DIGITAL StorageWorks UltraSCSI RAID Enclosure (DS–BA370 Series)

User's Guide

Part Number: EK–BA370–UG .C01

August 1998

The DS–BA370 series UltraSCSI RAID rack-mountable enclosure is the basic building block of UltraSCSI RAID subsystems. This guide and its related publications comprise the basic documentation set for these subsystems.

Digital Equipment Corporation
Maynard, Massachusetts

August 1998

This equipment generates, uses, and may emit radio frequency energy. The equipment has been type tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC rules, which are designed to provide reasonable protection against such radio frequency interference.

Operation of this equipment in a residential area may cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

Any modifications to this device—unless expressly approved by the manufacturer—can void the user's authority to operate this equipment under part 15 of the FCC rules.

Note

Additional information on the need to interconnect the device with shielded (data) cables or the need for special devices, such as ferrite beads on cables, is required if such means of interference suppression was used in the qualification test for the device. This information will vary from device to device and needs to be obtained from the EMC group or product manager.

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Preface

The *DIGITAL StorageWorks UltraSCSI RAID Enclosure (DS–BA370 Series) User's Guide* describes the functions, operations, components, configurations, assembly, and specifications of this enclosure.

Intended Audience

This document is for use by personnel responsible for designing, configuring, assembling, installing, and operating UltraSCSI RAID subsystems using a DS–BA370 series enclosure mounted in either a data center cabinet or a departmental server cabinet.

Structure

Manual organization is as follows:

Chapter 1
This chapter describes the UltraSCSI RAID enclosure functions, uses, components, and features.

Chapter 2
This chapter describes how to configure and operate an UltraSCSI RAID enclosure.

Chapter 3
This chapter describes the environmental monitoring unit (EMU) operation, functions, uses, configuration, and replacement procedures.

Chapter 4
This chapter describes the power verification and addressing (PVA) assembly operation, functions, uses, configuration, and replacement procedures.

Chapter 5
This chapter describes the single-ended input/output (I/O) module operation, functions, uses, configuration, and replacement procedures.

Chapter 6
This chapter describes the enclosure power distribution components operation, functions, uses, configuration, and replacement procedures.

Chapter 7
This chapter describes the disk drive operation, functions, uses, configuration, and replacement procedures.

Chapter 8
This chapter describes blower operation, status reporting, and replacement procedures.

Appendix A
This appendix describes enclosure specifications, which include physical, electrical, and environmental specifications.

Appendix B
This appendix describes the procedures for installing components in an enclosure to create an UltraSCSI RAID subsystem.

Appendix C
This appendix describes general procedures for installing EMU microcode into an UltraSCSI RAID subsystem.

Glossary

Documentation Conventions

Table 1 describes the conventions for this publication:

Table 1 Documentation Conventions

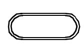
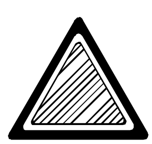
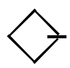
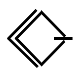
boldface type		Boldface type indicates the first instance of terms being defined in the text, the glossary, or both. Hypertext links connect each glossary term within a chapter to its definition in the glossary. Clicking on a glossary term within a chapter activates the link.
italic type		Italic type emphasizes important imformatioin and indicates complete titles of manuals. Italic type within the glossary indicates a cross-reference.
`courier type`		Courier type indicates a keyboard command or screen display data.
A/R		As required.
		The light emitting diode (LED) is OFF.
		The LED is FLASHING (blinking in half-second cycles).
		The LED is ON or blinking rapidly (blinking less than half-second cycles).
		**Warning** Information essential to the safety of personnel.
		**Caution** Information essential to avoid damaging software or hardware.

Table 1 Documentation Conventions (Continued)

Note	Notes contain information that might be of special interest to the user.
	Single-ended SCSI bus.
	Differential SCSI bus.

Related Documents

Table 2 lists publications that contain additional information about the UltraSCSI RAID subsystem:

Table 2 Related Publications

Publication Title	Order Number
HSZ70 Array Controller HSOF Version 7.0 CLI Reference Manual	EK–CLI70–RM
HSZ70 Array Controller HSOF Version 7.0 Configuration Manual	EK–HSZ70–CG
HSZ70 Array Controller HSOF Version 7.0 Service Manual	EK–HSZ70–SV
DIGITAL StorageWorks HSx80[1] *Array Controller ACS Version 8.n*[2] *User's Guide*	EK–HSG80–UG.x01[3]
Operating System Specific Release Notes	See system-specific "Getting Started" manual
Improving UltraSCSI RAID Subsystem Operation	EK–BA370–UP
Installing an External Cache Battery Cable	EK–HSZ70–TE

Table 2 Related Publications (Continued)

Publication Title	Order Number
Installing a Host Bus Cable Ferrite Bead	EK–SWXES–IG
StorageWorks Solutions SBB User's Guide	EK–SBB35–UG
UltraSCSI Subsystem Standby Power Operation	EK–POWER–IG
DIGITAL StorageWorks UltraSCSI RAID Data Center Cabinet (DS–SW600–Series) Installation and User's Guide	EK–SW600–UG

1. HSx80 array controllers include: HSG80 and HSZ80
2. Version 8.0, 8.1, or higher
3. Revision A01, B01, or higher

Manufacturer's Declarations

This section discusses electromagnetic compatibility and accoustic noise declarations.

Electromagnetic Compatibility

This **CE–Mark Class A** certified product can be installed in a commercial or an office environment.

WARNING!

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

ACHTUNG!

Dieses ist ein Gerät der Funkstörgrenzwertklasse A. In Wohnbereichen können bei Betrieb dieses Gerätes Rundfunkstörungen auftreten, in welchen Fällen der Benutzer für entsprechende Gegenmaßnahmen verantwortlich ist.

ATTENTION!

Ceci est un produit de Classe A. Dans un environnement domestique, ce produit risque de créer des interférences radioélectriques, il appartiendra alors à l'utilisateur de prendre les mesures spécifiques appropriées.

Acoustic Noise Declarations

DIGITAL™ declares that the acoustic values of this product are as shown in Table 1 and Table 2.

Table 1 Acoustics – Declared Values per ISO 9296 and ISO 7779

Product	Sound Power Level L_{WAd}, B		Sound Pressure Level L_{pAm} dBA (bystander positions)	
	Idle	Operate	Idle	Operate
RAID Array 7000 Subsystem (DS–SWXRA–HA) with: 2 — ac input boxes (DS–BA35X–HE) 8 — 180 W shelf power supplies (DS–BA35X–HH) 24 — disk drives (2, 4, 9, or 18 GB)	6.1	N/A	48.4	48.4
RAID Array 7000 Subsystem (DS–SWXRA–HA) with: 2 — ac input boxes (DS–BA35X–HE) 8 — 180 W shelf power supplies (DS–BA35X–HH) 24 — disk drives (2, 4, 9, or 18 GB)	6.1	6.3	48.4	48.4

Note

Current values for sound power levels are available from DIGITAL representatives.
1 Bel = 10 dBA.

Table 2 Schallemissionswerte – Werteangaben nach ISO 9296 und ISO 7779/DIN EN27779

Gerät	Schalleistungspegel L_{WAd}, B		Schalldruckpegel L_{pAm}, dBA (Zuschauerpositionen)	
	Leerlauf	Betrieb	Leerlauf	Betrieb
RAID Array 7000 Subsystem (DS–SWXRA–HA) with: 2 — ac input boxes (DS–BA35X–HE) 8 — 180 W shelf power supplies (DS–BA35X–HH) 24 — disk drives (2, 4, 9, or 18 GB)	6,1	N/A	48,4	48,4
RAID Array 7000 Subsystem (DS–SWXRA–HA) with: 2 — ac input boxes (DS–BA35X–HE) 8 — 180 W shelf power supplies (DS–BA35X–HH) 24 — disk drives (2, 4, 9, or 18 GB)	6,1	6,3	48,4	48,4

Note

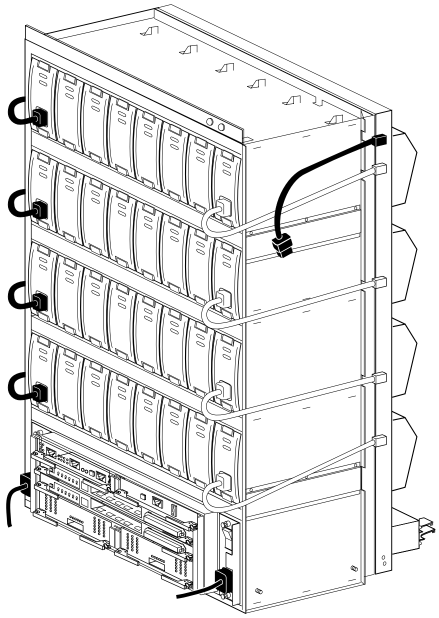
Aktuelle Werter für spezielle Austüstungsstufen sind über die Compaq Computer Vertretungen erhältlich. 1 Bel = 10 dBA.

1

Introducing the UltraSCSI RAID Enclosure

The DIGITAL **StorageWorks**™ **UltraSCSI RAID (redundant array of independent disks)** enclosure (DS–BA370 series) shown in Figure 1–1 is the basic building block for DIGITAL single-ended **UltraSCSI RAID subsystems**.

Figure 1–1 DS–BA370 Series UltraSCSI Enclosure



This enclosure cannot function until:

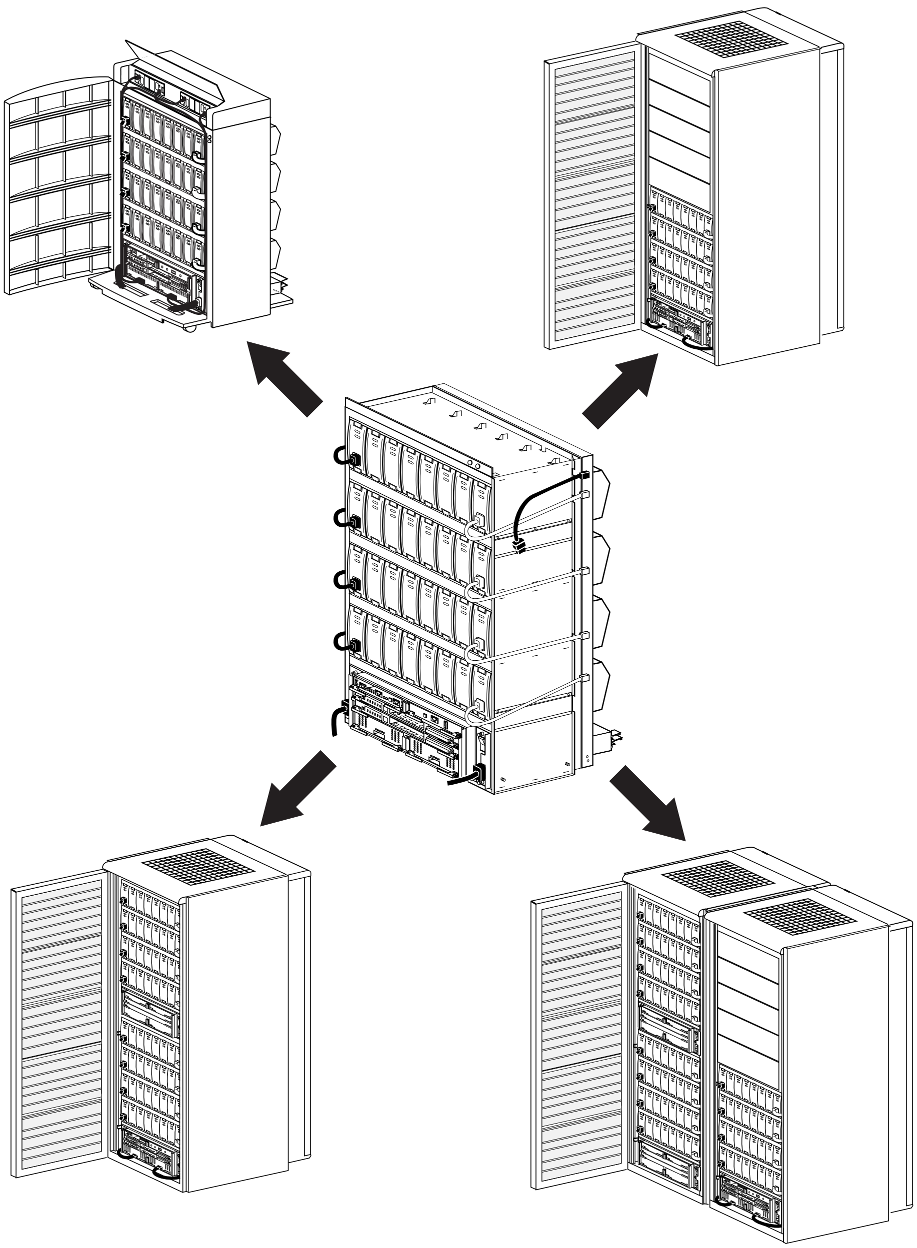
1. It is installed in an UltraSCSI **data center cabinet** (DS–SW600 series) or an UltraSCSI **departmental server cabinet** (DS–SWXRE series).
2. 3.5-inch **StorageWorks building block** (**SBB) disk drives** are installed.
3. A compatible **array controller** is installed and connected to a **host computer** or **adapter.**
4. The enclosure and the subsystem are configured for UltraSCSI operation.

Note

The “DS–” model number prefix defines *new* DIGITAL storage products. In some cases, these numbers might be similar to an existing product number. For example, the DS–BA35X–HE **ac input box** (also known as the **ac power controller**) and the BA35X–HE ac input box have similar model numbers but are *not interchangeable.* Installing incompatible products in a StorageWorks subsystem could result in degraded operation or noncompliance with country-specific certifications.

See Figure 1–2 for the DIGITAL-supported enclosure applications.

Figure 1–2 Typical DS–BA370 Applications



An UltraSCSI Bus Overview

UltraSCSI was developed by Digital Equipment Corporation (now Compaq Computer Corporation) and subsequently standardized by the ANSI (American National Standards Institute) **SCSI (small computer system interface)** committee as standard X3T10. UltraSCSI is a technology that incorporates several improvements over a **Fast 10** SCSI bus.

UltraSCSI increases the maximum transfer rate on a wide (16-bit) SCSI bus from 10 **megabits per second (Mb/s)** to 20 Mb/s. This change increases the maximum bus bandwidth from 20 **megabytes per second** (**MB/s**) to 40 MB/s for a wide (16-bit) SCSI bus.

UltraSCSI incorporates smaller **very high density cable interconnect** (**VHDCI**) cables and **connectors**. The connector is up to half the size of the Fast SCSI HD68 (high-density 68-pin) connector and the cables are thinner.

The higher speed of the single-ended UltraSCSI signals can cause degradation of signal integrity over the same distances as single-ended Fast SCSI signals. However, the UltraSCSI bus can run over much greater distances than Fast SCSI in either single-ended or differential mode. To attain these greater distances, UltraSCSI defines and StorageWorks UltraSCSI implements the **bus segment** concept.

An UltraSCSI bus segment is an unbroken electrical path consisting of conductors (in cables or on **backplanes**) and connectors. Every UltraSCSI bus segment must have two **terminators**, one at each end of the bus segment. Bus segments are either single-ended or differential, depending on the type of terminators used in that segment. In other words, an UltraSCSI bus segment corresponds to what Fast SCSI referred to as an entire SCSI bus. As in Fast SCSI, a bus segment only supports **devices** of the same type as its terminators. *Do not*, for example, attempt to use a **differential SCSI bus** device on a **single-ended SCSI bus** segment.

Note

The DIGITAL **UltraSCSI RAID enclosure** only supports single-ended UltraSCSI buses.

