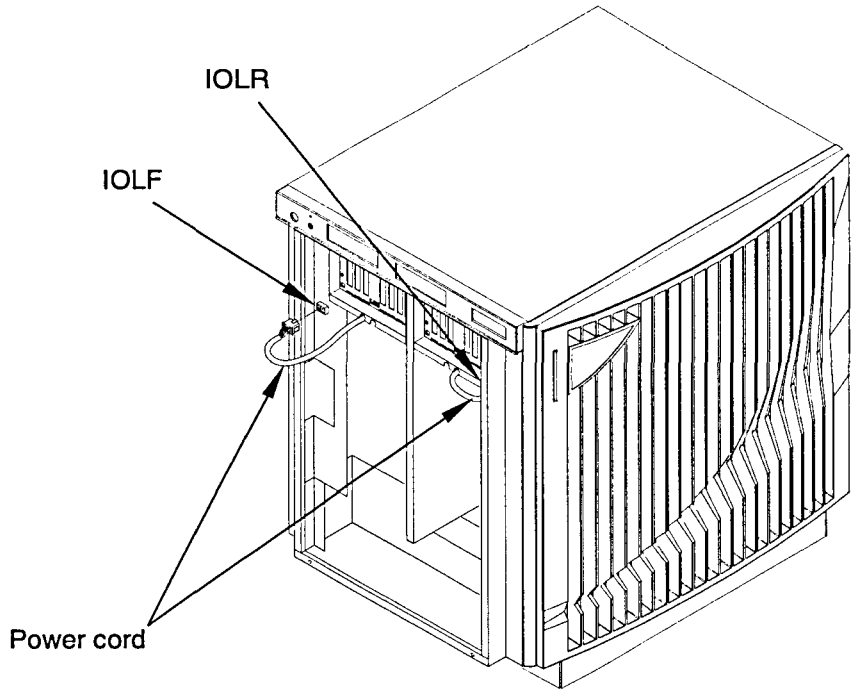
IOLR I/O Left Rear

IORF I/O Right Front

IORR I/O Right Rear

Figure 4 shows the location of the IOLF and IOLR EIOB power connections. The IORF and IORR connectors are on the opposite side of the chassis near the bottom.

Figure 4 Unplugging the EIOB power cable

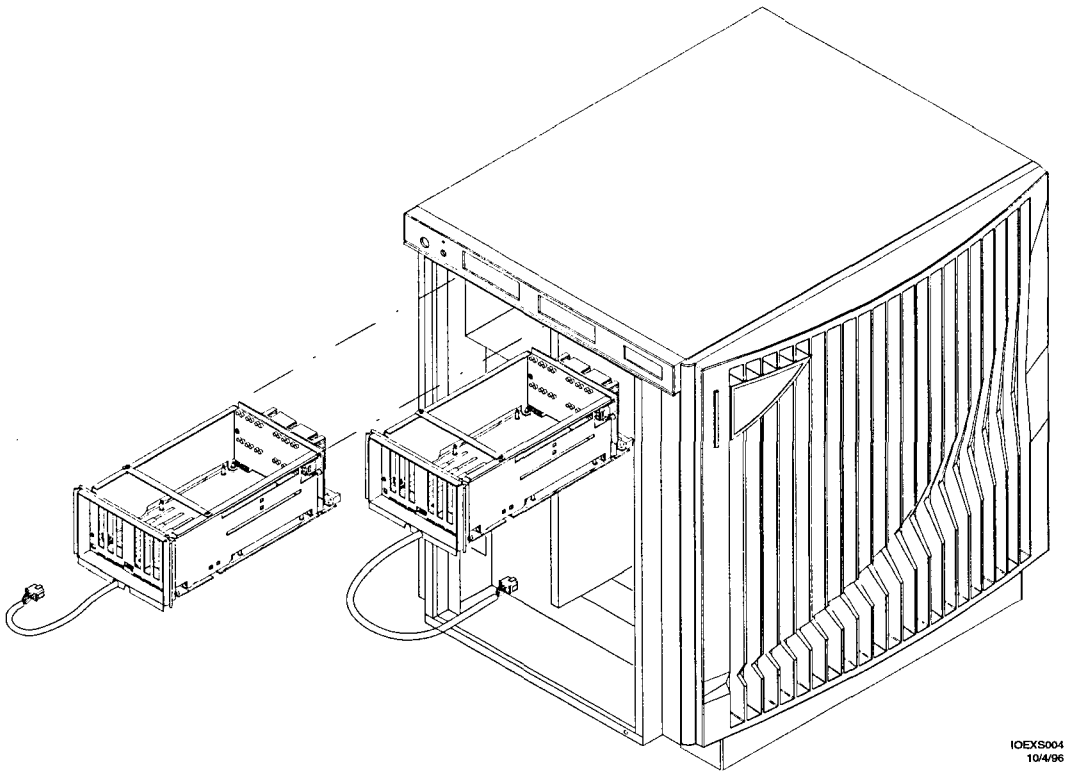


Step 7 Disconnect all SCSI and network cables attached to controllers in this EIOB. Mark or chart the connections for easy connection later.

Step 8 Remove the EIOB from the chassis by pulling the two extractor levers on the front of the EIOB toward you until the EIOB is unseated from the Exemplar Node Routing Board (ENRB). Continue sliding the EIOB all the way out, taking care to support it with one hand underneath (see Figure 5).

Step 9 Place the EIOB on a level work surface that contains a grounded static dissipating mat.

Figure 5 Removing the EIOB

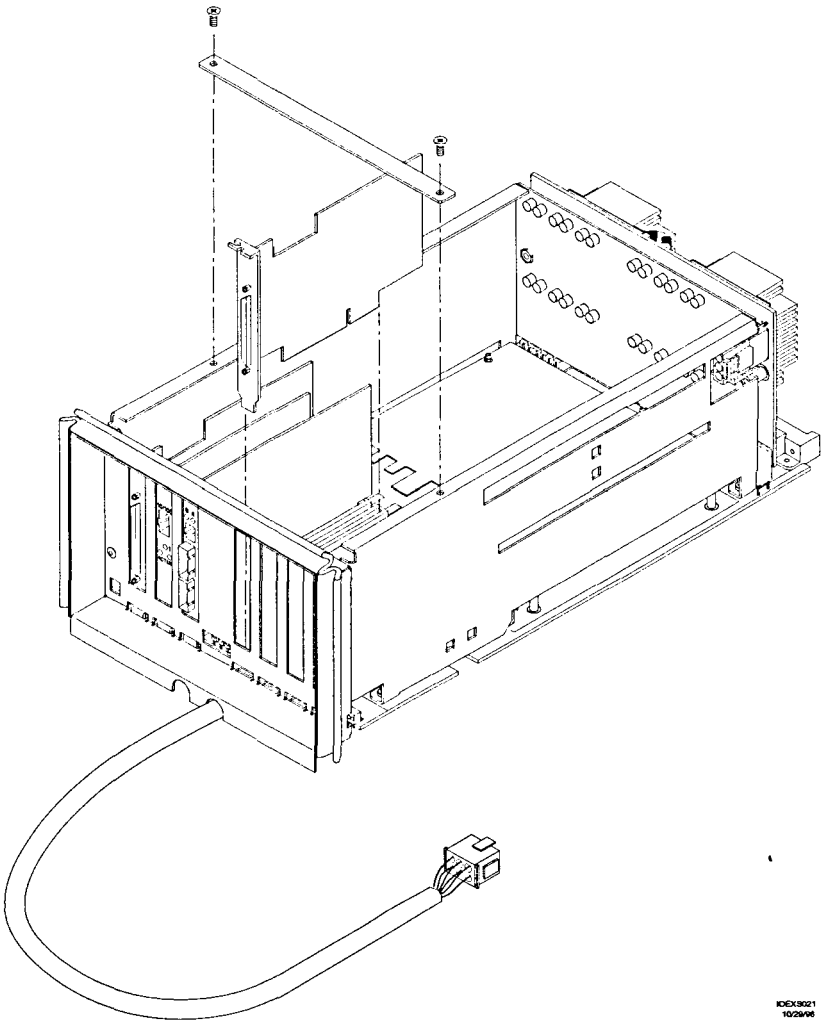


Installing the controller

To install the PCI Ultra SCSI controller, perform the following steps:

Step 1 Using a #2 Phillips screwdriver, remove the two screws that secure the bracket across the top of the PCI card cage. Refer to Figure 6 for the location of the bracket.

Figure 6 Installing the controller



Step 2 Select an available PCI slot and remove the PCI slot cover plate. Retain the screw for later use.

Step 3 Insert the controller into the PCI slot as shown in Figure 6. Make sure the board is fully seated. Terminators are preinstalled and the SCSI ID is pre-set to ID 7.

Step 4 Secure the controller faceplate to the PCI card cage using the screw from the PCI slot cover plate.