Product Description

The UltraSCSI enclosure is a rack-mountable **storage subsystem** that accommodates the following components:

- Depending upon the configuration, a minimum of zero, or a maximum of two, UltraSCSI **controllers** with **cache modules**[1], such as the DS–HSZ70 series.
- An **environmental monitoring unit** (DS–BA35X–EB), the **EMU**, that monitors enclosure operation, detects and reports error conditions, and can automatically initiate corrective actions.
- A **power verification and addressing assembly** (DS–BA35X–EC), the **PVA**, that establishes enclosure and storage device addressing, monitors enclosure operation, and detects and reports error conditions.
- A minimum of one, or a maximum of two, ac input boxes (DS–BA35X–HE), also called ac power controllers, that distribute ac power to the shelf power supplies.
- Either five or eight shelf power supplies (DS–BA35X–HH) that provide dc power for enclosure operations.
- Eight dual-speed **blowers** (DS–BA35X–ML) that cool the components by drawing air in through the front and exhausting it out the rear.
- Six single-ended **input/output (I/O) modules** (DS–BA35X–MN) for connecting enclosures together.
- A maximum of 24 single-ended, 3.5-inch SBB disk drives for data storage.

For enclosures with fewer than 24 disk drive SBBs or 8 power supplies, installing the *optional* blank bezels (DS–BA35X–PB, this model number provides six blank bezels) will improve air flow.

1. Each cache module requires an **external cache battery (ECB)**, DS–HS35X–Bx series. The batteries should be installed either in an ECB shelf or a departmental server cabinet top cover.

Expansion enclosures have **filler panels** installed in the controller and cache module slots that improve air flow and reduce **electromagnetic interference (EMI)** radiation.

The blank panels in the controller B and cache module B locations improve air flow and control EMI in enclosures with only one controller.

The enclosure backplane eliminates the need for cables to connect the six vertical buses to the four horizontal drive SBB shelves. All the devices on a shelf use the same SCSI bus **identifier (ID)**. The PVA address switch defines the SCSI bus ID of each shelf. See Figure 1–3 for bus and shelf identifiers when viewing the enclosure from the front.

Figure 1–3 Typical Enclosure Bus and Device Addressing

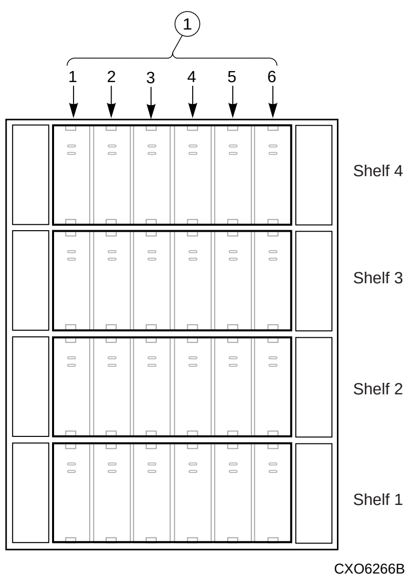


Figure CALLOUT

1. SCSI bus

The ac input boxes distribute ac power to the individual shelf power supplies through ac power cables. The backplane distributes the dc output voltages (+5 V dc and +12 V dc) from the power supplies to the following components:

- EMU
- PVA
- UltraSCSI bus array controllers and cache modules
- Disk drives
- I/O modules

UltraSCSI RAID Subsystem

A subsystem is one or more departmental server cabinets or data center cabinets with an enclosure. Each subsystem requires a **master enclosure** with an UltraSCSI controller installed. Installing one or two expansion enclosures and connecting them with cables creates an “expanded” subsystem. See Table 1–1 for the capacities of the various subsystems.

Table 1–1 UltraSCSI Subsystems Capacities

Enclosures	SCSI Buses	Disk Drives	Total Disk Drives
1	6	24	24
2	6	24	48
3	6	24	72

Note

Not all array controllers support configurations with expansion cabinets. Refer to the array controller documentation to ensure the controller supports expanded configurations.

EMU

The EMU monitors the status of the UltraSCSI RAID enclosure to include power, **ambient (intake) air temperature**, blower status, and so forth. The EMU also detects error and fault conditions, displays these conditions, reports the conditions to the user and the array controller, and, in some cases, implements corrective actions.

PVA

Each PVA functions only with its host enclosure and EMU. There is no master PVA in the UltraSCSI RAID subsystem.

The PVA has the following primary functions:

- Allows the user to select the enclosure UltraSCSI bus ID.
- Enables the user to place the subsystem in a standby power mode condition or return it to an operational status.
- In conjunction with the associated EMU, ensures that the major components are functioning properly and notify the user and the array controller of error or fault conditions.

Master Enclosure

Each UltraSCSI RAID subsystem (whether it has one, two, or three enclosures) is under the control of the master enclosure. The enclosure with the array controllers is the master enclosure. The EMU in the master enclosure is the only EMU that can communicate directly with the array controllers. In a multiple enclosure, or expansion configuration, the master enclosure also communicates with the other enclosures using the EMU-EMU communications bus. The master enclosure PVA SCSI bus address setting is always *0*. Using address 0 automatically assigns SCSI bus device addresses 0, 1, 2, and 3 to the four drive SBB shelves.

Master EMU

The EMU in the master enclosure is the master EMU. Only the master EMU communicates directly with the array controller. The master EMU communicates with the expansion enclosure EMUs over the EMU–EMU communications bus. The master EMU controls the operation of the entire subsystem to include error detection, reporting, and status displays.

Expansion Enclosure

An UltraSCSI RAID enclosure connected to the master enclosure with cables is an expansion enclosure. Depending upon the array controller, a subsystem can have a maximum of two expansion enclosures. The expansion PVA SCSI bus address setting is either:

2 — Establishing SCSI bus device addresses 8, 9, 10, and 11

3 — Establishing SCSI bus device addresses 12, 13, 14, and 15

Note

Not all array controllers support an UltraSCSI RAID subsystem with more than one enclosure. Refer to the array controller documentation to ensure that the controller supports expanded configurations.

Expansion EMU

An EMU installed in an expansion enclosure is an expansion EMU. This EMU communicates with the master EMU over the EMU-EMU communications bus. Upon loss of communications with the master EMU, the expansion EMU assumes control of certain expansion enclosure functions. In this state, the expansion EMU cannot communicate with the UltraSCSI controller.

I/O Module

The I/O modules provide termination for the internal UltraSCSI buses and are the connection points for the cables connecting the six buses to the expansion enclosures.

SCSI Bus Controller

A hardware-software device that manages SCSI bus communications. Controllers typically differ by the type of interface to the host and provide functions beyond those the devices support. A **host port adapter** connects the host to the controller. Other terms commonly used for the SCSI bus controller include array controller, **host controller**, or controller.

Note

DS–HSx70 series array controllers require DS–HSx70 series cache modules to operate properly; likewise, DS–HSx80 series array controllers require DS–HSx80 series cache modules.

Cache Module

A storage buffer that is required to support bus controller[1] operations.

ECB

The ECB provides backup power to the cache module to protect data integrity if there is a power failure.

Enclosure Status

When any of the multiple error detection circuits determine there is a problem, an audible alarm can sound and one or more sets of status **LEDs** (**light emitting diodes**) display an error code.

The enclosure has two LED indicators (see Figure 1–4). The green LED is the System OK LED; the amber LED is the Fault LED. When the Fault LED is ON, check the other status LEDs to determine the cause of the error.

- For an enclosure in a **pedestal**, these LEDs are part of the pedestal (see Figure 1–5).
- For an enclosure in a DS–SW600 series cabinet, the LEDs on the cabinet door also display the enclosure status.

1. The cache module located in the cache A slot only supports the array controller located in the controller A slot; likewise for cache module B and controller B.

Figure 1–4 DS–BA370 Status LEDs Locations

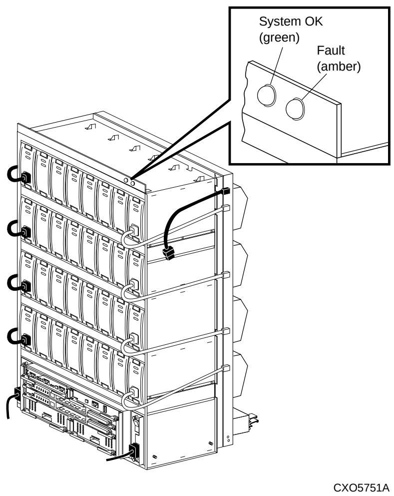
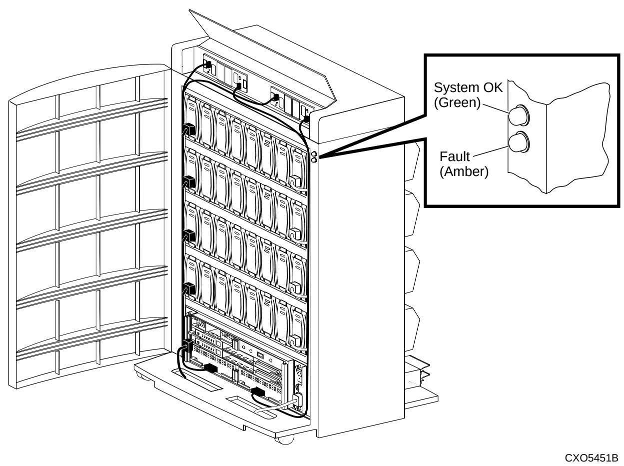


Figure 1–5 RA7000 Status LEDs Locations



CALLOUTS For Both Figures

1. System OK (green)
2. Fault (amber)

Options

The following sections describe the UltraSCSI RAID subsystem user selectable options.

Power

The standard UltraSCSI enclosure power configuration consists of one ac input box and five shelf power supplies. This configuration provides the *minimum power supply* redundancy. A system power failure will occur for any of the following conditions:

- Loss of the ac power source
- Failure of the ac input box
- Failure of two power supplies

The user has the option of modifying the **standard power configuration** to eliminate single points of failure.

Redundant Power Supply Configuration

Adding three power supplies and a second ac input box provides significantly more power redundancy than the standard configuration. The **redundant power supply configuration** uses a single ac power source. A system power failure will occur for any of the following conditions:

- Loss of the ac power source
- Failure of *both* ac input boxes
- Failure of *five* power supplies

This configuration provides additional *power supply* redundancy.

Optimum Power Configuration

Adding three shelf power supplies, a second ac input box, and a second ac power source provides *optimum* power redundancy. With separate ac power sources for each ac input box, there are no single points of failure.

Note

For optimum operation, each ac input box should use a different ac power source.

A system power failure will occur for any of the following conditions:

- Loss of *both* ac power sources
- Failure of *both* ac input boxes
- Failure of *five* power supplies
- Failure of the ac power source for bus B and one power supply on bus A
- Failure of the ac power source on bus A and one power supply on bus B
- Failure of the ac input box on bus B and one power supply on bus A
- Failure of the ac input box on bus A and one power supply on bus B

DIGITAL recommends using this configuration to eliminate all single points of power failure.

Dual Controllers

Establishing a subsystem with a **dual redundant configuration** (two UltraSCSI controllers, two cache modules, and ECBs) is the most effective and efficient method of ensuring continuous subsystem operation in the event of a component failure.

UltraSCSI Bus Expansion

Some controllers support expanding the UltraSCSI bus from the master enclosure to two expansion enclosures. Refer to the array controller documentation to determine if the controller supports this feature.

2

Operating the UltraSCSI Enclosure

Setting up an UltraSCSI RAID subsystem for operation involves implementing the procedures described in the system-specific "Getting Started" manual provided with each system. This chapter supplements and expands on this information.

Other chapters in this manual contain detailed information about individual component functions, operations, error conditions, and so forth.

UltraSCSI Configuration Rules

Proper operation of the subsystem requires complying with both the UltraSCSI and hardware configuration rules. In some instances, operating system-specific configuration rules might apply.

General

The following rules apply to the UltraSCSI bus:

- The UltraSCSI RAID subsystems can transfer data at a higher rate (40 MB/s versus 20 MB/s) than that of the FAST 10 subsystems.
- UltraSCSI subsystems require 68-pin VHDCI cables and connectors. The physical difference in the contact spacing precludes using FAST 10 cables.

- The following devices use a SCSI bus address (ID) and are SCSI bus **nodes**:
  - Adapters
  - Controllers
  - Storage devices
- Every node on a bus must have a unique **SCSI bus ID**.
- The SCSI bus ID for controller A is always *7*.
- The SCSI bus ID for controller B is always *6*.
- There are slots for six 3.5-inch disk drive SBB nodes in a shelf. The address switch on the PVA module determines node SCSI bus IDs. There are a maximum of 12 valid DS–BA370 SCSI bus IDs—*0 through 3* and *8 through 15*.
- A DS–BA370 series UltraSCSI bus *does not* support 5.25-inch devices.
- A DS–BA370 series enclosure *does not* support narrow devices.
- Only UltraSCSI devices have a maximum transfer rate of 40 MB/s.
- Installing a FAST 10 storage device reduces the bus average transfer rate as follows:
  - When the array controller communicates with a FAST 10 device, the transfer rate is at FAST 10 (the maximum rate this device can handle).
  - When the array controller communicates with a **FAST 20** device, the transfer rate is at FAST 20 (the maximum rate this device can handle).

UltraSCSI RAID Controllers

The following *general* configuration rules apply to the UltraSCSI RAID array controllers:

- The controller A SCSI bus ID is always *7*.
- The controller B SCSI bus ID is always *6*.

- DIGITAL UltraSCSI array controllers support FAST 10 (20 MB/s) 16-bit (wide) disk drives.
- DIGITAL UltraSCSI array controllers support FAST 20 (40 MB/s) 16-bit (wide) disk drives.

Caution

If a conflict in controller configuration information exists between this document and the controller-specific documentation, use information contained in the controller-specific documentation.

Note

Disk drive support is controller-specific. Refer to the array controller documentation to determine compatible disk drives.

UltraSCSI Nodes

A node is a **SCSI device** that uses a SCSI bus ID. In the UltraSCSI RAID enclosure, the following rules apply:

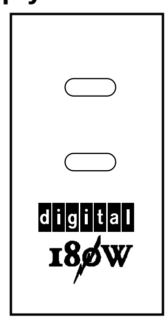
- SCSI bus ID *7* is reserved for the controller only.
- SCSI bus ID *6* is reserved for the controller only.
- SCSI bus IDs *4* or *5* cannot be used.
- 5.25-inch devices are not supported.
- The valid device SCSI bus IDs are device type dependent, meaning:
  - An UltraSCSI device can use device addresses *0 through 3* or *8 through 15*.
  - A wide (16-bit), FAST 10, SCSI device (–VW suffix) uses device addresses *0 through 3* or *8 through 15*.

UltraSCSI Enclosures

The following configuration rules apply to UltraSCSI RAID subsystem enclosures:

- The only compatible ac input box is model DS–BA35X–HE.
- The only compatible power supply is model DS–BA35X–HH (180 W). The bezel label shown in Figure 2–1 identifies these power supplies.

Figure 2–1 Power Supply Bezel Label



CXO5926A

Enclosure Addressing

The following configuration rules apply to the UltraSCSI RAID enclosure address settings:

- The enclosure containing the array controller is the master enclosure. The PVA **SCSI ID** switch setting for the master enclosure is always *0*.
- UltraSCSI subsystem expansion enclosures use either PVA SCSI ID switch setting *2* or *3*:
  - — The *first* expansion enclosure switch setting is always *2*.
  - — The *second* expansion enclosure switch setting is always *3*.

See Table 2–1 for the DIGITAL-supported PVA SCSI ID switch settings.