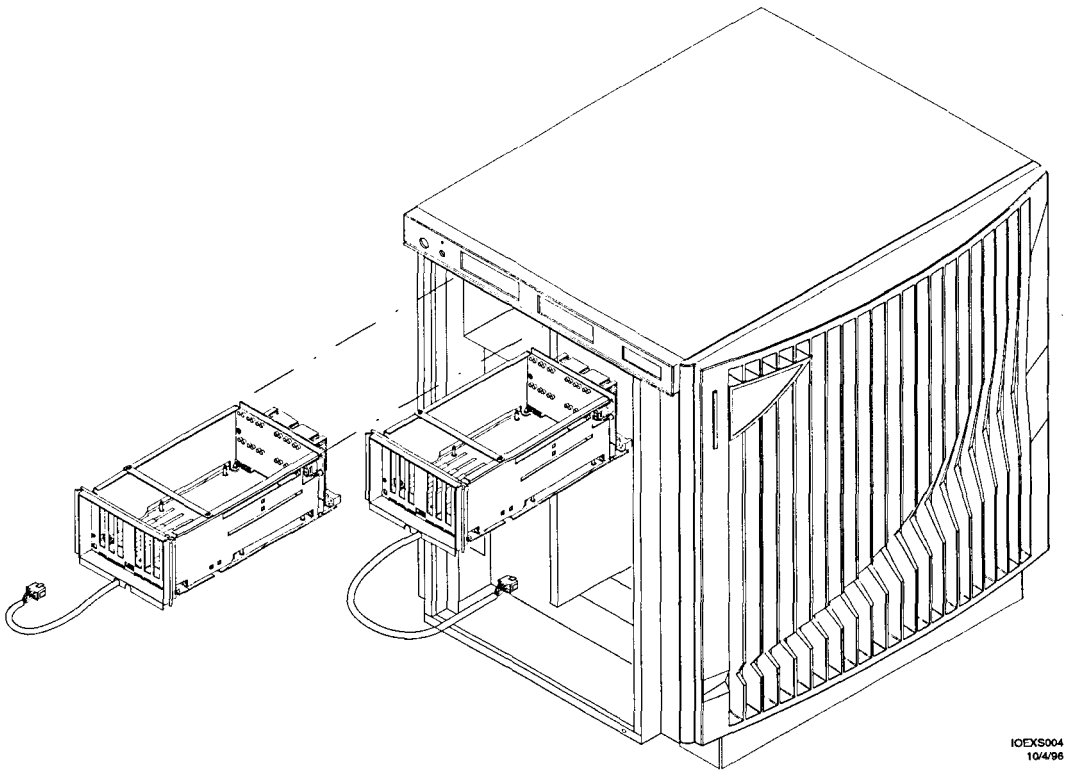
Step 5 Reinstall the bracket on top of the PCI card cage.

Reinstalling the EIOB

To reinstall the EIOB, use the following procedure:

Step 1 Reinstall the EIOB into the system chassis by lining up the EIOB card edges with the guide rails as shown in Figure 7. Continue sliding the EIOB into the chassis and secure it using the two extractor levers.

Figure 7 Reinstalling the EIOB



Step 2 Reattach the power cable on the front of the EIOB (refer to Figure 4 for the location of the EIOB power connector).

Step 3 Once you have installed the controller and EIOB, reattach any cables previously removed to their proper location.

Cabling

Once you have installed the controller and EIOB, you can attach the SCSI cable by following the steps below.

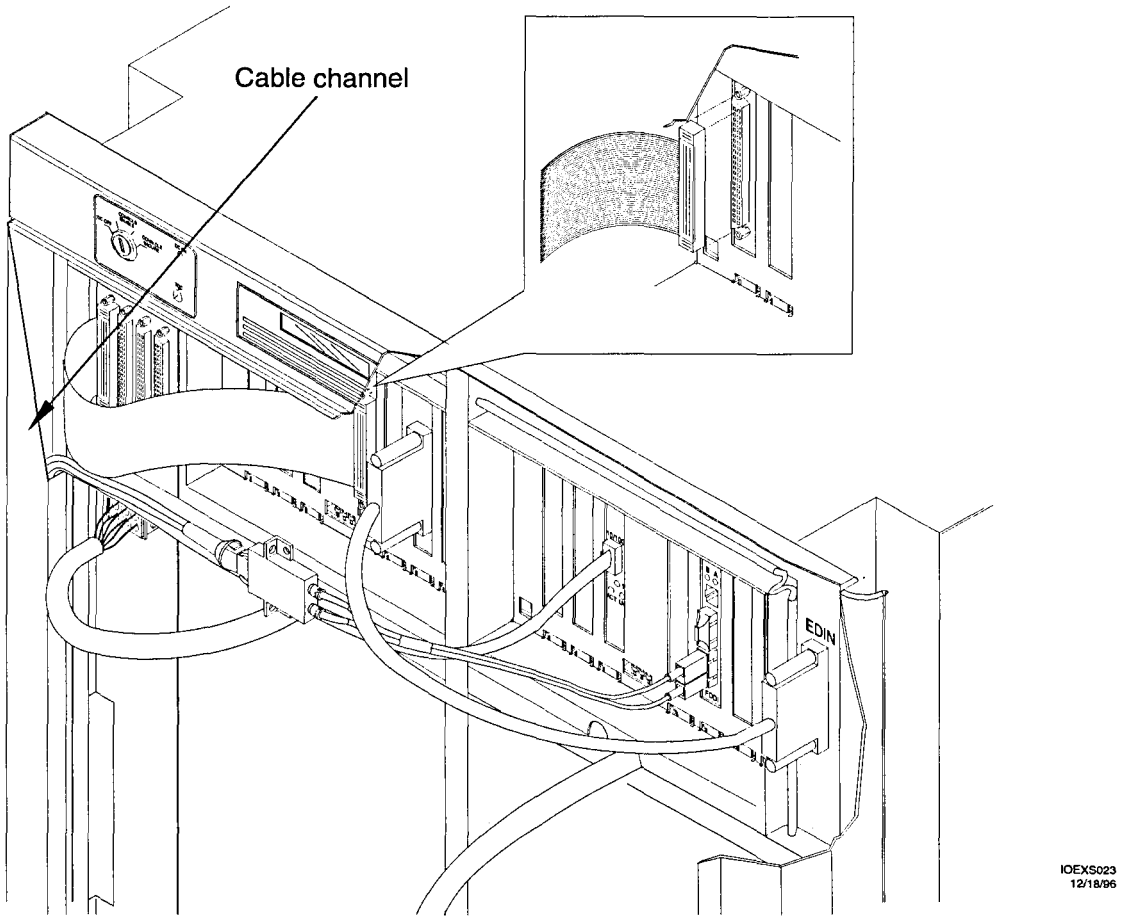
Note

A cable for connecting the PCI Ultra SCSI controller to a disk tray A or B port connector is supplied with the controller. Cables for connecting external devices are not supplied with the controller and must be purchased separately. Cable specifications are listed in Chapter 1.

Step 1 Attach the SCSI cable to the connector on the controller as shown in Figure 8. The example in Figure 8 shows how to connect a shielded SCSI cable to a disk tray A or B port connector on the chassis. This cable is provided with the controller.

If you are connecting the controller to an external device, connect the external cable to the controller and route the cable through the cable channel at the rear edge of the server chassis. There are similar cable channels on the left and right rear edges of the chassis (refer to Figure 8). External SCSI cables can be ordered from Hewlett-Packard. A listing of available cables is provided in Chapter 1.

Figure 8 Connecting the SCSI cable



Step 2 Complete the connection by attaching the other end of the cable to the SCSI device or appropriate disk tray port.

Completing the installation

To complete the installation, follow these steps:

Step 1 Reinstall the EMI panels and side skins.

Step 2 Restart the system by turning on the keyswitch on the operator panel.

Removal

4

Precautions

Protect personnel and equipment when removing any Hewlett-Packard product by always taking proper precautions.

Electrostatic discharge (ESD)

The PCI Ultra SCSI controller, as well as all other circuit boards, is highly susceptible to damage by electrostatic discharge during installation and routine maintenance procedures.

Caution

Do not handle circuit boards without a grounded wrist strap fastened to a good earth ground or to the system chassis.

Antistatic packaging

Circuit boards arrive in a specially designed bag that dissipates static electricity and serves as a shield against electrostatic fields while the board is in transit. Retain this bag and use it to store the circuit board if you remove it from the system for any reason.

The bag is not designed for use as a static dissipating mat. Do not use the antistatic bag for any other purpose than to enclose a circuit board. Holes in the bag render it useless as an antistatic measure. Therefore, it should always be completely closed and sealed when it contains a circuit board. Immediately discard and replace any bag that shows damage or wear.

Preparation

Prepare an ESD safe work surface large enough to accommodate the EIOB assembly.

Tools required

To remove the PCI Ultra SCSI controller, you need a #2 Phillips screwdriver.

Summary of removal procedure

Removing a PCI Ultra SCSI controller involves some minor disassembly of system assemblies. The following list provides a summary of the steps involved in the removal process.

Note

This list is intended for summary purposes only; detailed instructions for removal are presented in the sections that follow.

Step 1 Shut down the system.

Step 2 Remove side skins and Electromagnetic Interference (EMI) panels.

Step 3 Unplug EIOB power cable.

Step 4 Disconnect all SCSI and network cables attached to controllers in this EIOB. Mark or chart the connections for easy connection later.

Step 5 Remove EIOB.

Step 6 Remove the bracket on top of the PCI card cage.

Step 7 Remove the controller.

Step 8 If you are replacing the controller, install the new controller in an available PCI slot.

Step 9 Reinstall the bracket on top of the PCI card cage.

Step 10 Reinstall EIOB.

Step 11 Plug in the EIOB power cable.

Step 12 Reattach all SCSI and network cables to the proper controller.

Step 13 If you installed a new controller, attach the SCSI cable and route the cable through the cable channel if necessary.

Step 14 Reinstall EMI panels and side skins.

Step 15 Reboot system.

Detailed removal instructions

The following sections provide detailed instructions on removing the PCI Ultra SCSI controller.

Removing the EIOB

To remove the EIOB, perform the following steps:

Step 1 Shut down the system with the `/etc/shutdown` command.

```
/etc/shutdown -h <time>
```

The *time* argument can be used to schedule a timed shutdown or the keyword "`now`" can be used to shut down the system immediately. Refer to the *SPP UX System Administrator's Guide* or the `shutdown` man page for more information on `/etc/shutdown`.