Table 2–1 DIGITAL-Supported PVA SCSI ID Switch Settings

Total Number of Enclosures	Master Enclosure	First Expansion	Second Expansion
1	0	None	None
2	0	2	None
3	0	2	3

Starting the Subsystem

After assembling an enclosure and connecting enclosure cabling, power is applied to start the subsystem.

Note

Before applying power to the subsystem, configure the entire subsystem (including the host and the array controller) as described in the appropriate publications.

Applying power to all the enclosures causes the EMU, PVA, and array controller to automatically begin system operations.

Applying Power

Initial power application is a matter of turning on the ac input boxes located in the lower left and right corners of the enclosure (see Figure 2–2, labels A and B). Pressing the **I** on the ac power switch applies ac power only to the shelf power supplies on the associated power bus (bus A or B).

Note

Apply power in the following sequence:

1. All expansion enclosures
2. Master enclosure

Figure 2–2 AC Power Distribution

AC Input Box

AC Input Box and SBB Shelf Power Supply Locations

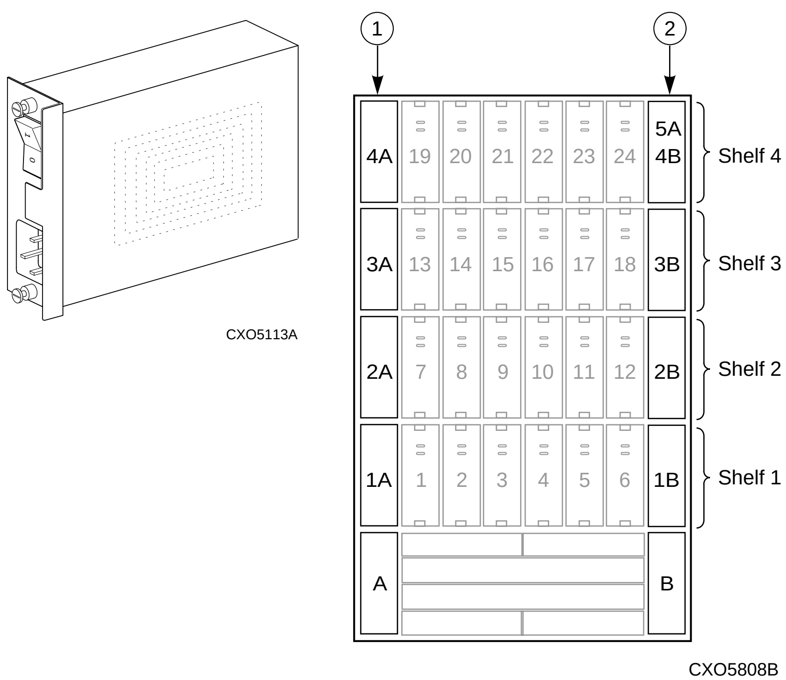


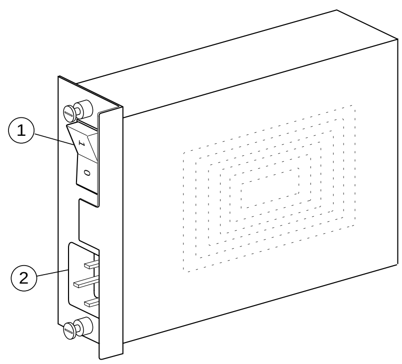
Figure CALLOUTS

1. Power bus A
2. Power bus B

Turning On the Subsystem

After completing subsystem assembly, expansion, or movement of the subsystem, complete the procedure in Table 2–2 to turn it back ON.

Table 2–2 Turning On the Subsystem Power

1.	If there are no expansion enclosures, go to step 2. If there are expansion enclosures, turn ON all the ac input boxes for each expansion enclosure by pressing **I** on each ac power switch (**CALLOUT 1**).	
2.	On the master enclosure, turn ON all the ac input boxes by pressing **I** on each ac power switch (CALLOUT 1).	
3.	Verify the array controller places the subsystem into an operational state.	

Shutting Down the Subsystem

Shutting down the subsystem involves:

- Clearing the cache module
- Shutting down the controller
- Either turning OFF the dc power for the subsystem (entering the standby power mode) or going one step further and turning OFF the ac input boxes (full power shutdown)

Caution

Failure to clear the cache module and shut down the array controller *before* removing power will disrupt data transfers. Therefore, always shut down the array controller as described in the array controller documentation.

Some array controllers bypass the standby power mode functionality from the PVA standby power switch. Refer to the array controller documentation for availability of this feature.

Standby Power Mode

Placing the subsystem in the standby power mode disconnects the dc power from the backplane. However, ac input power is still applied to the shelf power supplies. In this mode, the EMU alarm control switch now functions as the standby power switch. To restore the dc power to the backplane, press the alarm control switch on each enclosure EMU.

Full Power Shutdown

Powering down an enclosure always involves shutting down the array controller and then pressing the PVA standby power switch on each expansion enclosure. If there are no expansion enclosures, shut down the array controller and then press the PVA standby power switch on the master enclosure.

Turning the subsystem off involves shutting down the array controller, turning OFF the dc power, and then turning OFF the ac input boxes in each enclosure.

Using Standby Power Mode

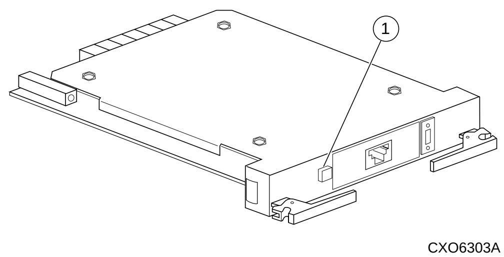
Complete the procedure in Table 2–3 to turn OFF the dc power distribution, placing the subsystem in standby power mode. Complete the procedure in Table 2–4 to restore dc power within the enclosures.

Table 2–3 Turning Off the DC Power

1. Clear the cache module and shut down the array controller per the array controller documentation.

2. If there are no expansion enclosures, go to step 3.

   If there are expansion enclosures, press and hold the PVA standby power switch (CALLOUT 1) on an expansion enclosure until the master EMU initiates a power shut down on all enclosures.



3. Press and hold the PVA standby power switch (CALLOUT 1) on the master enclosure until the EMU initiates a power shut down on the master enclosure.

Note

The EMU alarm control switch (CALLOUT 1 shown below) on each enclosure now functions as the dc power switch.

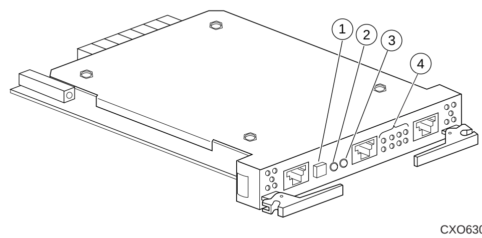
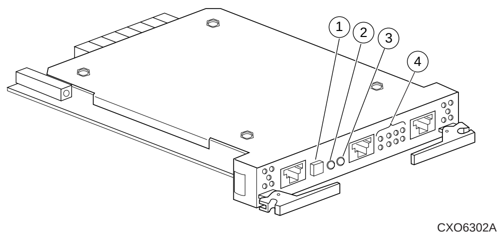


Table 2–4 Restoring the DC Power

1. If there are no expansion enclosures, go to step 3.
2. If there are expansion enclosures, momentarily press the EMU alarm control switch (CALLOUT 1) on each expansion enclosure.  3. Momentarily press the EMU alarm control switch (CALLOUT 1) on the master enclosure.
4. Verify that the array controller restores the subsystem to an operational state.

Turning Off the Subsystem

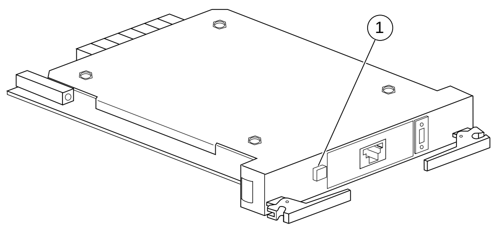
Adding enclosures or moving the subsystem might require removing all power from the subsystem. Complete the procedure in Table 2–5 to remove all power.

Table 2–5 Turning Off the Subsystem Power

1. Clear the cache module and shut down the array controller per the array controller documentation.

2. If there are no expansion enclosures, go to step 3.

   If there are expansion enclosures, press and hold the PVA standby power switch (CALLOUT 1) on an expansion enclosure until the master EMU initiates a power shut down of all enclosures.



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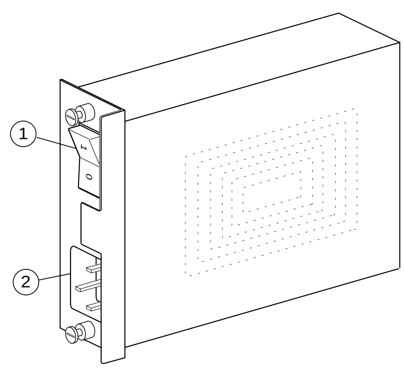
3. Press and hold the PVA standby power switch (CALLOUT 1) on the master enclosure until the master EMU initiates a power shut down on the master enclosure.

4. If there are no expansion enclosures, go to step 5.

   If there are expansion enclosures, turn OFF all the ac input boxes for each expansion enclosure by pressing **O** on each ac power switch (CALLOUT 1).

5. Turn OFF all the ac input boxes for the master enclosure by pressing **O** on each ac power switch (CALLOUT 1).



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Fault Detection

Fault detection involves identifying errors and providing an indication to the user for analysis. The following sections address how faults are identified, descriptions of status LED indications, and in some cases, possible corrective actions.

Error Detection, Reporting, and Analysis

The EMU and PVA constantly monitor the operational status of the enclosure and its components. In some instances, automatic corrective action implementation occurs. Status changes are indicated to the user through a combination of LEDs, an EMU audible alarm, and an *optional* **maintenance terminal** connected to the array controller. Table 2–6 lists the major enclosure components and the status items monitored by each component.

Table 2–6 Enclosure Status Monitoring

Component	Status Monitored
Enclosure	• Intake air temperature • Exhaust air temperature • AC input power • Number of operational 180 W power supplies • Enclosure SCSI bus address
Power	• Output of dc power supplies • DC bus voltages • Termination I/O module dc voltage
Storage devices (disk drive SBBs)	• Control signal response • Controller-detected fault condition • Removal • Installation
EMU	Installation
PVA	Installation

Table 2–6 Enclosure Status Monitoring (Continued)

Blowers	• Operation • Operating speed • Installation

For a detailed description of status LEDs, and specific error conditions, see the applicable chapter for each component.

Enclosure Status Indicators

The primary elements of the enclosure status indicators are the enclosure power supplies and blowers. Loss of either a dc voltage or a blower creates an error condition. The enclosure notifies the user of the problem by sounding an audible alarm and changing the status LED displays. When the enclosure is mounted in a data center cabinet or a departmental server cabinet, these two status LEDs might be connected to LEDs on the front door. The location of the enclosure status LEDs is shown in Figure 2–3 and Figure 2–4.

Figure 2–3 DS–BA370 Status LEDs Locations

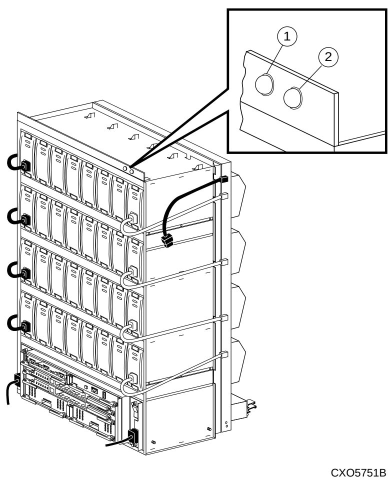
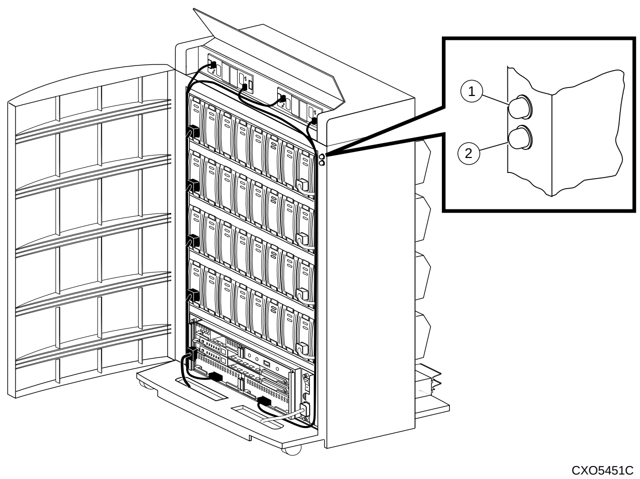


Figure 2–4 RA7000 Status LEDs Locations



CALLOUTS For Figures

1. System OK LED
2. System fault LED

CALLOUT 1 is the system OK LED and is green. Callout 2 is the system fault LED and is amber. One or both of these two LEDs can be ON at any time.

When the green system OK LED is ON, it indicates that the enclosure is operational. This LED can be ON as long as a minimum number of redundant components (such as blowers or power supplies) are functioning correctly.

If the amber system fault LED is ON, it indicates one or more components have an error or fault condition. To isolate an error condition, observe the status LEDs on the EMU, PVA, power supplies, disk drive SBBs, and array controllers. These component status LEDs are discussed under Controller Shelf Status Indicators later in this chapter. Table 2–7 lists possible enclosure status LED displays.

● LED is ON

○ LED is OFF

Table 2–7 Enclosure Status LED Displays

Enclosure Type		Description and Possible Corrective Actions
Data Center Cabinet	**Dept. Server Cabinet**	
● ○	● ○	The enclosure is operating normally. There are no detected errors.
● ●	● ●	There are one or more failed components: 1. Observe the EMU front panel to see if there is an **overtemperature** condition, a blower problem, or a power problem. Replace the defective blower or power components. 2. Observe individual disk drive SBBs for an error condition. 3. Check the array controller *optional* system maintenance terminal for error messages.
○ ○	○ ○	Either there is no power applied to the enclosure or the enclosure is in a reset state: 1. Ensure that ac power is present at the ac input boxes and that the array controllers are operational. 2. Ensure that there are at least four operational power supplies. 3. Check the array controller *optional* system maintenance terminal for error messages.

SBB Shelf Status Indicators

SBB shelf status indicators are provided by shelf power supplies and disk drive SBBs.

Power Supply Status LEDs

The two green LEDs on each power supply (see Figure 2–5) display the blower, the power bus, and the individual power supply status. Normally, both these LEDs are ON.

Figure 2–5 Power Supply Status LEDs

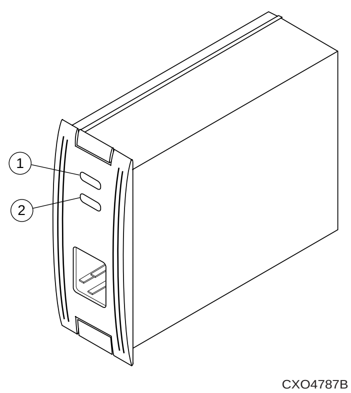


Figure CALLOUTS

1. Shelf status LED
2. Power supply status LED

The green shelf status LED (CALLOUT 1) is ON when all the power supplies and all the blowers are operational. If any blower or power supply fails, this LED turns OFF.

The green power supply status LED (CALLOUT 2) is ON when the power supply is operating properly. If the power supply fails, both its power supply status LEDs turn OFF.

Disk Drive SBB Configuration

Part of the initial configuration procedure for the subsystem involves configuring the disk drives. The disk drive SBB configuration tells the array controllers the drive SBB device type, plus its physical and logical location. The array controller requires this initial configuration information before transferring data blocks to specific disks to create **storage sets**. Once the configuration process is complete, the system cannot function properly unless all the disks remain in the same physical and logical location.

Removal of a disk drive SBB device is automatically sensed by the array controller.

When installing a replacement device in a configured subsystem, the array controller ensures that the replacement device type is identical to the one removed. Only after establishing complete compatibility can the array controller start configuring the disk drive SBB. As part of the configuration process, the array controller will restore all data that was on the original disk.

Disk Drive Status LEDs

Each disk drive SBB has two LEDs that display its operating status (Figure 2–6). The green device activity LED (CALLOUT 1) is ON or FLASHING whenever the disk drive SBB is **active**.

Figure 2–6 Disk Drive Status LEDs

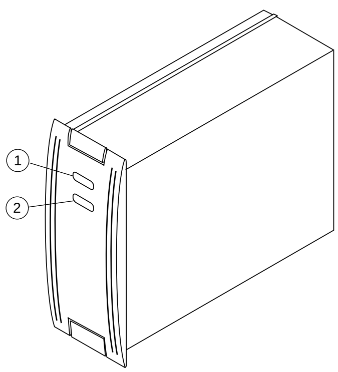


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Figure CALLOUTS

1. Device activity LED
2. Device fault LED

The amber device fault LED (CALLOUT 2) FLASHES whenever the array controller detects that this device has an error condition. This LED also FLASHES when the array controller issues a locate command. This LED is only ON or FLASHING when there is a device malfunction, except when a locate command is issued.

For detailed information about the disk drive SBB status LEDs, see Chapter 7.

Controller Shelf Status Indicators

Controller shelf status indicators are provided by the array controllers, EMU, PVA, and I/O modules.

Typical Controller Status LEDs

The operator control panel (OCP) status LEDs (see Figure 2–7) display the controller status. For a detailed explanation of each status code, refer to the controller documentation.

Figure 2–7 Typical Array Controller OCP LEDs

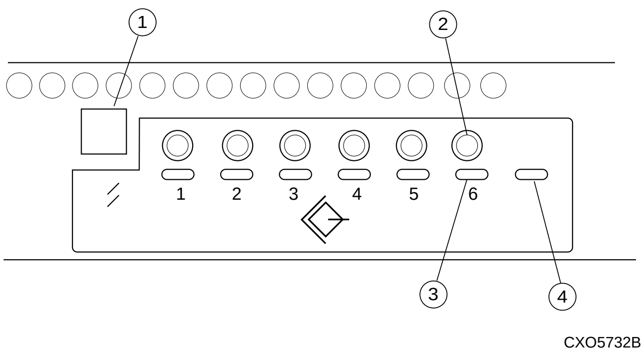


Figure CALLOUTS

1. Reset button (contains the array controller LED)
2. Port buttons (6 each)
3. Port/fault LEDs (6 each)
4. Host port power fault LED

The green array controller LED (CALLOUT 1) inside the Reset button indicates controller status. This LED flashes constantly once the controller initialization is complete and the software is functioning. Pressing this switch resets the controller.

The amber **port** LEDs (CALLOUT 3) are OFF when the bus is functioning properly. A port LED that is ON or FLASHING indicates that a device on that bus is not functioning properly.

EMU Status LEDs

The EMU status LEDs (see Figure 2–8) have multiple functions (see Chapter 3).

Figure 2–8 EMU Status LED Locations

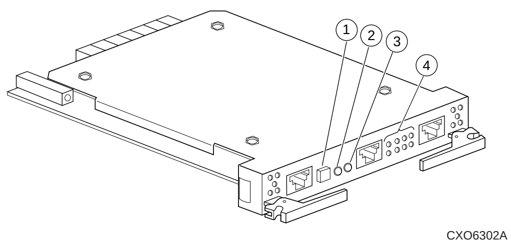


Figure CALLOUTS

1. System fault LED (amber)
2. Temperature fault LED (amber)
3. Power status LED (green)
4. Blower fault, error condition, and fault code LEDs (amber)

PVA Status LED

The PVA (see Figure 2–9) has only one status LED, the power status LED. For a detailed description of the PVA status displays and alarm, see Chapter 4.

Figure 2–9 PVA Status LED Location

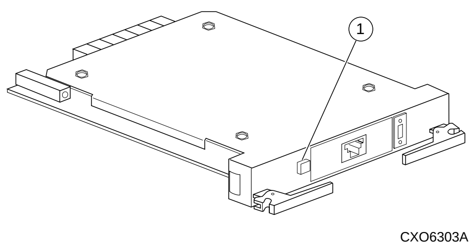


Figure CALLOUTS

1. The green power status LED is part of the standby power switch.

I/O Module LEDs

Each I/O module (see Figure 2–10) has two green status LEDs that display the status of both the internal (CALLOUT 2) and external (CALLOUT 1) SCSI bus terminator power (**TERMPOWER**). Whenever TERMPOWER is present, the applicable LED (internal or external) is ON. During normal operation, both LEDs are ON. See Chapter 5 for detailed information about these LEDs.

Figure 2–10 I/O Module TERMPOWER LEDs

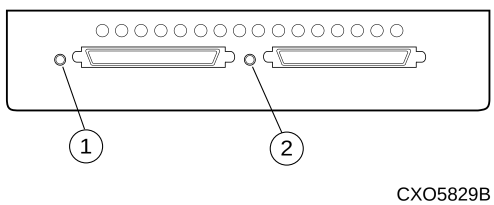


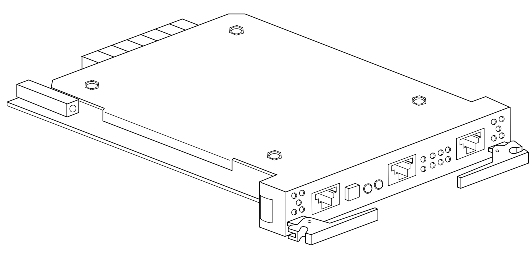
Figure CALLOUTS

1. External TERMPOWER
2. Internal TERMPOWER

3
Environmental Monitoring Unit

The primary function of the EMU (Figure 3–1) is to monitor, process, report, and display power distribution, temperature, blower, configuration, SCSI addressing, I/O module, communications, and microcode status information. The EMU and the array controller exchange and process some of this information.

Figure 3–1 EMU



Caution

Proper operation of an UltraSCSI subsystem requires an operational EMU and PVA in each enclosure. Also, communication links between EMUs are required in multiple enclosure configurations to ensure proper subsystem operation and error reporting.

Product Description

The EMU detects enclosure error conditions and configuration faults, and then notifies the user of existing or impending failures, using one or more of the following error reporting systems:

- EMU LEDs
- EMU audible alarm
- Error messages on the host interface
- Enclosure LEDs

The EMU (CALLOUT 1) mounts directly above array controller "A" (upper bus controller) as shown in Figure 3–2.

Figure 3–2 EMU Location

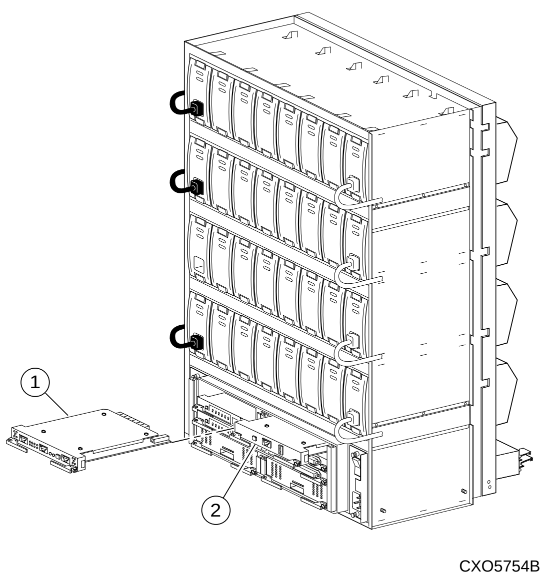


Figure CALLOUTS

1. EMU
2. PVA

In some instances [such as a blower failure, a high intake air temperature, or a high internal enclosure (exhaust) temperature], the EMU automatically initiates corrective action. For example, the EMU will command the blowers to operate at high-speed to prevent component damage due to an overtemperature condition. In a severe case, the EMU might even turn OFF the enclosure power.

Caution

Some array controllers bypass the standby power mode functionality from the PVA standby power switch. Refer to the array controller documentation for availability of this feature.

Note

An overtemperature condition (greater than 50°C) causes the EMU to turn the enclosure dc power OFF. When any enclosure has an overtemperature condition, the cache module data is preserved prior to turning OFF the enclosure dc power.

Controller Status

The master EMU monitors the state of both array controllers. If the EMU detects a controller fault, the EMU can implement the following actions:

- Sound an audible alarm
- Turn the EMU system fault status LED to FLASHING
- Display a controller fault code on the blower LEDs (only displayed if the user momentarily presses the alarm control switch)

Note

An error on the EMU-array controller communications path might also cause a controller fault indication.

I/O Module Status

The EMU verifies that the six I/O modules are present, properly installed, and communicating with the backplane, and that TERMPOWER is at the correct level. The EMU reports an error condition whenever any one of these conditions are not met. The EMU also reports the I/O module type to the array controller. If the controller determines that all modules are not the same type, it displays this information on the *optional* maintenance terminal, if connected.

An integrated circuit on each I/O module functions as a **bus expander**. The EMU and the array controller can either enable or disable this circuit on an individual I/O module, thereby controlling individual external SCSI buses.

Enclosure Configuration Information

The EMU maintains the following configuration information:

- Enclosure number (the PVA SCSI ID switch setting)
- EMU microcode revision
- EMU message protocol revision
- Temperature sensor set points
- Number of installed power supplies by location
- Number of installed disk drive SBBs by location
- Number of operational blowers in each drive SBB shelf bank
- Number and type of I/O modules installed

EMU Front Panel

The EMU user interface controls, connectors, and LED displays are on the front panel (see Figure 3–3). The following sections describe the function of each component.

Figure 3–3 EMU Major Component Locations

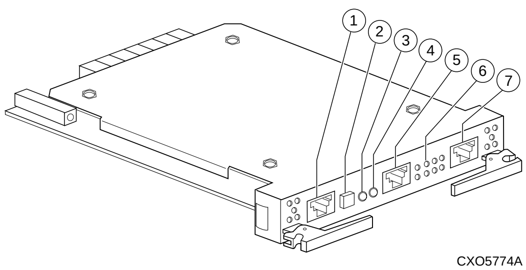


Figure CALLOUTS

1. EMU communications connector (labeled IIC)
2. System fault LED (amber) and alarm control switch
3. Temperature fault LED (amber)
4. Power status LED (green)
5. Maintenance terminal connector
6. Blower fault LEDs (amber)
7. EMU communications connector (labeled IIC)

EMU Communications Connectors

These connectors (CALLOUTS 1 and 7) provide for EMU–EMU communications between the master EMU and expansion EMUs.

System Fault LED and Alarm Control Switch

The amber system fault LED is part of the alarm control switch (CALLOUT 2). This LED turns ON if an error condition is detected.

The system fault LED starts FLASHING if the EMU has one or more fault codes to display.

If the system fault LED is FLASHING, momentarily pressing the EMU alarm control switch turns the audible alarm OFF and initiates a fault code LED display.

Pressing the alarm control switch for at least 5 seconds clears all stored active fault codes. New fault detection and display continues.

If the enclosure is in standby power mode, momentarily pressing the alarm control switch restores dc power to the enclosure.

Temperature Fault LED

If either the intake or exhaust air temperature exceeds user-defined temperature setpoints, this amber LED (CALLOUT 3) turns ON. The LED remains ON until the overtemperature condition is corrected.

Power Status LED

This green power status LED (CALLOUT 4) turns ON if *all* the following normal operating conditions exist:

- +5 V dc is greater than +4.7 V dc.
- +12 V dc is greater than +11.4 V dc.
- At least four power supplies are operational.
- TERMPOWER is present on all six I/O modules.

The power status LED turns OFF if any *one* of the following error conditions exist:

- +5 V dc is less than +4.7 V dc.
- +12 V dc is less than +11.4 V dc.
- Fewer than four power supplies are operational.
- TERMPOWER is missing from one or more I/O modules.

Maintenance Terminal Connector

This connector (CALLOUT 5) is used to connect the *optional* maintenance terminal or a personal computer (PC) to the EMU for displaying EMU:

- Error messages
- Information messages

This connector and a PC are also used to load microcode updates into EMU memory.

Blower Fault LEDs

One or more of these eight amber blower fault LEDs (CALLOUT 6) turn ON if one of the following error conditions exist:

- One or more blowers are not operational.
- One or more blowers are not operating at the correct speed.
- A blower is removed.

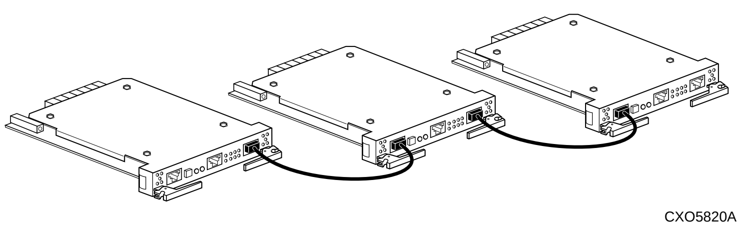
Configuring the EMU

Configuring the EMU requires connecting the EMU-EMU communications bus and using the **command line interpreter** (**CLI**) `set emu` command. This command establishes operating temperature set points and desired blower speed operating mode (high-speed or automatic).

Connecting the EMU Communication Bus

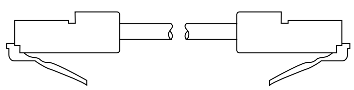
In an expansion configuration, an EMU-EMU communications bus between the master EMU and each expansion EMU must be established. To establish this communications bus, connect the EMU communications connector using a BN26M series cable, as shown in Figure 3–4. The center EMU in this figure is the master EMU. Establishing this EMU-EMU communication bus ensures that the master EMU can monitor and control all the enclosures within the UltraSCSI subsystem.

Figure 3–4 EMU Communications Bus Connections



DIGITAL recommends using a BN26M cable (see Table 3–1) no longer than 4 m (13.1 ft) to connect the EMUs.

Table 3–1 EMU Communication Cables

Description	Length		Part Number
	Meters	Feet	
8-conductor 24 AWG, PVC, round cable assembly with: 2 – 8 position (8MP) locking, plug connectors  CXO5747A	0.5 1.0 3.0 4.0	1.6 3.3 9.8 13.1	BN26M–0E BN26M–01 BN26M–03 BN26M–04

EMU Firmware

EMU firmware allows the user to use CLI commands to establish limits for EMU functions such as temperature and blower speed control. Different firmware versions determine the specific commands or functions available. The master EMU compares the temperature sensor readings and blower speed readings against limits the user entered.

If the EMU is controlling blower speed (automatic mode), the blowers are automatically placed into high-speed mode when any sensor reports an airflow temperature that is within 4 degrees Celsius (°C) or 7 degrees Fahrenheit (°F) of the sensor set point. For example, if a temperature set point is 37°C (99°F), the EMU would cause the blowers to operate at high-speed when the temperature reaches 33°C (91°F). Operating the blowers in high-speed should prevent an overtemperature condition from occurring and should prevent shutting down the enclosure.

DIGITAL recommends using predetermined set points for EMU firmware versions 1.0, 1.1, and 1.2, as identified in the following sections.

Caution

For EMU firmware versions 1.0 and 1.1, the command `set emu sensor_n_setpoint=default` cannot be used. This command establishes a temperature set point that is too low for proper operation and might result in an erroneous subsystem alarm.

Removing and replacing the master EMU automatically changes the temperature set points. This situation requires the user to reenter all the temperature set points using CLI commands.