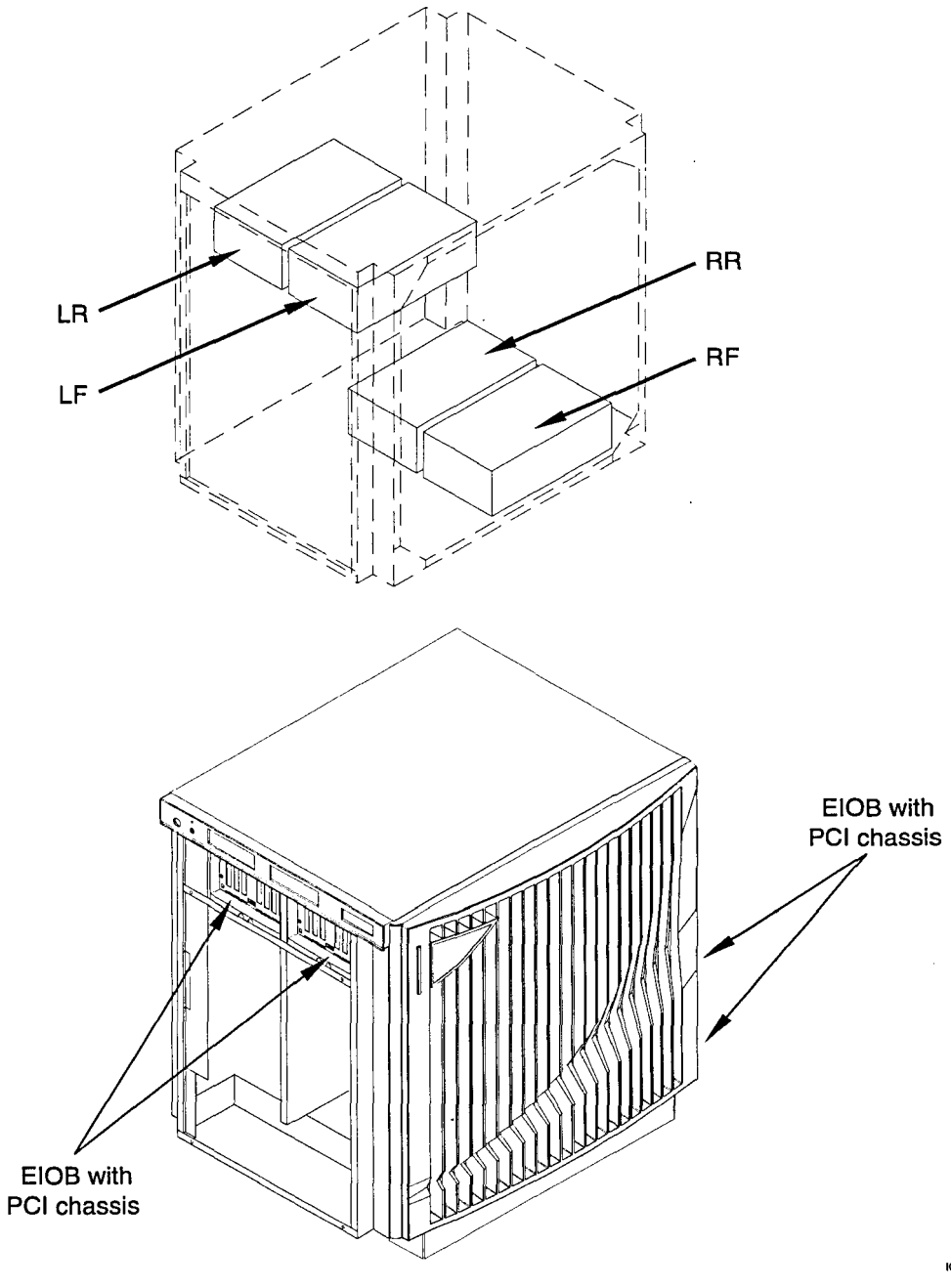
Step 2 Terminate power to the system by turning the keyswitch on the operator panel to the OFF position.

Caution

Do not remove the EIOB without first removing power to the system. Failure to remove power before removing the EIOB will damage electronic components on the board assembly.

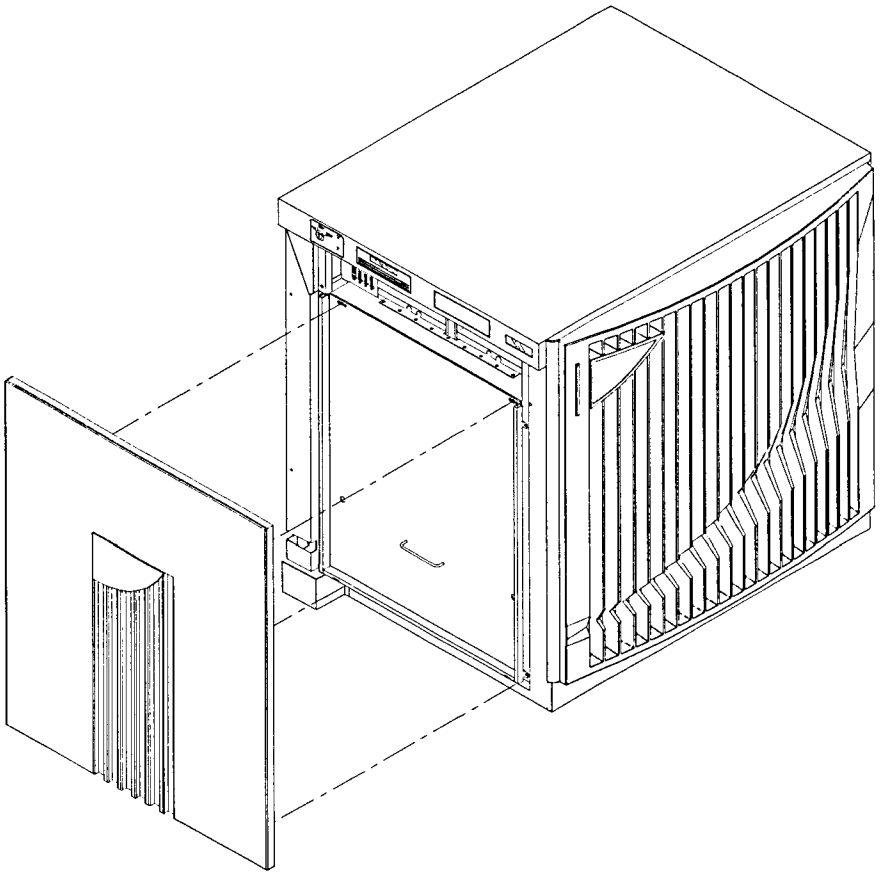
Step 3 Select the EIOB where you intend to remove the controller. The chassis can contain from one to four EIOBs, depending on your system configuration. The EIOB you are targeting determines which side skin you need to remove in Step 4. Figure 9 shows the four possible locations of an EIOB in the chassis.

Figure 9 EIOB locations



Step 4 Remove the left or right side cabinet skin by pulling from the top and bottom of the skin until it pops out. Each skin has a set of four catch pins that secure it to the chassis as shown in Figure 10.

Figure 10 Removing side skins



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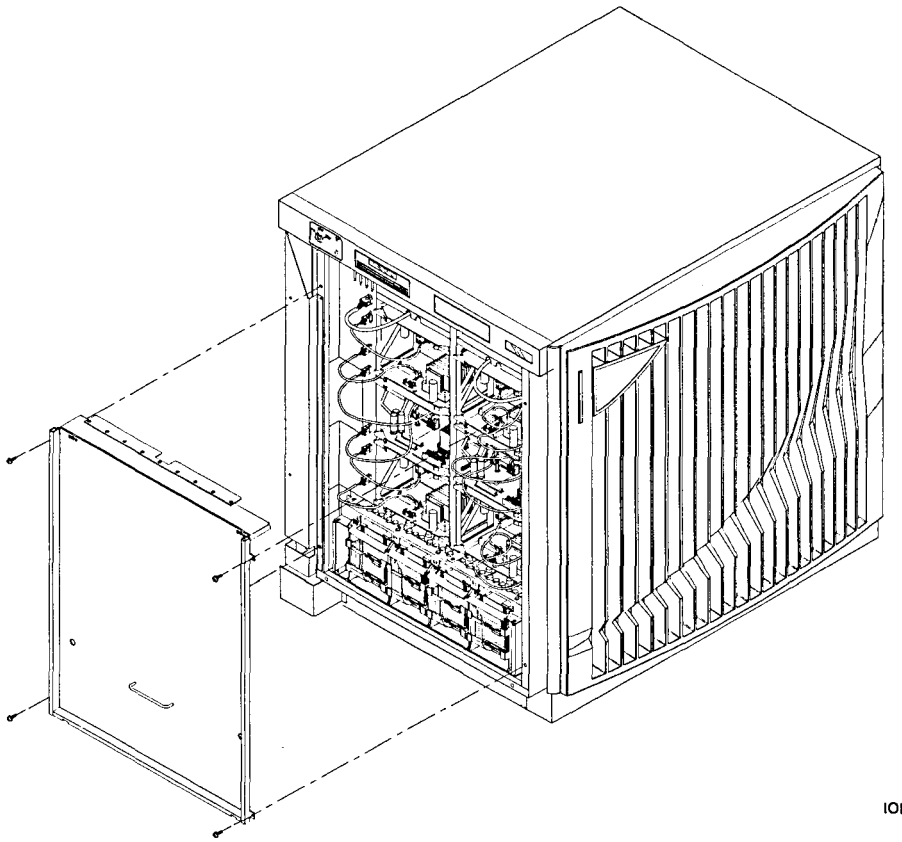
Step 5 Remove the EMI panel by removing the four screws that fasten the panel to the chassis as shown in Figure 11.