EMU Firmware Versions 1.0 and 1.1

To set the temperature set point for an EMU, the following CLI commands must be used:

```
set emu sensor_1_setpoint=48
set emu sensor_2_setpoint=48
set emu sensor_3_setpoint=41
```

Where: 1 = backplane sensor 1 (exhaust)
2 = backplane sensor 2 (exhaust)
3 = EMU sensor (intake)

EMU Firmware Version 1.2

To set the temperature set point for an EMU, the following CLI commands must be used:

```
set emu sensor_1_setpoint=default
set emu sensor_2_setpoint=default
set emu sensor_3_setpoint=default
```

Where: 1 = backplane sensor 1 (exhaust)
2 = backplane sensor 2 (exhaust)
3 = EMU sensor (intake)

Note

Default temperature settings for EMU firmware version 1.2 are:

- Sensors 1 and 2 — 47
- Sensor 3 — 37

Installing EMU Firmware Updates

EMU firmware updates are installed by DIGITAL field service personnel. Appendix C provides general microcode installation procedures.

Setting the Temperature Sensors

Three temperature sensors are found in each UltraSCSI RAID enclosure:

- One mounted on the EMU module.
- Two on the rear of the backplane, placed at the top middle.

The EMU sensor monitors the EMU intake air temperature, while the two enclosure sensors monitor the backplane exhaust air temperature. Naturally, the exhaust air temperature is higher than the EMU intake air temperature during normal operation.

In an expansion enclosure configuration, only master EMU temperatures are set. The temperature set points for the other enclosures automatically change to match the master EMU setting.

Users have the option of setting the temperature at which an individual sensor reports an overtemperature condition. The desired temperature is entered in degrees Celsius within the range of 0°C (32°F) through 49°C (120°F). See Table 3–2 for the relationship between °C and °F.

Table 3–3 and Table 3–4 explains the rules to *always* follow when setting temperature set points.

Note

For detailed instructions about using the `set emu` commands, refer to the array controller CLI documentation.

Table 3–2 EMU Set Point Temperature Conversions

°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
32	0	50	10	68	20	86	30	104	40
34	1	52	11	70	21	88	31	106	41
36	2	54	12	72	22	90	32	108	42
37	3	55	13	73	23	91	33	109	43
39	4	57	14	75	24	93	34	111	44
41	5	59	15	77	25	95	35	113	45
43	6	61	16	79	26	97	36	115	46
45	7	63	17	81	27	99	37	117	47
46	8	64	18	82	28	100	38	118	48
48	9	66	19	84	29	102	39	120	49

Table 3–3 Temperature Set Point Rules—EMU Firmware Versions 1.0 and 1.1

1.	Enter all temperatures in degrees Celsius (°C). Do not use fractions, decimals, or degrees Fahrenheit (°F).
2.	The EMU set point (sensor_3) temperature must be a minimum of 6°C (11°F) *greater than* the highest expected ambient (intake) temperature.
3.	The backplane set points (sensor_1 and sensor_2) must be the same temperature and a minimum of 13°C (23°F) *greater than* the highest expected ambient temperature. This requires a minimum setting of 7°C (13°F) *greater than* the EMU set point.

Table 3–3 Temperature Set Point Rules—EMU Firmware Versions 1.0 and 1.1 (Continued)

4. EMU firmware versions 1.0 or 1.1 *cannot use* the `set emu sensor_n_setpoint=default` command. Instead, the following command is required: `set emu sensor_n_setpoint=nn` (where *nn* is the desired temperature in °C).

Table 3–4 Temperature Set Point Rules—EMU Firmware Versions 1.2

1. Enter all temperatures in degrees Celsius (°C). Do not use fractions, decimals, or degrees Fahrenheit (°F).
2. The EMU set point (sensor_3) temperature must be a minimum of 2°C (4°F) *greater than* the highest expected ambient (intake) temperature.
3. The backplane set points (sensor_1 and sensor_2) must be the same temperature and a minimum of 12°C (22°F) *greater than* the highest expected ambient temperature. This requires a minimum setting of 10°C (18°F) *greater than* the EMU set point.

Setting the Blower Speed Control

UltraSCSI enclosure blowers normally operate at low-speed and provide sufficient air flow to cool the enclosure components and ensure proper operation. Use the CLI `set emu fanspeed` command as follows to change the operating speed of the blowers:

- Enter `set emu fanspeed=high` and all blowers in all enclosures operate at high-speed.
- Enter `set emu fanspeed=automatic` and the local EMU controls the blower speed in each enclosure.

Note

For detailed instructions about using the `set emu` commands, refer to the array controller documentation.

DIGITAL recommends using the `set emu fanspeed=automatic` command, allowing individual EMUs to implement corrective action if one of the following error conditions occur:

- A blower fails.
- A blower is removed.
- A blower is rotating too slowly to provide sufficient air flow in the shelf.
- The EMU intake air temperature exceeds the user-defined temperature setting.
- The backplane exhaust air temperature exceeds the user-defined temperature setting.

DIGITAL suggests using the `set emu fanspeed=high` command for either of the following conditions:

- EMU intake air temperature is more than 38°C (100°F).
- No air conditioning is available.

If the EMU detects a blower or temperature error condition, it automatically switches all the operational blowers to high-speed. This speed increases the air flow through the enclosure and reduces the possibility of component failure. Simultaneously, the EMU initiates the following actions:

- Sounds the audible alarm on the EMU.
- Turns ON the amber system fault LED if the temperature exceeds an established set point.
- Turns ON the amber temperature fault LED.
- Notifies the array controller of the error condition.

- Starts the EMU timer if: (1) all blowers in a shelf bank are defective, or (2) a blower is removed.
- Approximately eight minutes after the EMU timer begins operating, the array controllers will shut down and then the EMU turns OFF the dc power in the enclosure to prevent continued overheating and potential equipment damage.

Momentarily depressing the alarm control switch causes the EMU audible alarm to turn OFF, but the fault status LEDs remains ON. At this time, the blower LEDs display system fault codes that are essential to pinpointing the fault. See the Configuration Fault Code Reporting section within this chapter.

EMU Status Reporting

The EMU processes subsystem status reports and notifies the user of problems via an EMU audible alarm and EMU status LEDs. Figure 3–5 identifies the numerous EMU status LEDs.

Figure 3–5 EMU Status LEDs

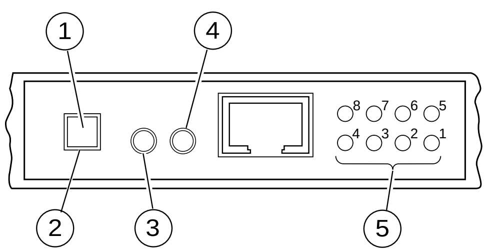


Figure CALLOUTS

1. System fault LED
2. Alarm control switch
3. Temperature LED
4. Power LED
5. Blower LEDs

The EMU processes two types of problems:

- **Error conditions—**involves the failure of a component or conditions outside the predetermined environment, such as an overtemperature condition.

  If an error condition is detected, the system fault LED (CALLOUT 1) turns ON. For detailed information about other system fault LED indications, see the Error Condition Reporting section within this chapter.

- **Fault conditions—**involves a subsystem configuration problem, such as a Boot ROM checksum failure.

  If a fault condition is detected, the system fault LED (CALLOUT 1) starts FLASHING. For detailed information about other system fault LED indications, see the Configuration Fault Code Reporting section within this chapter.

Whenever the audible alarm sounds, check the EMU status LEDs to determine the problem.

Caution

If the audible alarm sounds, but the status LEDs do not indicate an error condition, it is possible that the error condition no longer exists. However, always check the error log on the *optional* maintenance terminal to verify that the error no longer exists.

The master EMU reports the status of all enclosures, including error conditions, to the array controller. The array controller records *some* of this information in an error log and displays the log on the controller console.

Alarm Control Switch

If a power, environment, blower error, or fault condition occurs, the EMU turns ON its audible alarm and the amber system fault LED. The alarm remains on until one of the following occurs:

- The error condition is corrected.
- The user momentarily presses the alarm control switch.

Momentarily pressing the alarm control switch (CALLOUT 2, Figure 3–5) turns OFF the audible alarm for all *current* fault conditions within the enclosure. The alarm remains OFF until one of the following conditions occur:

- A different fault occurs.
- An existing fault clears and reoccurs.

- The error condition still exists after 1 hour has passed. This situation causes the audible alarm to continue sounding once every hour for approximately 5 seconds.

To clear all the fault code displays, press and hold the alarm control switch for at least 5 seconds.

> **Note**
>
> The alarm control switch does not affect either the error condition or the error condition code *stored* by the EMU. The only way to clear a stored error condition code is to correct the problem.

If the enclosure is in standby power mode, the alarm control switch functions as an enclosure power switch. Press the alarm control switch on each enclosure to restore dc power to the enclosure.

EMU Status LEDs

Table 3–5 shows the three indications possible for EMU status LEDs. If an LED's blinking or flashing interval is more than 1 second, the LED is considered ON.

Table 3–5 Subsystem Status LEDs Displays

Symbol		Condition
○	□	LED is OFF.
◍	▨	LED is FLASHING (blinking rapidly—blinks more than once per second).
●	■	LED is ON or blinking slowly (blinks less than once per second).

Monitoring Power Supply Operations

Even with four operational power supplies, it is possible that a power supply problem might cause one or both of the dc voltages to be too low. Both the PVA and EMU monitor power supply operations to ensure that dc voltages are within a specified range (see Table 3–6).

Table 3–6 DC Voltage Ranges

Nominal Voltage	+5 V dc	+12 V dc
Minimum Voltage	+4.7 V dc	+11.4 V dc

At least four operational power supplies are required to maintain the minimum voltage requirements shown in Table 3–6. With less than four operational power supplies, the EMU notifies the array controllers of a fault condition. The array controllers shut down and then the EMU initiates standby power mode.

Caution

Some array controllers bypass the standby power mode functionality from the PVA standby power switch. Refer to the array controller documentation for availability of this feature.

Note

Only the EMU monitors the I/O module +5 V dc TERMPOWER. The PVA does not monitor this voltage.

Error Condition Reporting

EMU status LEDs identify system (enclosure) status, power status, temperature status, blowers status, and error conditions. During normal operations, only the power LED is ON. Refer to Figure 3–5 as necessary to recall EMU status LED names and locations. Figures contained in Table 3–7 describe:

- EMU status LED display appearance
- Enclosure status associated with each display
- A probable cause for the detected error condition
- Action recommended to correct the problem

Note

Presenting all possible LED display combinations is not practical in this document. Therefore, Table 3–7 lists only a representative sampling of the displays possible.

Table 3–7 EMU Status Displays

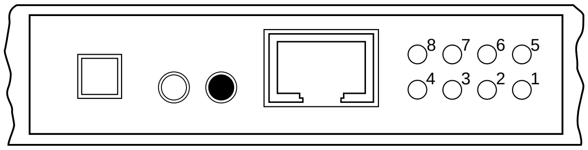
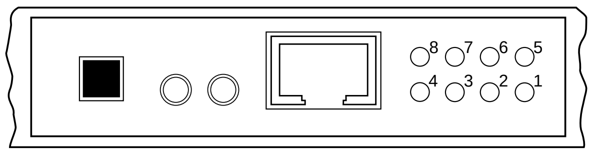
EMU Status	EMU LED Display
Operational Enclosure The subsystem is fully operational. The power supplies and blowers are functioning properly. The EMU intake and backplane exhaust air temperatures are within user-specified limits.	 CXO5778A

Table 3–7 EMU Status Displays (Continued)

Nonoperational Enclosure



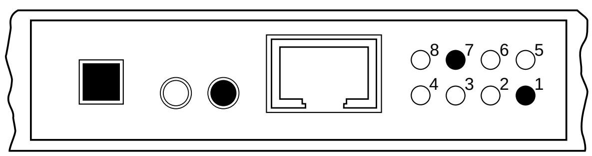
CXO5780A

Probable Cause 1—Either +5 V dc or 12 V dc out of range. Observe the individual power supply status LEDs to determine the defective power supply and replace it.

Probable Cause 2—TERMPOWER less than +4.5 V dc on one or more I/O modules. Replace the I/O modules displaying a TERMPOWER LED OFF indication.

Single Blower Fault

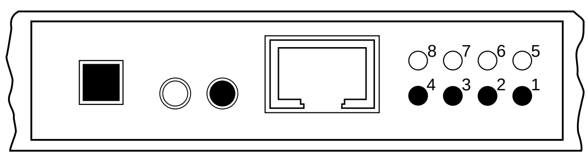
Operational blowers are running at high-speed.



CXO5781A

Missing Blower Fault
or
Multiple Blower Faults

Operational blowers are running at high-speed.



CXO5782A

Probable Cause 1—A blower is removed. Replace the missing blower.

Probable Cause 2—All blowers in one bank are not operating. Remove and install blowers correctly within 8 minutes.

Probable Cause 3—Multiple blowers are installed incorrectly. Remove and install blowers correctly within 8 minutes.

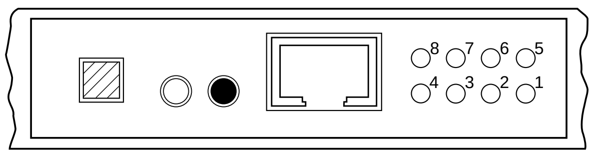
Comment—In this example, one of the following conditions exist in shelf bank 1:

- A blower is removed.
- Two or more blowers are not operating.

Failure to replace the missing or defective blowers within 8 minutes might result in the enclosure entering standby power mode.

Table 3–7 EMU Status Displays (Continued)

Configuration Error (Example 1)



CXO5783A

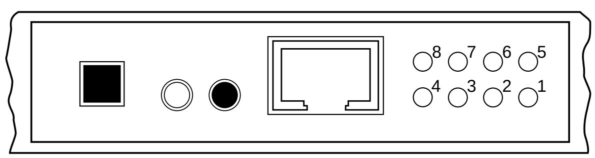
Probable Cause 1—Configuration error. See the Configuration Fault Code Reporting section for the specific error condition.

Probable Cause 2—Slave EMU cannot communicate with the master EMU. See the Configuration Fault Code Reporting section for the specific error condition.

Probable Cause 3—External SHELF_OK signal indicates error. See the Configuration Fault Code Reporting section for the specific error condition.

Configuration Error (Example 2)

Configuration errors listed in probable causes 1 through 4 also sound the audible alarm.



CXO6546A

Probable Cause 1—Invalid cache module installed. Verify that the cache module is the proper model.

Probable Cause 2—Defective cache module. Replace the defective cache module.

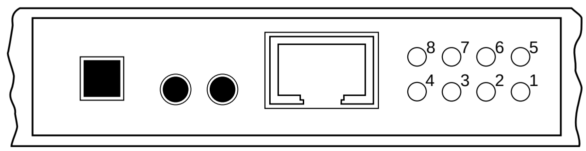
Probable Cause 3—Defective ECB. Replace the defective ECB.

Probable Cause 4—Misconfigured array controller setup. Setup as dual redundant, but only one controller is running. Setup as nondual redundant, but two controllers are running. Reconfigure the array controller setup.

Probable Cause 5—Defective or misconfigured disk drive. Replace or reconfigure the applicable disk drive.

Table 3–7 EMU Status Displays (Continued)

Overtemperature Condition



CXO5779A

Probable Cause 1—A temperature in one or more enclosures is above the user specified limit. Determine and correct the cause of this condition quickly to prevent an overtemperature condition from inducing a subsystem RESET or failure.

Probable Cause 2—A temperature set point is too low for this environment. Change the temperature set point.

Configuration Fault Code Reporting

The system fault, temperature, power, and blower LEDs cannot display all possible system faults. Therefore, if the system fault LED is FLASHING, associate this indication with a system fault somewhere within the enclosure. To identify a system fault, observe the blower LEDs. They represent a hexadecimal code that is presented using the a binary format. The upper LEDs (8 through 5) display the first digit (the most significant digit) of the hexadecimal code; the lower LEDs (4 through 1) display the second digit (the least significant digit) of the hexadecimal code.