Figure 11 Removing EMI panels



Step 6 Unplug the power cable on the front of the target EIOB. The power connections are labeled on the chassis and are designated as follows:

IOLF I/O Left Front

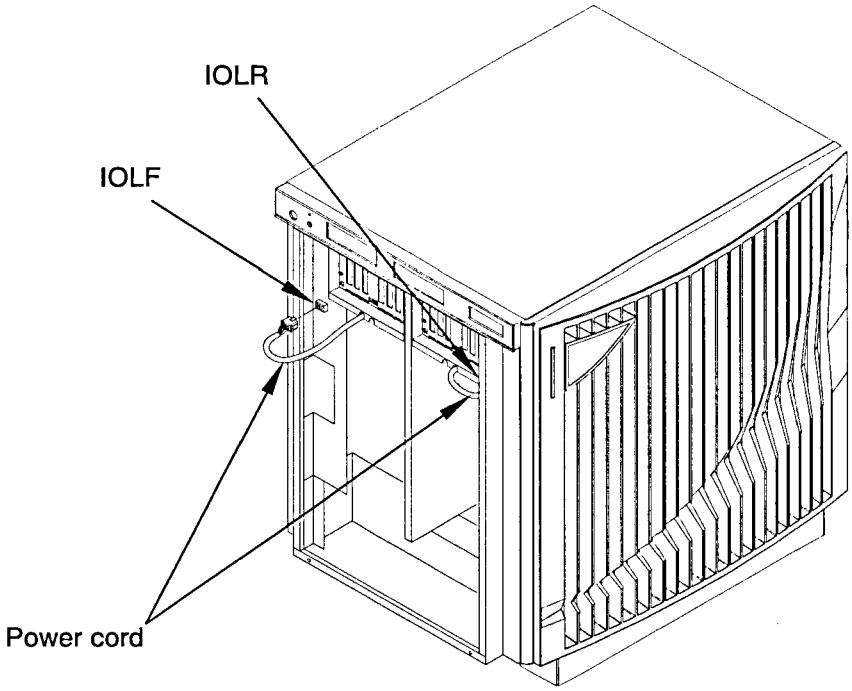
IOLR I/O Left Rear

IORF I/O Right Front

IORR I/O Right Rear

Figure 12 shows the location of the IOLF and IOLR EIOB power connections. The IORF and IORR connectors are on the opposite side of the chassis near the bottom.

Figure 12 Unplugging the EIOB power cable

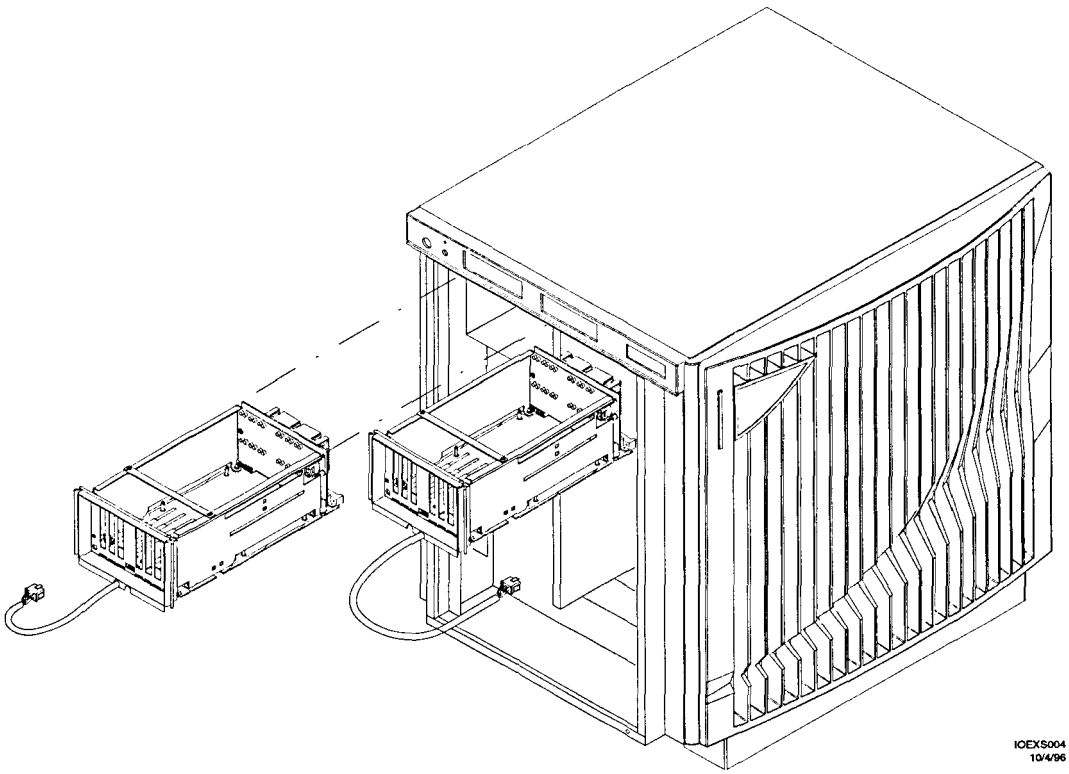


Step 7 Disconnect all SCSI and network cables attached to controllers in this EIOB. Mark or chart the connections for easy connection later.

Step 8 Remove the EIOB from the chassis by pulling the two extractor levers on the front of the EIOB toward you until the EIOB is unseated from the Exemplar Node Routing Board (ENRB). Continue sliding the EIOB all the way out, taking care to support it with one hand underneath (see Figure 13).

Step 9 Place the EIOB on a static free, level work surface.

Figure 13 Removing the EIOB

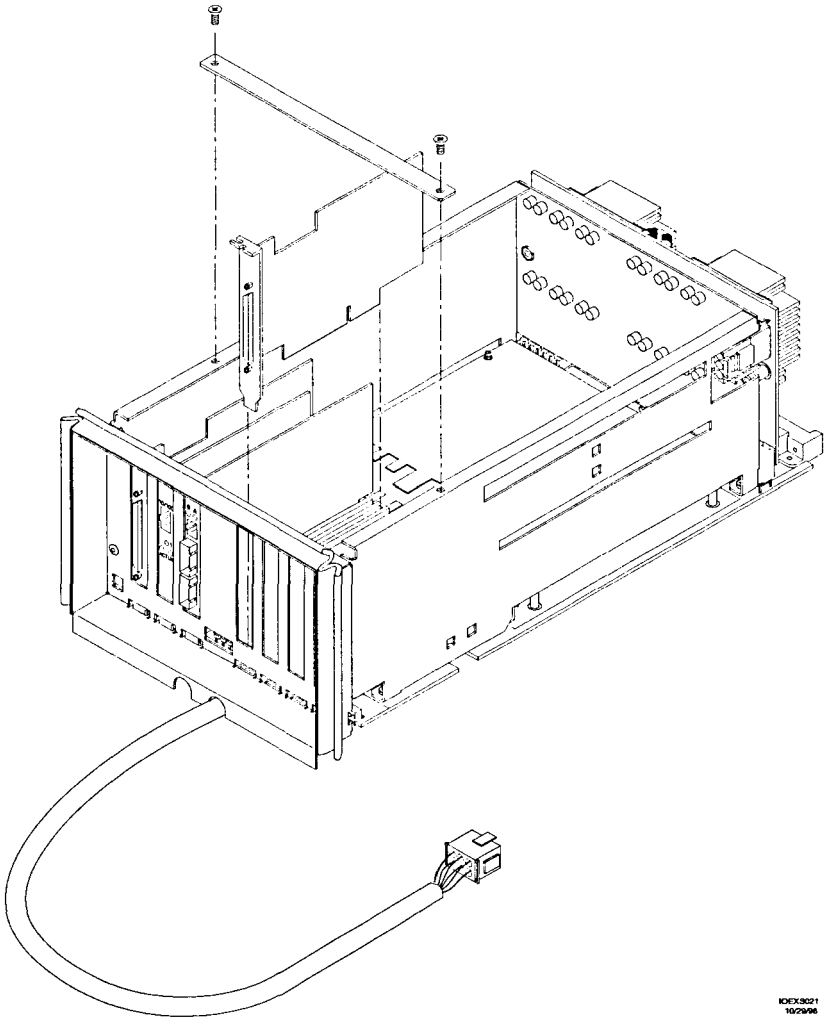


Removing the controller

To remove a PCI Ultra SCSI controller, perform the following steps:

Step 1 Using a #2 Phillips screwdriver, remove the two screws that secure the bracket across the top of the PCI card cage. Refer to Figure 14 for the location of the bracket.

Figure 14 Removing the controller



Step 2 Remove the screw on the faceplate of the PCI Ultra SCSI controller. Retain the screw for later use.

Step 3 Remove the controller by grabbing the edges of the board and pulling upward until the controller is free from the PCI connector.

Step 4 If you are replacing the controller, install the new controller at this time. If you are not replacing the controller, install a PCI slot cover plate over the space where the controller was removed. Secure the cover with the screw you removed in Step 2.

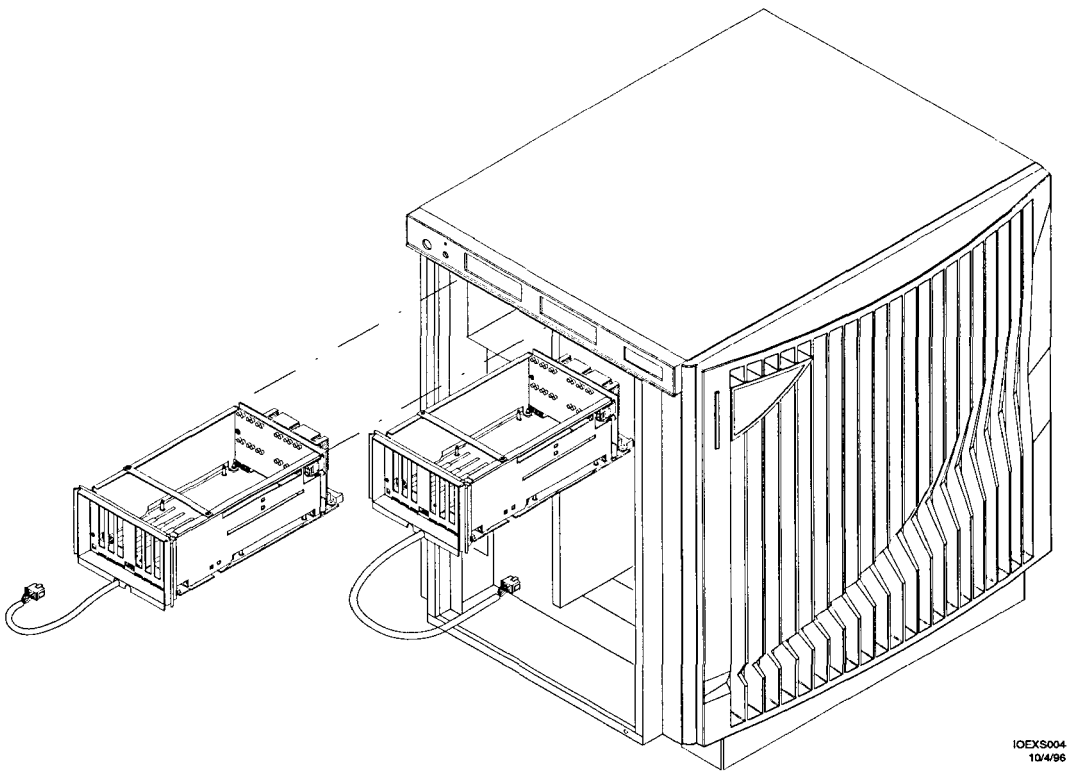
Step 5 Reinstall the bracket on top of the PCI card cage.

Reinstalling the EIOB

To reinstall the EIOB, use the following procedure:

Step 1 Reinstall the EIOB into the system chassis by lining up the EIOB card edges with the guide rails as shown in Figure 15. Continue sliding the EIOB into the chassis and secure it using the two extractor levers.

Figure 15 Reinstalling the EIOB



Step 2 Reattach the power cable on the front of the EIOB (refer to Figure 12 for the location of the EIOB power connector).

Step 3 Once you have installed the EIOB, reattach any cables previously removed to their proper location.

Completing the removal procedure

To complete the removal procedure, follow these steps:

Step 1 Reinstall the EMI panels and side skins.

Step 2 Restart the system by turning on the keyswitch on the operator panel.

Maintenance

5

This chapter provides information on troubleshooting, testing, and diagnosing problems with the PCI Ultra SCSI controller.

Troubleshooting

The PCI Ultra SCSI controller is a single Field Replaceable Unit (FRU) and does not contain any field-serviceable parts. Troubleshooting procedures described in this section are limited to verifying that the controller is operational and a valid connection is established. A listing of SCSI sense codes reported in SCSI error messages is provided in Appendix C, as an aid in troubleshooting.

Check the connection

Check to see if the correct cable is used and that the cable is connected and operating properly.

Check the controller

Perform a visible inspection to make sure the controller is seated properly in the PCI bus slot. If necessary, power down the system, reseat the controller, and restart the system.

Run diagnostics

If a visual inspection of the controller and cable does not reveal any problems, or if an action taken as a result of the inspection does not produce a working controller, you may want to run diagnostics to determine whether the controller can communicate and respond to PCI bus instructions. Diagnostics are described in the next section.

If diagnostics determine that the controller is defective, you need to replace it. Contact your local Hewlett-Packard customer representative or call the Technical Assistance Center at one of the following locations for information on replacing and repairing the controller:

- Within the continental U.S., call 1 (800) 952-0379.
- From Canada, call 1 (800) 345-2384.
- All others, contact your local Hewlett-Packard sales office.

Diagnostics

If you are experiencing problems with your SCSI devices and suspect that the controller may be malfunctioning, you can perform a diagnostic check of the controller to determine whether it is operational. To run these diagnostics, you need to reboot the system to the system Test Controller in standalone mode and run the `cxtest` utility.

Overview

The `cxtest` utility provides a graphical interface to the diagnostic environment. Diagnostic tests for the PCI Ultra SCSI controller are located in the io3000 suite of diagnostics. The io3000 diagnostic suite is organized into *classes*. Within each class there are one or more diagnostic *subtests*. The PCI SCSI controller diagnostic classes are called Class 3 - EPIC PCI Access Test and Class 4 - QLogic Mailbox Test.

Class 3 EPIC PCI Access Test

The Class 3 EPIC PCI Access diagnostic consists of two subtests:

- 300 EPIC Configuration Space Test
- 305 EPIC I/O and Memory Space Test

The EPIC Configuration Space Test determines whether the EPIC (Exemplar PCI Interface Chip) can talk to the PCI Ultra SCSI controller by using PCI config space cycles to read the vendor ID and device ID of the controller. If this test fails, it indicates that the EPIC is unable to talk to the controller.

The EPIC I/O and Memory Space Test then maps the controller into I/O and memory space by setting the I/O Base Address Register and Memory Base Address Register on the controller. If this test fails, it indicates that the EPIC can communicate with the controller, but it is unable to read and write the Control and Status Registers (CSRs) via I/O and/or memory cycles. Instructions for

running these tests are provided in the section, "Running SCSI diagnostics."

These two diagnostic subtests are designed to test whether the controller can be recognized and initialized by the PCI config, I/O, and memory cycles. They do not test the full functionality of the board. To test the operation of specific disk and tape drives connected to a PCI Ultra SCSI controller, refer to the manual for that individual disk or tape drive and to the *Exemplar Diagnostics Guide.*

Class 4 QLogic Mailbox Test

The Class 4 QLogic Mailbox diagnostic consists of two subtests:

- 400 QLogic Mailbox Test
- 405 QLogic Firmware Download and Test

The QLogic Mailbox Test verifies the QLogic mailbox interface by using the controller's mailbox loopback mechanism to write data to and read data from the controller CSRs. The mailbox is a command interface to the controller that allows an opcode and associated arguments to be sent to the controller via controller CSR write commands. Responses to these commands are placed into controller CSR space and can be subsequently read by the host once the command finishes.

The QLogic Firmware Download and Test loads the controller firmware from system flash memory on the Exemplar CU Board (ECUB) into a specified location in the controller's SRAM. The download is accomplished through the `load ram` mailbox command. Once the code is loaded, a `verify checksum` mailbox command is issued to verify the code, followed by an `execute from ram` mailbox command to run the newly loaded code.

The firmware revision is then checked with the `about firmware` mailbox command. Options have been provided to use a version of SCSI firmware other than the released version (refer to the section "Upgrading controller firmware" for details). This subtest is the first subtest to require an EPIC to transfer data from coherent memory to the controller.

For a complete description of `cxtest` and the Test Controller diagnostic environment, refer to the *Exemplar Diagnostics Guide.* For specific information on the io3000 diagnostics suite, refer to the io3000 man page.

Running SCSI diagnostics

To run the PCI Ultra SCSI controller diagnostics, perform the following steps:

Step 1 From the Test Station, reboot the system so that it boots the Test Controller in standalone mode instead of OBP. For specific instructions on booting the system to the Test Controller and operating in the diagnostic environment, refer to the *Exemplar Diagnostics Guide.*

Step 2 Execute `cxtest`:

```
/spp/bin/cxtest -d
```

Step 3 In the Tests menu, select io3000 to display the io3000 Class Menu dialog.

Step 4 In the Class Menu dialog, select Class 3 - EPIC PCI Access Test and Class 4 - QLogic Mailbox Test. When you select a class, you select all the subtests within that class. You can, however, select specific subtests within a class by selecting the subtest button.

Step 5 From the Class Menu dialog, select the Parameters button to specify the parameters of the test(s). The parameters are as follows:

Epic

This parameter identifies the EPIC where the Ultra SCSI controller resides. Valid entries can be any of the values from the first column in Table 4.

Table 4 EPIC and PCI slot numbering

Parameter to enter	EPIC	PCI slots	Description
IOLF_B	0 (rear)	0, 1, 2	Left front EIOB, rear EPIC
IOLF_A	4 (front)	0, 1, 2	Left front EIOB, front EPIC
IOLR_B	1 (rear)	0, 1, 2	Left rear EIOB, rear EPIC
IOLR_A	5 (front)	0, 1, 2	Left rear EIOB, front EPIC
IORF_B	3 (rear)	0, 1, 2	Right front EIOB, rear EPIC
IORF_A	7 (front)	0, 1, 2	Right front EIOB, front EPIC
IORR_B	2 (rear)	0, 1, 2	Right rear EIOB, rear EPIC
IORR_A	6 (front)	0, 1, 2	Right rear EIOB, front EPIC

Controller

This parameter identifies the PCI slot number of the controller. The value can be 0, 1, 2, or 0xf. An entry of 0xf indicates that this device specification is unused.

Target device number

This is the target device number of the device (SCSI ID), expressed in hexadecimal. For diagnostic Classes 3 and 4, this field is unused.

Logical Unit Number

This is the logical unit number of the device, expressed in hexadecimal. For diagnostic Classes 3 and 4, this field is unused.

Step 6 Click the Done button to close the Class Menu dialog.

Step 7 Select Go from the `cxtest` Command menu to execute the tests. You will see the following in the Console window:

```
Execution Starting.
.......
```

Step 8 When the test terminates (successfully or unsuccessfully), the console window will display the following message:

```
Execution Completed.
```

The results of the test will be displayed in the `cxtest` window.

If the test fails, an error message will be displayed. For a complete description of error messages, refer to the io3000 man page and the *Exemplar Diagnostics Guide.*

Upgrading controller firmware

The PCI Ultra SCSI controller contains two sets of firmware: runtime firmware and forth code that is required for the controller to be in the boot path.