Note

Fault codes are not displayed by the blower LEDs until the user momentarily presses the FLASHING alarm control switch.

Each time the alarm control switch is momentarily pressed, the EMU initiates the following sequence of actions:

1. The blower LEDs display the first *reported* hexadecimal fault code three times in succession.
   - The LEDs display the first reported fault code (for the *first* time) for 1 second and then turn OFF.
   - The LEDs display the first reported fault code (for the *second* time) for 1 second and then turn OFF.
   - The LEDs display the first reported fault code (for the *third* time) for 1 second and then turn OFF.
2. After the first reported fault code is displayed three times, the LEDs sequence the display to present the next reported fault code.
3. Steps 1 and 2 repeat for all reported fault codes.

For a detailed explanation of possible fault codes, see Table 3–8. The numbered corrective actions represent the sequence to follow to resolve the problem.

Table 3–8 EMU Fault Code Displays

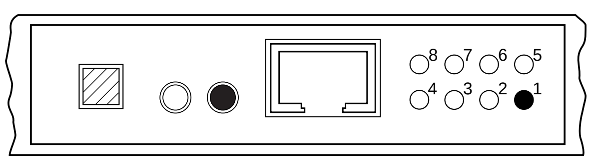
Fault Code, Cause, Corrective Action	EMU LED Display
Fault Code 01 One of the following Boot ROM error conditions exists: 1. A Boot ROM Signature failure. Replace the EMU. 2. A Boot ROM Checksum failure. Replace the EMU.	 CXO5760A

Table 3–8 EMU Fault Code Displays (Continued)

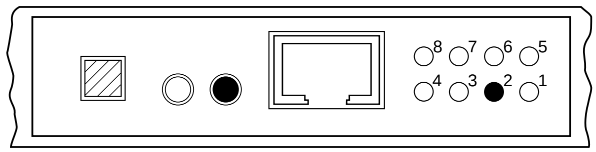
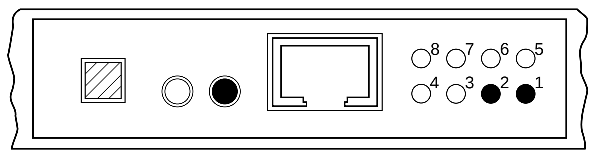
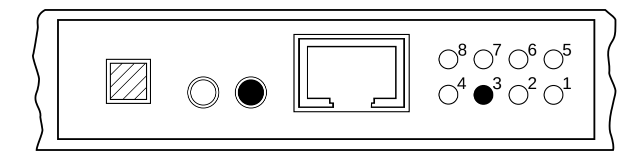
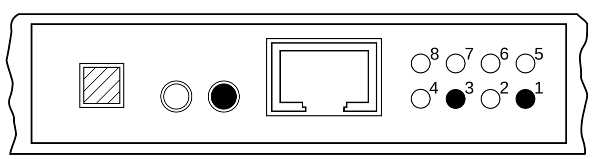
<table>
<tr><th>Fault Code, Cause, Corrective Action</th><th>EMU LED Display</th></tr>
<tr><td>Fault Code 02
Both microcode images are bad.
1. Load microcode image into the EMU from a PC.
2. Replace the EMU.</td><td>
CXO5761A</td></tr>
<tr><td>Fault Code 03
Either a PVA SCSI ID switch setting is invalid (set to 1, 4, 5, 6, or 7) or there is no master enclosure identified (SCSI bus ID = 0).</td><td>
CXO5762A</td></tr>
<tr><td colspan="2">1. Ensure PVA SCSI ID switches settings are as follows:
• Master enclosure — 0
• First expansion enclosure — 2
• Second expansion enclosure — 3
2. If any PVA SCSI ID switch setting is changed, the controllers must be RESET to recognize the new setting.
3. Replace each of the PVAs in sequence (first the master, then the expansions) until the fault condition clears.</td></tr>
</table>

Table 3–8 EMU Fault Code Displays (Continued)

<table>
<tr><th>Fault Code, Cause, Corrective Action</th><th>EMU LED Display</th></tr>
<tr><td>Fault Code 04

Master EMU cannot communicate with expansion EMU.</td><td>
CXO5763A</td></tr>
<tr><td colspan="2">1. Ensure PVA SCSI ID switches settings are as follows:
• Master enclosure — 0
• First expansion enclosure — 2
• Second expansion enclosure — 3
2. If any PVA SCSI ID switch setting is changed, the controllers must be RESET to recognize the new setting.
3. Ensure the EMU cables are properly connected.
4. Disconnect and reconnect each EMU cable one at a time. Replace the defective cable.
5. Replace the EMU.</td></tr>
<tr><td>Fault Code 05

Master EMU cannot communicate with the array controller.
1. Replace the EMU.
2. Replace the array controller.</td><td>
CXO5764A</td></tr>
<tr><td>Fault Code 06

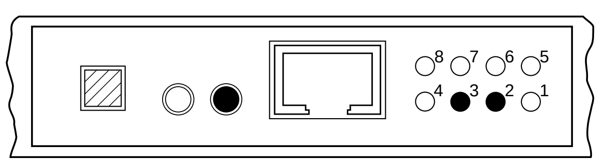
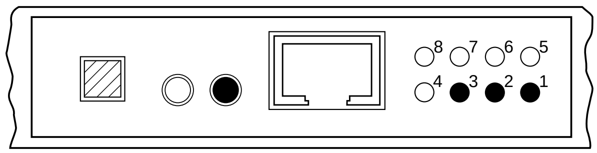
One or more temperature sensors indicate an “invalid” temperature—one that is greater than 49°C (120°F).</td><td>
CXO5765A</td></tr>
<tr><td colspan="2">1. Replace the EMU.
2. Instruct field service that temperature sensors need replacing.</td></tr>
</table>

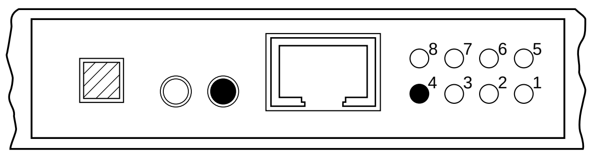
Table 3–8 EMU Fault Code Displays (Continued)

<table>
<tr><th>Fault Code, Cause, Corrective Action</th><th>EMU LED Display</th></tr>
<tr><td>Fault Code 07

Invalid configuration.

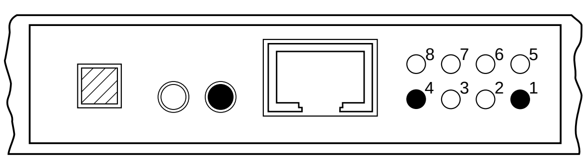
Requires an array controller-specific action (see the array controller documentation).</td><td>

CXO5766A</td></tr>
<tr><td>Fault Code 08

Two PVA SCSI ID switch settings are the same.</td><td>

CXO5767A</td></tr>
<tr><td colspan="2">1. Ensure the PVA SCSI ID switch settings are as follows:
• Master enclosure — 0
• First expansion enclosure — 2
• Second expansion enclosure — 3
2. If any PVA SCSI ID switch setting is changed, the controllers must be RESET to recognize the new setting.
3. Replace each of the PVAs in sequence (first the master, then the expansions) until the fault condition clears.</td></tr>
<tr><td>Fault Code 09

An EMU is installed in a PVA slot.

Remove the EMU from the PVA slot and install it into the slot immediately to the left.</td><td>

CXO5768A</td></tr>
</table>

Table 3–8 EMU Fault Code Displays (Continued)

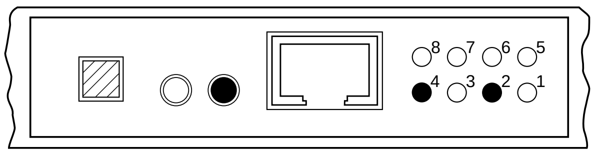
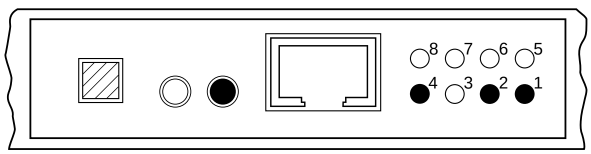
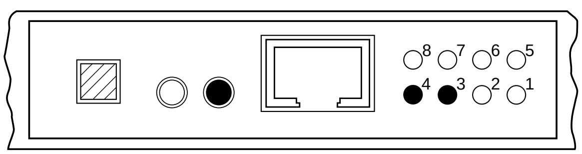
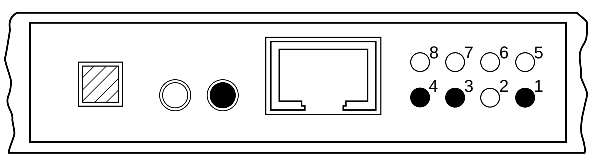
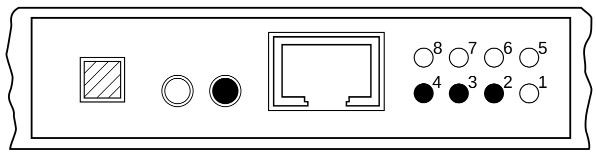
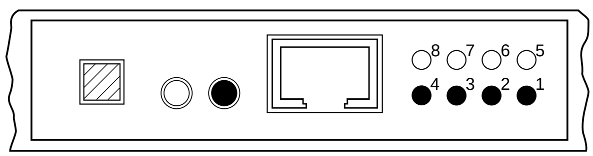
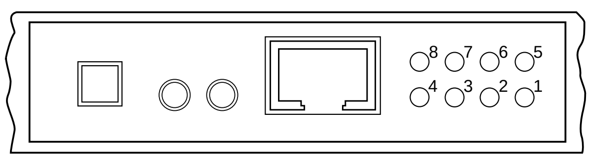
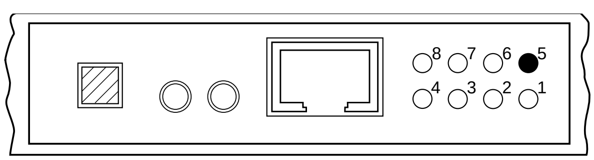
Fault Code, Cause, Corrective Action	EMU LED Display
Fault Code 0A No PVA is installed. Install a PVA.	 CXO5769A
Fault Code 0B Controller fault. Requires an array controller-specific action (see the array controller documentation).	 CXO5770A
Fault Code 0C One or more defective power supplies. Observe all power supply status LEDs. Replace any power supply with the lower (power supply status) LED turned OFF.	 CXO5771A
Fault Code 0D The master enclosure SCSI bus ID address is incorrect or an array controller is installed in an expansion enclosure.	 CXO5772A
1. Change the master enclosure SCSI bus ID to 0. The controllers must be RESET to recognize the new setting. 2. If necessary, remove the array controller from the expansion enclosure and install it in the master enclosure.	

Table 3–8 EMU Fault Code Displays (Continued)

Fault Code, Cause, Corrective Action	EMU LED Display
Fault Code 0E EMU memory test failed. Replace the EMU.	 CXO5773A
Fault Code 0F Less than four operational power supplies remain. Replace the defective power supplies. **Comment—**The EMU places the system in the standby power mode for this fault indication. After replacing the defective power supplies, momentarily press the alarm control switch to restore dc power to the enclosure. The initial display appears when a fault is detected; the standby power mode display appears after the EMU removes dc power from the enclosure.	**Initial Display**  CXO5784A **Standby Power Mode Display**  CXO5815A
Fault Code 10 EMU diagnostic program is loaded. The audible alarm is on continuously and it cannot be cleared by pressing the alarm control switch.	 CXO5814A
1. Load new microcode. The controllers must be RESET to recognize the new microcode. 2. Replace the EMU with one containing the proper microcode. The controllers must be RESET to recognize the new microcode.	

Replacing an EMU

Complete the procedure in Table 3–9 to remove an EMU and complete the procedure in Table 3–10 to install an EMU.

Table 3–9 Removing an EMU

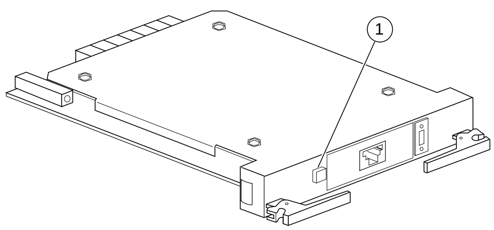
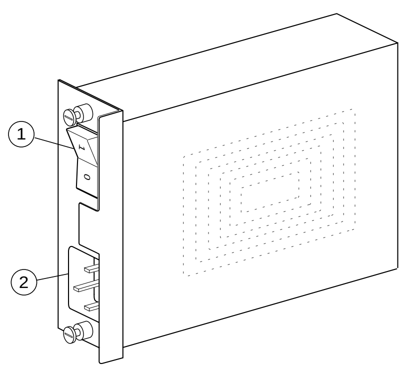
1. Clear the cache module and shut down the array controller per the array controller documentation.
2. If there are no expansion enclosures, go to step 3. If there are expansion enclosures, press and hold the PVA standby power switch (CALLOUT 1) on an expansion enclosure until the master EMU initiates a power shut down of all enclosures.  CXO6303A 3. Press and hold the PVA standby power switch (CALLOUT 1) on the master enclosure until the master EMU initiates a power shut down on the master enclosure.
4. If there are no expansion enclosures, go to step 5. If there are expansion enclosures, turn OFF all the ac input boxes for each expansion enclosure by pressing **O** on each ac power switch (CALLOUT 1). 5. Turn OFF all the ac input boxes for the master enclosure by pressing **O** on each ac power switch (CALLOUT 1).  CXO5488B

Table 3–9 Removing an EMU (Continued)

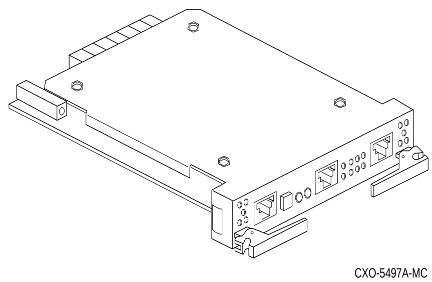
6. Pull the EMU extractor latches outward and remove the EMU.	

Table 3–10 Installing an EMU

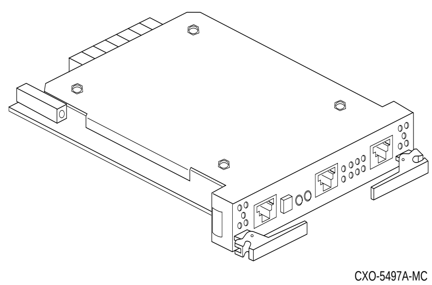
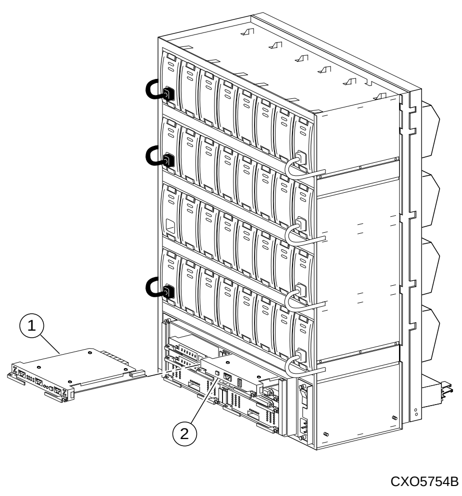
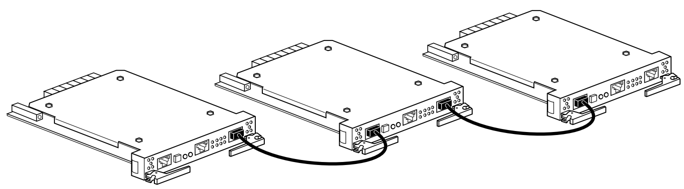
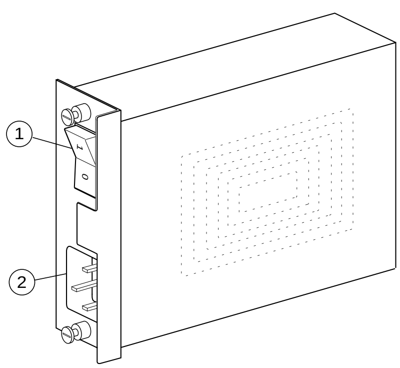
1. Verify that the EMU is a model DS–BA35X–EB.	
2. Align the EMU in the top, left-hand slot (CALLOUT 1) and insert it.	

Table 3–10 Installing an EMU (Continued)

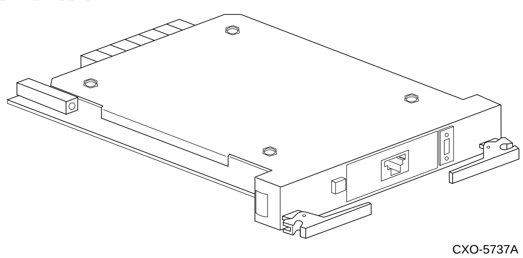
3. Pull the EMU extractor latches outward. Push the EMU into the slot until the extractor latches engage the enclosure, then push the extractor latches inward to seat and secure the EMU.
4. If there are no expansion enclosures, go to step 6. For an expansion configuration, use a BN26M series cable (see Table 3–1) to create the EMU-EMU communications bus connections as illustrated below. 
5. If there are expansion enclosures, turn ON all the ac input boxes for each expansion enclosure by pressing **I** on each ac power switch (CALLOUT 1). 6. Turn ON all the ac input boxes for the master enclosure by pressing **I** on each ac power switch (CALLOUT 1). 
7. After the array controller is operational, verify that the subsystem is functioning properly.

4

Power Verification and Addressing

An enclosure's PVA assembly (see Figure 4–1) and associated EMU monitors the status of major UltraSCSI enclosure components to verify their proper operation. If an error or fault condition occurs, these modules notify the user, and in some instances, the array controller, that a problem exists. The array controller can identify and display information about some problems. The PVA and EMU status LEDs indicate possible root causes of problems.

Figure 4–1 PVA



Caution

Proper operation of an UltraSCSI RAID subsystem requires an operational EMU (model DS–BA35X–EB) and PVA (model DS–BA35X–EC) in each enclosure. Also, EMU communications bus links must be established between all EMUs for proper subsystem operation and error reporting.

The PVA and EMU mount next to each other in the enclosure—the EMU (CALLOUT 1) is on the left and the PVA is on the right (CALLOUT 2) as shown in Figure 4–2.

Figure 4–2 PVA Location

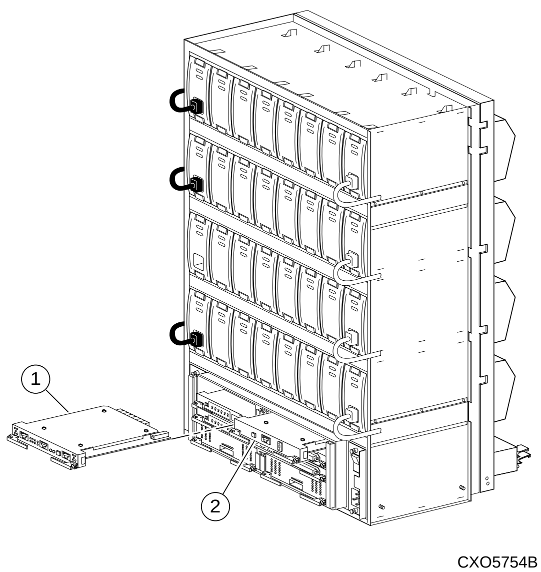


Figure CALLOUTS

1. EMU
2. PVA

Product Description

Figure 4–3 identifies the major PVA components.

Figure 4–3 PVA Major Component

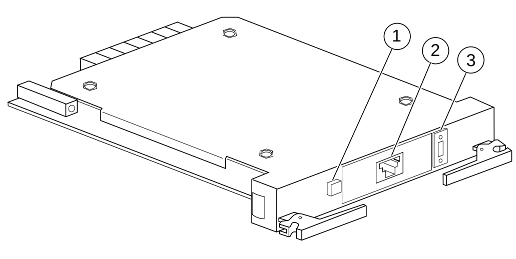


Figure CALLOUTS

1. Standby power switch
2. Communications port
3. SCSI ID switch

The PVA has two status indicators:

- A green power status LED that is part of the standby power switch (CALLOUT 1). This LED is ON if there are at least four operational power supplies. If an error condition occurs, the LED turns OFF.

Caution

Some array controllers bypass the standby power mode functionality from the PVA standby power switch. Refer to the array controller documentation for availability of this feature.

Note

The standby power switch initiates the standby power mode when the array controller is shut down. In this mode, ac power is applied to the ac input box and the power supplies. However, dc power is disconnected from the backplane.

- An audible alarm that sounds when the PVA detects removal of the EMU. This alarm reminds the user to install an operational EMU for restoring the subsystem to an operational status.

Functions

The primary functions of the PVA include the following:

- Monitors the enclosure EMU status and notifies the user when the EMU is missing.
- Allows the user to select a DIGITAL-**supported device** SCSI bus address (device ID) for each enclosure.
- Ensures at least four operational power supplies are in the enclosure.
- Notifies the array controller if less than four operational power supplies are functioning in the enclosure. The array controller then removes power from the enclosure.

This action—removing power from the enclosure—duplicates an EMU function and ensures optimum subsystem performance and integrity.

PVA Operation

Most PVA operations occur automatically and do not require user intervention. The following sections define major PVA operations.

EMU Installation Monitoring

If the EMU is removed or installed incorrectly (for example, not fully seated), the PVA detects this condition and sounds the PVA audible alarm. This alarm continues until the PVA senses that an operational EMU is present.

Caution

Removing the EMU and PVA at the same time will cause the system to RESET and cause conflicts between the enclosures due to duplicate SCSI bus ID settings.

Disk Drive SBB Device IDs

The 24 disk drive SBBs in each enclosure are arranged on 6 vertical buses in 4 horizontal shelves. All six devices on the same horizontal shelf use the same device address or ID, but each device uses a separate vertical bus. See Figure 4–4 for the master enclosure disk drive SBB device IDs.

Figure 4–4 Master Enclosure Device IDs

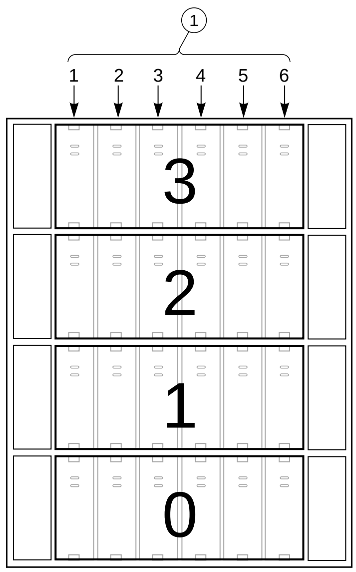


Figure CALLOUT

1. SCSI bus

Use the PVA SCSI ID switch to establish SCSI bus IDs for all devices in the enclosure. This switch has eight (0 through 7) positions.

Caution

To preclude SCSI bus addressing conflicts, DIGITAL only supports PVA SCSI ID switch settings of 0, 2, and 3.

Always set the master enclosure PVA SCSI ID switch setting to *0*.

Monitoring Power Supply Operations

Even with four operational power supplies, it is possible that a power supply problem might cause one or both of the dc voltages to be too low. Both the PVA and the EMU monitor power supply operations to ensure that the dc voltages are within the ranges specified in Table 4–1.

Table 4–1 DC Voltage Ranges

Nominal Voltage	+5 V dc	+12 V dc
Minimum Voltage	+4.7 V dc	+11.4 V dc

With at least four operational power supplies, the minimum voltage levels sufficient to run the system are present. Fewer than four operational power supplies cannot maintain the minimum voltages. If this occurs, the EMU notifies the array controllers so they can shut down before standby power mode is initiated.

Caution

Some array controllers bypass the standby power mode functionality from the PVA standby power switch. Refer to the array controller documentation for availability of this feature.

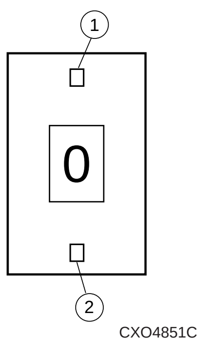
Note

The EMU monitors the system dc voltages and I/O module +5 V dc TERMPOWER. The PVA *only* monitors the system dc voltages.

Setting the Enclosure Address

The PVA SCSI ID switch establishes the SCSI bus address (device ID) for all disk drive SBBs in the enclosure. Table 4–2 identifies how to set the PVA SCSI ID switch setting for each enclosure.

Table 4–2 Setting the Enclosure Configuration

	**To decrease the configuration number:** Press the upper switch (CALLOUT 1) to step the address down one address at a time (decrement). **To increase the configuration number:** Press the lower switch (CALLOUT 2) to step the address up one address at a time (increment).

The following restrictions apply to establishing an enclosure address:

- The master enclosure address is *always* 0.
- There is only one master enclosure in any subsystem.
- No two enclosures in a subsystem are allowed to have the same address.

See Table 4–3 for the DIGITAL-supported enclosure addresses.

Caution

All devices on the same SCSI bus must have a unique SCSI bus ID.

To preclude SCSI bus addressing conflicts, DIGITAL only supports PVA SCSI ID switch settings of 0, 2, and 3.

If the PVA SCSI ID switch setting is changed for an enclosure, the controllers must be RESET to recognize the new setting.

Table 4–3 DIGITAL-Supported PVA SCSI ID Switch Settings

Total Number of Enclosures	Master Enclosure	First Expansion	Second Expansion
1	0	None	None
2	0	2	None
3	0	2	3

Master Enclosure Address

The master enclosure PVA SCSI ID switch setting is always 0. This setting establishes the disk drive SBB SCSI bus IDs shown in Figure 4–5.

Figure 4–5 Master Enclosure Address 0: Shelf and SCSI Bus IDs

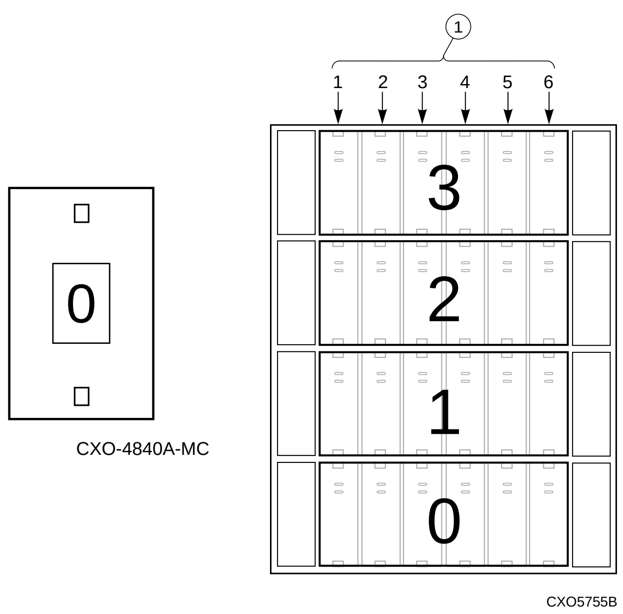


Figure CALLOUT

1. SCSI bus

Expansion Enclosure Addresses

DIGITAL supports *only* PVA SCSI ID switch settings of 2 (see Figure 4–6) and 3 (see Figure 4–7) for expansion enclosures:

- 2 — Used for the *first* expansion enclosure.
- 3 — Used for a *second* expansion enclosure.

Caution

To preclude SCSI bus addressing conflicts, DIGITAL array controllers *do not support* enclosure address settings of 1, 4, 5, 6, or 7.

Figure 4–6 Expansion Enclosure Address 2: Shelf and SCSI Bus IDs

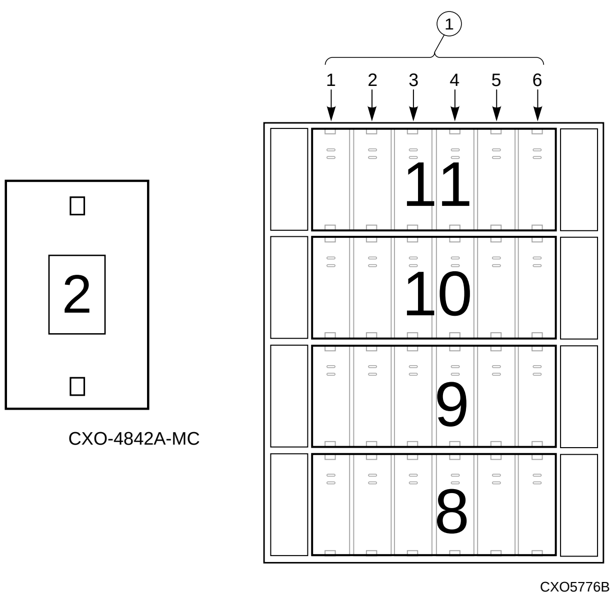


Figure Callout

1. SCSI bus

Figure 4–7 Expansion Enclosure Address 3: Shelf and SCSI Bus IDs

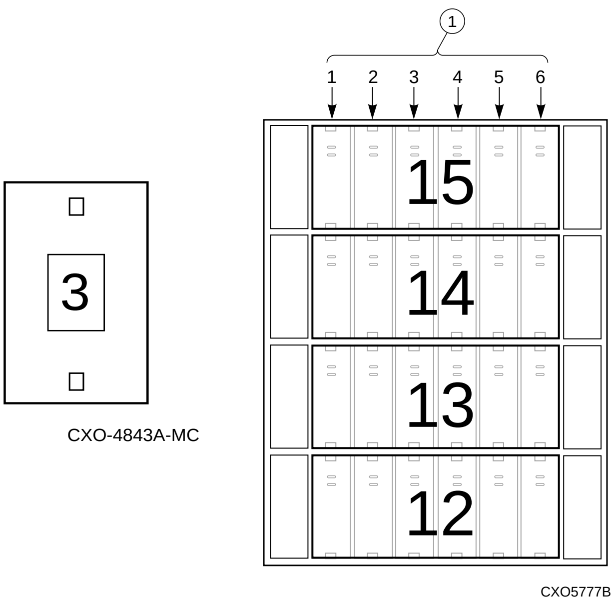


Figure CALLOUT

1. SCSI bus

Implementing the Standby Power Mode

A major function of the PVA is implementing the standby power mode. This mode removes dc power from all enclosure components, except for the EMU alarm control switch. In standby power mode, the EMU alarm control switch now functions as a dc power switch when pressed. Complete the procedure in Table 4–4 to place the subsystem into standby power mode. Complete the procedure in Table 4–5 to restore dc power to each enclosure.

Caution

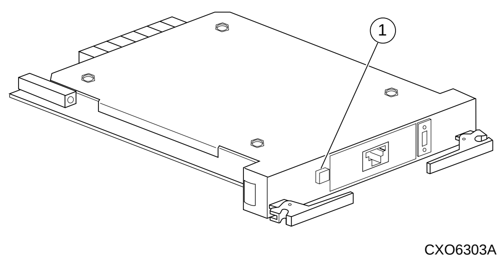
Some array controllers bypass the standby power mode functionality from the PVA standby power switch. Refer to the array controller documentation for availability of this feature.