Ultra SCSI runtime firmware

To use a different version of the runtime firmware (other than the released version), follow these procedures:

Step 1 Load the new firmware onto the Test Station. Released firmware is stored in the /spp/firmware directory on the Test Station.

Caution

Do not overwrite the original released firmware filename when storing custom firmware on the Test Station.

Step 2 Load the new firmware into core logic flash on the system using the `obp fwcp` command. The syntax for fwcp is:

`fwcp` *<test_station_ip_address>:<firmware_path>* *<tag>*

where:

test_station_ip_address

is the IP address of the Test Station

firmware_path

is the absolute path to the firmware file

tag

identifies the address in flash for OBP

For example:

```
[0:8] ok fwcp 15.99.111.99:/spp/firmware/myuscsi.fw USCSI
```

Step 3 Run the `cxtest` utility and load the io3000 diagnostics suite. Refer to the section "Running SCSI diagnostics" in this chapter for instructions on running `cxtest`.

Step 4 In io3000, set the custom SCSI firmware enable option and the custom SCSI firmware length. Use the `ll` command to obtain the size of the firmware file for the custom SCSI firmware length option. For example:

```
# ll /spp/firmware/myuscsi.fw
-r--r--r--   1 sppuser  sppuser    21826 Nov  1 17:37 /spp/firmware/myuscsi.fw
```

The length option must be specified in half-words (16 bit quantity) and in hexadecimal notation. Therefore, you must divide the firmware file size by 2 and convert it to hexadecimal. Once you decide to operate the PCI Ultra SCSI controller with nonreleased firmware, you must always set the custom SCSI firmware enable and custom SCSI firmware length options when running SCSI diagnostics.

Ultra SCSI forth code

To upgrade the controller's forth code, use the following procedure:

Step 1 Load the new firmware onto the Test Station. Released firmware is stored in the /spp/firmware directory on the Test Station.

Caution

Do not overwrite the original released firmware filename when storing custom firmware on the Test Station.

Step 2 Load the new firmware into core logic flash on the system using the `obp fwcp` command. The syntax for fwcp is:

`fwcp` *<test_station_ip_address>:<firmware_path>* *<tag>*

where:

test_station_ip_address

is the IP address of the Test Station

firmware_path

is the absolute path to the firmware file

tag

identifies the address in flash for OBP

For example:

```
[0:8] ok fwcp 15.99.111.99:/spp/firmware/myfth_code.fw PAD
```

Step 3 Run the `cxtest` utility and load the io3000 diagnostics suite. Refer to the section "Running SCSI diagnostics" in this chapter for instructions on running `cxtest`.

Step 4 In io3000, select Class 12 - Utility Functions and execute both subtests (SCSI forth code download and SCSI forth code verify). The forth code will be loaded and verified.

FRU list

The following table lists the Hewlett-Packard part numbers for the PCI Ultra SCSI controller Field Replaceable Units (FRUs).

Table 5 PCI Ultra SCSI controller FRU list

Description	Part number
PCI Ultra SCSI controller	220-000058-201
10-inch SCSI shielded cable with back shell	612-000019-001
13-inch SCSI shielded cable with back shell	612-000019-002
18-inch SCSI shielded cable with back shell	612-000019-003

PCI overview

A

This appendix provides a brief introduction and overview to the PCI Local Bus. For a complete description of the bus, refer to the PCI Local Bus Specification, Revision 2.1. You can obtain a copy of the specification by contacting the PCI Special Interest Group:

PCI Special Interest Group
P.O. Box 14070
Portland, OR
USA 97214

In the US call (800) 433-5177
International call 1 (503) 797-4207
Fax 1 (503) 234-6762

PCI bus description

The Peripheral Component Interconnect (PCI) Local Bus is an industry standard, high-performance, 32-bit or 64-bit synchronous bus with multiplexed address and data lines. It is specified for data rates up to 132 MBytes/second using a 32-bit wide data path and 264 MBytes/second using a 64-bit data path. The bus provides a complete set of multiprocessing and high performance features, including:

- Multiple bus master
- Overlapped (hidden) bus arbitration
- Burst-mode data transfers
- Multiprocessing support (resource locking)
- Cache coherency support
- 64-bit addressing capability
- Interrupts
- Configuration space

The PCI Local Bus is intended to be an interconnect mechanism between highly integrated peripheral controller components, peripheral expansion cards, and processor/memory systems. The processor and memory are connected through a *bridge* that provides a low latency path by which a processor can access PCI devices mapped anywhere in memory or I/O address space. It also provides a high bandwidth path allowing a PCI master direct access to main memory. The bridge may also include functions such as data buffering and posting, and PCI central functions such as arbitration.

Exemplar S-Class and X-Class Technical Servers support the 32-bit PCI Local Bus. There can be from one to eight independent busses in a node, with three expansion slots in each bus.

PCI terminology

The PCI specification defines several terms and acronyms. Some of these terms are described below.

PCI Local Bus

The Peripheral Component Interconnect bus. PCI was originally developed by Intel as a local bus for high-end PC systems. It now falls under the jurisdiction of the PCI Special Interest Group (PCI-SIG).

controller

A PCI expansion card.

PCI interface

The whole block of logic that implements the PCI bus.

PMC

PCI Mezzanine Card. A small form factor expansion card based on the PCI specification.

agent

An entity that operates on a computer bus.

arbitration boundary

A point at which bus mastership may be assumed by another master.

transaction

An atomic transfer of one or more bytes on the PCI bus. A transaction defines an arbitration boundary.

master

A master is a PCI module which can initiate a PCI transaction.

target

A PCI target is a module which responds to a PCI transaction.

DAC

Dual Address Cycle. A PCI transaction where a 64-bit address is transferred across a 32-bit data path in two clock cycles.

SAC

Single Address Cycle. A PCI transaction where a 32-bit address is transferred across a 32-bit data path in a single clock cycle.

bus device

General term that refers to either a bus master or target.

burst transfer

The basic bus transfer mechanism of PCI. A burst is comprised of an address phase and one or more data phases.

configuration cycle

Bus cycles used for system initialization and configuration via the configuration address space.

Configuration Address Space

A set of 64 registers (DWORDS) used for configuration, initialization, and catastrophic error handling. This address space consists of two regions: a header region and a device-dependent region.

PCI bus commands

Bus commands indicate to a target agent the type of transaction the bus master is requesting. All bus commands are encoded on the Bus Command and Byte Enable pins (C/BE[3::0]#) during the address phase. PCI bus command types are as follows:

Interrupt Acknowledge

Acknowledges an interrupt. The Interrupt Acknowledge command is a read that is implicitly addressed to the interrupt controller.

Special Cycle

Simple message broadcast mechanism. Used as an alternative to physical signals when sideband communication is required.

I/O Read.

Reads data from an agent mapped in I/O address space.

I/O Write

Writes data to an agent that is mapped in I/O address space.

Reserved

Reserved for future use.

Memory Read

Reads data from an agent mapped in memory address space.

Memory Write

Writes data to an agent mapped in memory address space.

Configuration Read

Reads the configuration space of an agent.

Configuration Write

Transfers data to the configuration space of an agent.

Memory Read Multiple

Similar to the Memory Read Command. Indicates that the master may want to fetch more than one cacheline before disconnecting.

Dual Address Cycle

Transfers a 64-bit address to devices that support 64-bit addressing when the address is not in the low 4 GB address space. Targets that support only 32-bit addressing treat this command as Reserved.

Memory Read Line

Similar to the Memory Read Command. Indicates that the master intends to fetch a complete cacheline. It is typically used with bulk sequential data transfers to increase performance.

Memory Write and Invalidate

Similar to the Memory Write Command. Guarantees a minimum of one complete cacheline.

PCI physical characteristics

PCI defines two expansion card connectors: 5 volt signaling connectors and 3.3 volt signaling connectors. To accommodate both voltages and to provide a smooth migration path between voltages, three electrical types are defined for expansion cards:

- *5 volt boards,* which plug into a 5 volt connector
- *3.3 volt boards,* which plug into 3.3 volt connectors
- *universal boards,* which plug into either 5 volt or 3.3 volt connectors

Additionally, PCI specifies two form factors for expansion cards. One type is known as PMC (PCI Mezzanine Card), based on CMC IEEE P1386. Mezzanine cards have a form factor similar to an SBUS card. The other type is similar to an EISA bus card and is common in most PCs. PCI defines three sizes of these cards:

- long
- short
- variable short length

It is not a requirement for any system to support all three sizes.

Two types of backplates are currently defined: ISA/EISA and Micro-Channel compatible.

PCI bus signals

The PCI bus requires a minimum of 47 pins for a target-only device and 49 pins for a master to handle data and addressing, interface control, arbitration, and system functions. Table 6 and Table 7 list required and optional signals.

Table 6 PCI bus signals (required pins)

Functional group	Signal name	Description
Address and data	AD[31::00]	Address and Data (multiplexed on same pins)
	C/BE[3::0]#	Bus Command (address phase) and Byte Enables (data phase) (multiplexed on same pins)
	PAR	Parity (even)—required by all PCI agents
Interface control	FRAME#	Cycle Frame—used by master to indicate the start and duration of an access
	TRDY#	Initiator Ready—initiating agent is ready to complete current data phase of the transaction
	IRDY#	Target Ready—target agent is ready to complete current data phase of the transaction
	STOP#	Stop—used by target to request that master stop the current transaction
	DEVSEL#	Device Select—when asserted, indicates driving device has decoded its address as the target of the current access
	IDSEL	Initialization Device Select—chip select during config and R/W transactions
Error reporting	PERR#	Parity Error—used to report data parity errors during PCI transactions (except Special Cycle)
	SERR#	System Error—used to report address parity errors, data parity errors on Special Cycle command, and all other catastrophic errors
Arbitration (masters only)	REQ#	Request—request the use of the bus
	GNT#	Grant—access to bus is granted
System	CLK	Clock—provides timing for all transactions
	RST#	Reset—sets PCI-specific registers, sequencers, and signals to a consistent state

Table 7 PCI bus signals (optional pins)

Functional group	Signal name	Description
64-bit extension (optional)	AD[63::32]	Address and Data (multiplexed on same pins)
	C/BE[7::4]#	Bus Command (address phase) and Byte Enables (data phase) (multiplexed on same pins)
	PAR64	Parity Upper DWORD—even parity that protects AD[63::32] and C/BE[7::4]#
	REQ64#	Request 64-bit Transfer—indicates that the master wishes to transfer data using 64 bits
	ACK64#	Acknowledge 64-bit transfer—indicates the target is ready to transfer data using 64 bits
Interface control (optional)	LOCK#	Lock—indicates an atomic operation that may require more than one transaction
Interrupts (optional)	INTA#	Interrupt A—request an interrupt
	INTB#	Interrupt B—request an interrupt (only meaningful on a multi-function device)
	INTC#	Interrupt C—request an interrupt (only meaningful on a multi-function device)
	INTD#	Interrupt D—request an interrupt (only meaningful on a multi-function device)
Cache support (optional)	SBO#	Snoop Backoff—when asserted, indicates a hit to a modified line
	SDONE	Snoop Done—indicates status of snoop for current access
JTAG/Boundary Scan pins. IEEE Standard 1149.1, Test Access Port and Boundary Scan Architecture (optional).	TDI	Test Data Input
	TDO	Test Output
	TCK	Test Clock
	TMS	Test Mode Select
	TRST#	Test Reset

SCSI overview

B

This section presents an overview of Small Computer Systems Interface (SCSI) concepts and terminology.

SCSI

SCSI is an I/O bus protocol that uses a parallel bus connection between peripherals. The word "small" in the acronym is an inaccurate description of this popular interface. The SCSI interface is highly flexible and lends itself to a wide variety of applications in systems of all sizes.

SCSI protocol is the logical capabilities of the bus itself rather than the physical characteristics of the peripheral devices. The bus is designed to support up to 16 devices, including one or more hosts. Either asynchronous or synchronous transfer modes can be utilized making a great variety of peripheral devices available for use.

SCSI terminology

SCSI interfaces are generally classified using a combination of the following seven attributes:

Ultra

a synchronous transfer rate of 20 MHz (50 nanosecond cycle time)

Fast

a synchronous transfer rate of 10MHz (100 nanosecond cycle time)

Slow

a synchronous transfer rate of 5MHz (200 nanosecond cycle time)

Wide

a 16-bit wide data path

Narrow

an 8-bit wide data path

Single-ended

a cable/driver configuration intended for cabling devices that are in close physical proximity, such as in the same cabinet

Differential

a cable/driver configuration intended for cabling devices between cabinets

The SCSI interface can support the following types of devices:

- Ultra-and-Wide
- Ultra-and-Narrow
- Fast-and-Wide
- Fast-and-Narrow
- Slow-and-Wide
- Slow-and-Narrow

The type of SCSI interface used is dependent on both the controller and the peripheral device's configuration. In addition, all SCSI devices support asynchronous transfers, which always use a narrow data path.

Devices on the SCSI bus are known as either:

Initiators

a device, such as a host system that requests another device on the bus to perform a SCSI operation, or

Targets

the object of a request, such as a peripheral device

Some devices can function as both an Initiator and a Target, but usually a device is either one or the other.

Devices on the SCSI bus are characterized by:

SCSI ID

a unique bus address, ranging from 0 to 15

SCSI IDs 7 - 0 have the highest priority, and devices 15 - 8 the lowest. Within each group the device with the higher numbered ID has highest priority. ID 7 is normally reserved for the host/initiator as it is in the case of the PMC Ultra SCSI.

Logical Unit

a physical or virtual peripheral device addressable through a target

LUN

the Logical Unit Number. An encoded three-bit identifier for the logical unit.

The continued logical connection between two devices is identified by a:

Nexus

a relationship or connection between devices that begins with the establishment of an initial connection and ends with the completion of the I/O process

IT Nexus

a Nexus between initiator and target, established with the selection phase

ITL Nexus

a Nexus between initiator, target, and logical unit, established with the Identify message

SCSI bus phases

Communication on the SCSI bus can occur only between two devices at any time.

The SCSI architecture includes eight distinct phases:

1. BUS FREE

   The BUS FREE phase indicates that there is no current I/O process, and that the SCSI bus is available for a connection.

2. ARBITRATION

   The ARBITRATION phase allows one SCSI device to gain control of the SCSI bus so that it can initiate or resume an I/O process.

3. SELECTION

   The SELCTION phase allows an initiator to select a target for the purpose of requesting a target function.

4. RESELECTION

   A target may disconnect, that is the action of releasing control of the SCSI bus and allowing it to go to the BUS FREE Stage, to perform an operation. RESELECTION therefore, is the reacquisition of the SCSI bus to complete the I/O process begun in the initial connection made during a SELECTION PHASE.

   Information transfer phases

5. COMMAND
6. DATA

7. STATUS
8. MESSAGE

   The COMMAND, DATA, STATUS, and MESSAGE phases are all grouped together as the information transfer phases. They are used to transfer data or control information via the DATA BUS.

   The information transfer phases use one or more request/acknowledge handshakes to control the information transfer. Each request/acknowledge handshake allows the transfer of one byte or halfword of information.

   Synchronous data transfer is optional and is only used in data phases if an agreement has been established between the initiator and target. The agreement specifies the request/acknowledge offset and the minimum transfer period.

SCSI physical characteristics

The ANSI SCSI-3 draft specification defines the physical characteristics of the SCSI bus (cable) that includes: cables (bus), transceivers, connectors, signals, terminators, and timing. The controller is designed to comply with the SCSI-3 SPI (SCSI Parallel Interface).

The SCSI bus consists of 28 signals, a differential sense signal, multiple termination power signals, and multiple grounds. Table 8 lists these signals. SCSI devices are connected together in a daisy-chain fashion, making the signals common to all devices. Each end of the cable must be terminated with the characteristic impedance of the bus. The PCI Ultra SCSI controller has onboard terminators that terminate its end of the SCSI cable. The opposite end of the SCSI cable must also have an appropriate termination plug attached.

Table 9 lists the PCI Ultra SCSI controller's SCSI cable signals with their pin locations.

Table 8 SCSI signals

Signal Name	Driven By	Number of Signals	Meaning
DB0-15	Initiator or target	16	Data bus
Parity	Initiator or target	2	Parity for data bus
-ATN	Initiator	1	Indicate ATTENTION condition to target
-BSY	Initiator or target	1	Bus in use
-ACK	Initiator	1	Acknowledge REQ/ACK transfer handshake to target
-REQ	Target	1	Request a transfer from initiator
-SEL	Initiator or target	1	Indicate target of SELECTION or RESELECTION phase
-C/D	Target	1	Indicate control or data on bus
-MSG	Target	1	Indicate that a message phase is occurring
-I/O	Target	1	Direction control
-RST	Any	1	Indicate bus reset condition
DIFFSENS	Cable	1	Differential cable in use

Table 9 SCSI 68-pin differential cable pinout

Pin	Signal	Pin	Signal
1..4	+DB12..DB15	35..38	-DB12..DB15
5	DBP1	39	-DBP1
6	GND	40	-GND
7..14	+DB0..DB7	41..48	-DB0..DB7
15	+DBP	49	-DBP
16	DIFFSENS0	50	GND
17	TERMPWR	51	TERMPWR
18	TERMPWR	52	TERMPWR
19	RESERVED	53	RESERVED
20	+ATN	54	-ATN
21	GND	55	GND
22	+BSY	56	-BSY
23	+ACK	57	-ACK
24	+RST	58	-RST
25	+MSG	59	-MSG
26	+SEL	60	-SEL
27	+C/D	61	-C/D
28	+REQ	62	-REQ
29	+I/O	63	I/O
30	GND	64	GND
31..34	+DB8..+DB11	65..68	-DB8..-DB11

Ultra SCSI

Ultra SCSI (also called Fast-20) is also defined by ANSI. Ultra SCSI has double the performance of Fast SCSI.

An Ultra SCSI device can connect computers to other computers or to peripheral devices such as disk drives, tape drives, or CD-ROM drives.

Ultra SCSI allows up to 15 SCSI or Ultra SCSI devices to be connected to a single port in daisy chain fashion. Each SCSI device must have a unique SCSI ID. You must have Ultra SCSI devices to achieve Ultra SCSI transfer speeds, but the PCI Ultra SCSI controller is backwards compatible with slower SCSI devices.

SCSI sense codes

This appendix lists the SCSI status codes, lists SCSI sense keys, and provides an interpretation of the Additional sense and Qualifier codes contained in SCSI error messages reported by the console.

A typical SCSI error message is shown below. In the error message, the status (CHECK CONDITION) and sense key (RECOVERED ERROR) are interpreted in the message. Table 10 and Table 11 list all possible status and sense key codes respectively.

The Additional sense and Qualifier codes require interpretation. Use both codes to locate the interpretation in Table 12. In the example, the Additional Sense (0x18) and Qualifier (0x01) codes are interpreted as "recovered data with error correction and retries applied."

```
[+6708 72410001 002a9858 0:7] scsi disk: CHECK CONDITION on disk 0:6:5:0
        Read of logical block 509856, count 128
        disk sd45a, block 254920, 65536 bytes
        Valid = 1, Error code = 0x70
        Segment number = 0x00, Filemark = 0, EOM = 0, ILI = 0
        Sense key = 0x1, "RECOVERED ERROR"
        Information = 0x00 0x07 0xc7 0xe4
[+6709 72410001 002a9a10 0:7] scsi disk:        Additional sense length = 0x0a
        Command-specific information = 0x00 0x00 0x00 0x00
        Additional sense = 0x18, Qualifier = 0x01
        Field replaceable unit code = 0xea
        SKSV = 1, C/D = 0, BPV = 0, Bit pointer = 0
        Field pointer = 0x0003
```

Table 10 SCSI status codes

Value	Name
0x00	good
0x02	check condition
0x04	condition met
0x08	busy
0x10	intermediate
0x14	intermediate - condition met
0x18	reservation conflict
0x22	command terminated
0x28	queue full

Table 11 SCSI sense keys

Value	Name
0	no sense
0x1	recovered error
0x2	not ready
0x3	medium error
0x4	hardware error
0x5	illegal request
0x6	unit attention
0x7	data protect
0x8	blank check
0x9	vendor-specific
0xa	copy aborted
0xb	aborted command
0xc	equal
0xd	volume overflow
0xe	miscompare
0xf	reserved

Table 12 SCSI Additional sense and Qualifier codes

Additional sense	Qualifier	Description
0x00	0x00	no additional sense information
0x00	0x01	filemark detected
0x00	0x02	end-of-partition/medium detected
0x00	0x03	setmark detected
0x00	0x04	beginning of partition/medium detected
0x00	0x05	end-of-data detected
0x00	0x06	i/o process terminated
0x00	0x11	audio play operation in progress
0x00	0x12	audio play operation paused
0x00	0x13	audio play operation successfully completed
0x00	0x14	audio play operation stopped due to error
0x00	0x15	no current audio status to return
0x01	0x00	no index/sector signal
0x02	0x00	no seek complete
0x03	0x00	peripheral device write fault
0x03	0x01	no write current
0x03	0x02	excessive write errors
0x04	0x00	logical unit not ready, cause not reportable
0x04	0x01	logical unit is in process of becoming ready
0x04	0x02	logical unit not ready, initializing command required
0x04	0x03	logical unit not ready, manual intervention required
0x04	0x04	logical unit not ready, format in progress

Table 12 SCSI Additional sense and Qualifier codes **(continued)**

Additional sense	Qualifier	Description
0x05	0x00	logical unit does not respond to selection
0x06	0x00	reference position found
0x07	0x00	multiple peripheral devices selected
0x08	0x00	logical unit communication failure
0x08	0x01	logical unit communication time-out
0x08	0x02	logical unit communication parity error
0x09	0x00	track following error
0x09	0x01	tracking servo failure
0x09	0x02	focus servo failure
0x09	0x03	spindle servo failure
0x0a	0x00	error log overflow
0x0c	0x00	write error
0x0c	0x01	write error recovered with auto reallocation
0x0c	0x02	write error - auto reallocation failed
0x10	0x00	id crc or ecc error
0x11	0x00	unrecovered read error
0x11	0x01	read retries exhausted
0x11	0x02	error too long to correct
0x11	0x03	multiple read errors
0x11	0x04	unrecovered read error - auto reallocate failed
0x11	0x05	l-ec uncorrectable error
0x11	0x06	circ unrecovered error
0x11	0x07	data resynchronization error
0x11	0x08	incomplete block read
0x11	0x09	no gap found
0x11	0x0a	miscorrected error

Table 12 SCSI Additional sense and Qualifier codes **(continued)**

Additional sense	Qualifier	Description
0x11	0x0b	unrecovered read error - recommend reassignment
0x11	0x0c	unrecovered read error - recommend rewrite the data
0x12	0x00	address mark not found for id field
0x13	0x00	address mark not found for data field
0x14	0x00	recorded entity not found
0x14	0x01	record not found
0x14	0x02	filemark or setmark not found
0x14	0x03	end-of-data not found
0x14	0x04	block sequence error
0x15	0x00	random positioning error
0x15	0x01	mechanical positioning error
0x15	0x02	positioning error detected by read of medium
0x16	0x00	data synchronization mark error
0x17	0x00	recovered data with no error correction applied
0x17	0x01	recovered data with retries
0x17	0x02	recovered data with positive head offset
0x17	0x03	recovered data with negative head offset
0x17	0x04	recovered data with retries and/or circ applied
0x17	0x05	recovered data using previous sector id
0x17	0x06	recovered data without ecc - data auto-reallocated
0x17	0x07	recovered data without ecc - recommend reassignment

Table 12 SCSI Additional sense and Qualifier codes **(continued)**

Additional sense	Qualifier	Description
0x17	0x08	recovered data without ecc - recommend rewrite
0x18	0x00	recovered data with error correction applied
0x18	0x01	recovered data with error correction and retries applied
0x18	0x02	recovered data - data auto-reallocated
0x18	0x03	recovered data with circ
0x18	0x04	recovered data with lec
0x18	0x05	recovered data - recommend reassignment
0x18	0x06	recovered data - recommend rewrite
0x19	0x00	defect list error
0x19	0x01	defect list not available
0x19	0x02	defect list error in primary list
0x19	0x03	defect list error in grown list
0x1a	0x00	parameter list length error
0x1b	0x00	synchronous data transfer error
0x1c	0x00	defect list not found
0x1c	0x01	primary defect list not found
0x1c	0x02	grown defect list not found
0x1d	0x00	miscompare during verify operation
0x1e	0x00	recovered id with ecc
0x20	0x00	invalid command operation code
0x21	0x00	logical block address out of range
0x21	0x01	invalid element address
0x22	0x00	illegal function
0x24	0x00	invalid field in cdb
0x25	0x00	logical unit not supported
0x26	0x00	invalid field in parameter list

Table 12 SCSI Additional sense and Qualifier codes **(continued)**

Additional sense	Qualifier	Description
0x26	0x01	parameter not supported
0x26	0x02	parameter value invalid
0x26	0x03	threshold parameters not supported
0x27	0x00	write protected
0x28	0x00	not ready to ready transition (medium may have changed)
0x28	0x01	import or export element accessed
0x29	0x00	power on, reset, or bus device reset occurred
0x2a	0x00	parameters changed
0x2a	0x01	mode parameters changed
0x2a	0x02	log parameters changed
0x2b	0x00	copy cannot execute since host cannot disconnect
0x2c	0x00	command sequence error
0x2c	0x01	too many windows specified
0x2f	0x00	commands cleared by another initiator
0x30	0x00	incompatible medium installed
0x30	0x01	cannot read medium - unknown format
0x30	0x02	cannot read medium - incompatible format
0x30	0x03	cleaning cartridge installed
0x31	0x00	medium format corrupted
0x32	0x00	no defect spare location available
0x32	0x01	defect list update failure
0x33	0x00	tape length error
0x36	0x00	ribbon, ink, or tower failure
0x37	0x00	rounded parameter
0x39	0x00	saving parameters not supported

Table 12 SCSI Additional sense and Qualifier codes **(continued)**

Additional sense	Qualifier	Description
0x3a	0x00	medium not present
0x3b	0x00	sequential positioning error
0x3b	0x01	tape position error at beginning-of-medium
0x3b	0x02	tape position error at end-of-medium
0x3b	0x03	tape or electronic vertical forms unit not ready
0x3b	0x04	slew failure
0x3b	0x05	paper jam
0x3b	0x06	failed to sense top-of-form
0x3b	0x07	failed to sense bottom-of-form
0x3b	0x08	reposition error
0x3b	0x09	read past end of medium
0x3b	0x0a	read past beginning of medium
0x3b	0x0b	position past end of medium
0x3b	0x0c	position past beginning of medium
0x3b	0x0d	medium destination element full
0x3b	0x0e	medium source element empty
0x3d	0x00	invalid bits in identify message
0x3e	0x00	logical unit has not self-configured yet
0x3f	0x00	target operating conditions have changed
0x3f	0x01	microcode has been changed
0x3f	0x02	changed operating definition
0x3f	0x03	inquiry data has changed
0x40	0x00	ram failure
0x40	nn	diagnostic failure on component nn
0x41	0x00	data path failure
0x42	0x00	power-on or self-test failure
0x43	0x00	message error

Table 12 SCSI Additional sense and Qualifier codes **(continued)**

Additional sense	Qualifier	Description
0x44	0x00	internal target failure
0x45	0x00	select or reselect failure
0x46	0x00	unsuccessful soft reset
0x47	0x00	scsi parity error
0x48	0x00	initiator detected error message received
0x49	0x00	invalid message error
0x4a	0x00	command phase error
0x4b	0x00	data phase error
0x4c	0x00	logical unit failed self-configuration
0x4e	0x00	overlapped commands attempted
0x50	0x00	write append error
0x50	0x01	write append position error
0x50	0x02	position error related to timing
0x51	0x00	erase failure
0x52	0x00	cartridge fault
0x53	0x00	media load or eject failed
0x53	0x00	unload tape failure
0x53	0x00	medium removal prevented
0x53	0x00	scsi to host system interface failure
0x53	0x00	system resource failure
0x53	0x00	unable to recover table-of-contents
0x53	0x00	generation does not exist
0x53	0x00	updated block read
0x53	0x00	operator request or state change input (unspecified)
0x53	0x00	operator medium removal request
0x53	0x00	operator selected write protect
0x53	0x00	operator selected write permit

Table 12 SCSI Additional sense and Qualifier codes **(continued)**

Additional sense	Qualifier	Description
0x53	0x00	log exception
0x53	0x00	threshold condition met
0x53	0x00	log counter at maximum
0x53	0x00	log list codes exhausted
0x53	0x00	rpl status change
0x53	0x00	spindles synchronized
0x53	0x00	spindles not synchronized
0x53	0x00	lamp failure
0x53	0x00	video acquisition error
0x53	0x00	unable to acquire video
0x53	0x00	out of focus
0x53	0x00	scan head positioning error
0x53	0x00	end of user area encountered on this track
0x53	0x00	illegal mode for this track

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