Table 4–4 Turning Off the DC Power Distribution

1. Clear the cache module and shut down the array controller per the array controller documentation.

2. If there are no expansion enclosures, go to step 3.

   If there are expansion enclosures, press and hold the PVA standby power switch (CALLOUT 1) on an expansion enclosure until the master EMU initiates a power shut down on all enclosures.



3. Press and hold the PVA standby power switch (CALLOUT 1 in step 2) on the master enclosure until the EMU initiates a power shut down on the master enclosure.

Note

The EMU alarm control switch (CALLOUT 1 shown below) on each enclosure now functions as the dc power switch.

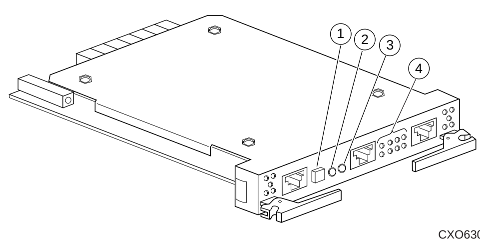
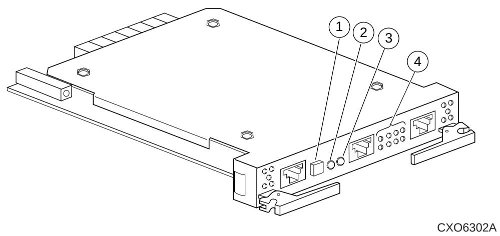


Table 4–5 Turning On the DC Power Distribution

1. If there are no expansion enclosures, go to step 3.
2. If there are expansion enclosures, momentarily press the EMU alarm control switch (CALLOUT 1) on each expansion enclosure.



3. Momentarily press the EMU alarm control switch (CALLOUT 1) on the master enclosure.
4. Verify that the array controller restores the subsystem to an operational state.

Replacing a PVA

Complete the procedures in Table 4–6 to remove a PVA. Complete the procedures in Table 4–7 to install a PVA.

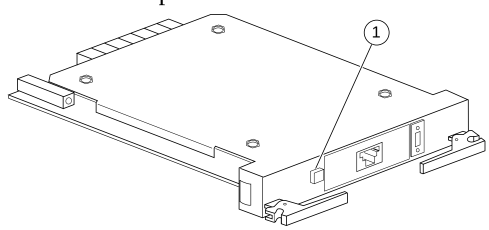
Table 4–6 Removing a PVA

1. Clear the cache module and shut down the controller per array controller documentation.

Table 4–6 Removing a PVA (Continued)

2. If there are no expansion enclosures, go to step 3.

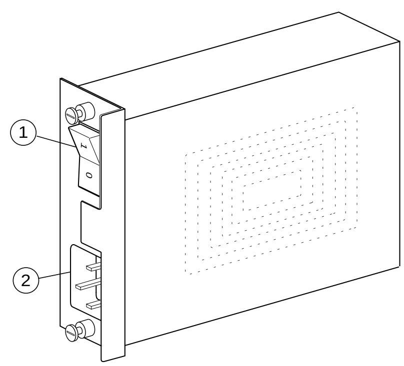
   If there are expansion enclosures, press and hold the PVA standby power switch (CALLOUT 1) on an expansion enclosure until the master EMU initiates a power shut down on all enclosures.



CXO6303A

3. Press and hold the PVA standby power switch (CALLOUT 1) on the master enclosure until the master EMU initiates a power shut down on the master enclosure.

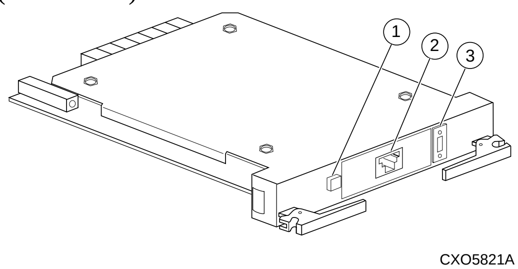
4. Turn OFF all the ac input boxes by pressing **O** on each ac power switch (CALLOUT 1) on any expansion enclosure and then the master enclosure.



CXO5488B

Table 4–6 Removing a PVA (Continued)

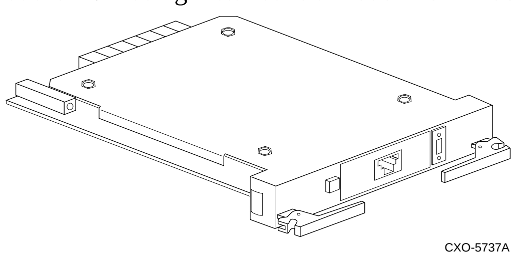
5. Note the enclosure address setting (0, 2, or 3) on the PVA SCSI ID switch (CALLOUT 3).



6. Pull both extractor latches outward and remove the PVA.

Table 4–7 Installing a PVA

1. Verify that the PVA being installed is a model DS–BA35X–EC.



2. Align the PVA (CALLOUT 2) with the top, *right*-hand slot and insert it.

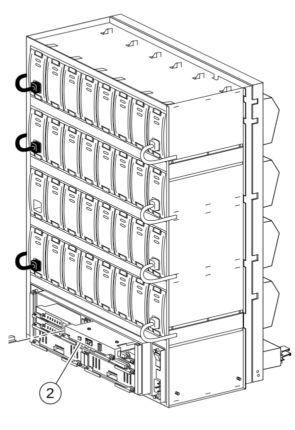
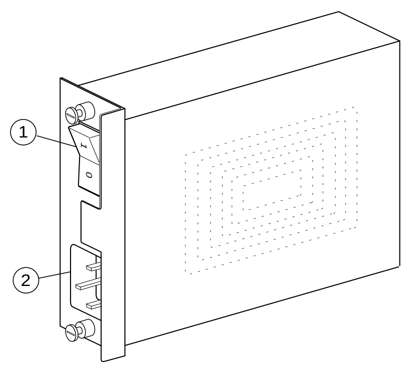


Table 4–7 Installing a PVA (Continued)

3.	Pull the PVA extractor latches outward. Push the PVA into the slot until the extractor latches engage the enclosure, then push the extractor latches inward to seat and secure the PVA.
4.	Ensure that the PVA SCSI ID switch is set to the valid number for the enclosure: • Master enclosure — 0 • First expansion enclosure — 2 • Second expansion enclosure — 3
5.	If there are no expansion enclosures, go to step 6. If there are expansion enclosures, turn ON all the ac input boxes for each expansion enclosure by pressing **I** on each ac power switch (CALLOUT 1).
6.	Turn ON all the ac input boxes for the master enclosure by pressing **I** on each ac power switch (CALLOUT 1). 
7.	After the array controller is operational, verify that the subsystem is functioning properly.

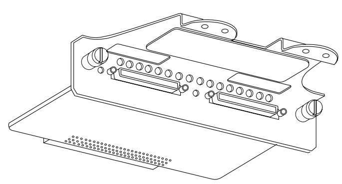
5

Single-Ended I/O Module

The single-ended I/O module (see Figure 5–1) performs two functions:

- Provides termination for both the internal and external SCSI buses
- Establishes SCSI bus communications between enclosures

Figure 5–1 Single-Ended I/O Module



CXO5816A

Caution

I/O modules provide termination for both the internal and external SCSI buses. Therefore, install the same type of operational I/O modules on each of the six **enclosure connectors**.

Note

Not all array controller firmware supports an UltraSCSI RAID subsystem with more than one enclosure. Refer to the array controller documentation to ensure that the controller supports expanded configurations.

Six I/O modules mount on the bottom rear (see Figure 5–2, CALLOUT 1) of each enclosure. These modules connect the array controller to the devices in the expansion enclosures. In an UltraSCSI RAID subsystem, the I/O module number corresponds to the SCSI bus number. For example, SCSI bus 2 and I/O module 2 are different elements of the same **physical bus**.

Figure 5–2 I/O Module Location

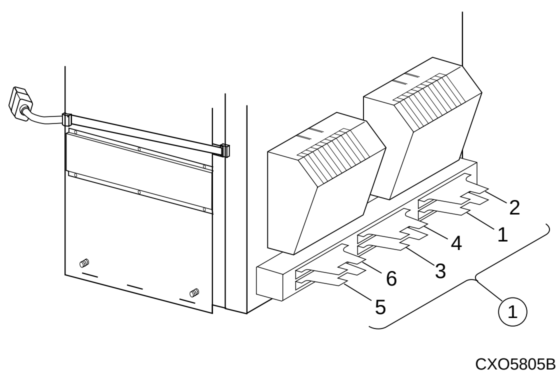
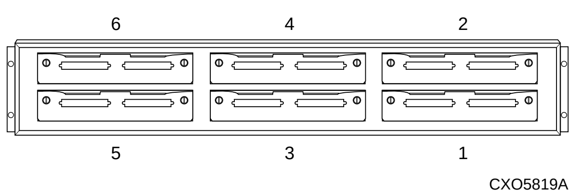


Figure CALLOUT

1. SCSI bus ports (1–6) for I/O modules (1–6), respectively

Odd numbered I/O ports are located in the bottom row and even number ports are located in the top row (see Figure 5–3). Viewing from the enclosure rear, port 1 is in the *lower right* corner and port 6 is in the *upper left* corner.

Figure 5–3 I/O Module Numbering



I/O Module and Expansion Cable Error Conditions

Removal of an I/O module causes the EMU to report the following error conditions to the controller:

- Installation of different I/O modules
- Loss of TERMPOWER

Either of these error conditions might cause the controller to cease operation without implementing procedures to protect the data.

Before removing an I/O module or an expansion cable, completion of the following procedures is *mandatory* to prevent inducing a controller error condition:

1. Clear the cache and shut down the array controller.
2. Turn OFF the enclosure power.

Caution

Replacing an I/O module or an expansion cable without first shutting down the controller can adversely affect data integrity.

Expanding the UltraSCSI Bus

Each I/O module has an UltraSCSI single-ended bus expansion integrated circuit that isolates the internal and external SCSI bus, enhances SCSI signals, and allows the use of a longer UltraSCSI bus cable.

Two 68-pin VHDCI receptacle connectors on the I/O module are the connection points for expanding the SCSI buses between enclosures. These connectors are wired in parallel and act as a **trilink connector**.

In an expansion configuration, DIGITAL recommends a *maximum cable length* of 2 m (6.6 ft) between enclosures.

Controlling the Internal SCSI Bus

The I/O module controls the internal SCSI bus in the following manner:

- Isolates the internal SCSI bus from the external SCSI bus
- Provides single-ended SCSI bus termination for each internal bus
- Disconnects the internal SCSI bus from the external SCSI bus when directed by the EMU
- Distributes TERMPOWER (+5 V dc) to the internal SCSI bus
- Turns ON the green internal TERMPOWER LED when internal TERMPOWER is present
- Turns OFF the green internal TERMPOWER LED when there is either an internal TERMPOWER overcurrent condition or no TERMPOWER

Controlling the External SCSI Bus

The I/O module controls the external SCSI bus in the following manner:

- Provides single-ended SCSI bus termination for the external bus
- Distributes TERMPOWER (+5 V dc) to the external SCSI bus
- Turns ON the green external TERMPOWER LED when external TERMPOWER is present
- Turns OFF the green external TERMPOWER LED when there is either an external TERMPOWER overcurrent condition or no TERMPOWER
- Disables the external bus termination when a cable is connected to the right VHDCI connector

Controlling the Fault Bus

The I/O module controls fault bus operation in the following manner:

- Provides a fault bus driver for improved signal transmission
- Distributes the FAULT_CLK and FAULT_DATA signals from the master enclosure to the expansion enclosures
- Distributes the SHELF_OK and SWAP_L signals from the expansion enclosures to the master enclosure

Error Reporting

The EMU monitors the status of the I/O modules for the following error conditions:

- Installation of incompatible I/O modules
- TERMPOWER problems

Incompatible I/O Modules

An I/O module error condition exists if any of the following conditions exist:

- One or more nonoperating I/O modules
- Installation of fewer than six operational I/O modules
- All I/O modules are not the same type

When the EMU detects an I/O module error condition, it automatically reports the problem to the array controller. Any operational controller will automatically turn OFF without implementing procedures to clear the cache module. The result is that the controller will cease to operate and be in an error state, a state that can adversely affect the integrity of the data.

Note

Existance of an I/O module error condition prevents the subsystem from operating.

Only when all I/O modules are the same type can an UltraSCSI RAID subsystem function properly. The DIGITAL UltraSCSI controller only supports single-ended buses. Therefore, use only single-ended I/O modules (DS–BA35X–MN). The enclosure does not support the following conditions:

- Improperly installing a single-ended I/O module
- Installing fewer than six single-ended I/O modules
- Installing a termination I/O module
- Installing a differential I/O module

TERMPOWER Errors

The I/O module displays a TERMPOWER status indication for both the internal and external bus as shown in Figure 5–4.

Figure 5–4 I/O Module TERMPOWER LEDs

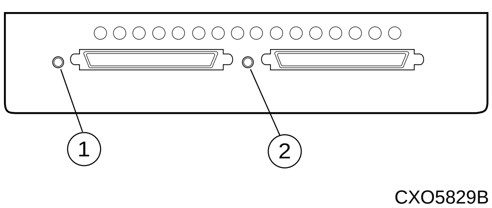


Figure CALLOUTS

1. External TERMPOWER
2. Internal TERMPOWER

The nominal TERMPOWER for both buses is +5 V dc.

The green internal (CALLOUT 2) and external (CALLOUT 1) TERMPOWER LEDs are ON during normal operation.

If a TERMPOWER overcurrent condition exists or there is no TERMPOWER, the associated LED is OFF.

See Table 5–1 for possible causes of TERMPOWER problems.

Table 5–1 TERMPOWER Problems

TERMPOWER Error	Possible Causes
Internal	I/O module Power supply
External	I/O module Power supply External SCSI bus cable

Removing an I/O module disconnects the SCSI bus termination, resulting in a loss of TERMPOWER available to the internal SCSI bus. Without TERMPOWER, the bus cannot function correctly.

Rules for Expanding an UltraSCSI Bus

By connecting the master enclosure to one or two expansion enclosures, each SCSI bus is expanded from a 4-device bus to an 8- or 12-device bus, respectively. See Chapter 4 for a discussion of valid enclosure SCSI bus addresses and the associated array controller and storage device SCSI bus IDs.

Note

Wide UltraSCSI supports a maximum of 16 devices per bus (2 array controllers and 14 disk drives). However, DIGITAL does not support any configuration with more than 12 disk drives.

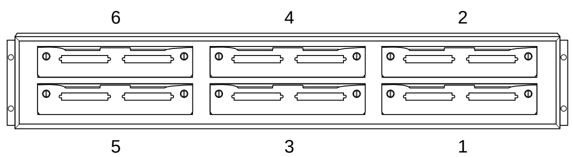
To expand a SCSI bus, use the 68-pin VHDCI receptacle connectors on the I/O module and a BN37A series cable. See Table 5–2 for a list of the rules for expanding an UltraSCSI bus.

Single-Ended I/O Module

Caution

The DIGITAL UltraSCSI controller does not support connecting or disconnecting a SCSI bus cable when both data and power are present on the connector—a “**hot swap**.” Only connect or disconnect SCSI bus cables using the “**cold swap**” method.

Table 5–2 UltraSCSI Bus Expansion Rules

1. The I/O module numbers (1 through 6) correspond to the enclosure SCSI bus numbers. 
2. Always connect cables between enclosures to the same I/O module number. That is, connect I/O module 1 on the master enclosure to I/O module 1 on an expansion enclosure.
3. The *first cable* on any I/O module always connects to the *left connector.* **Note** Connecting a cable to the *right* I/O module connector removes the external SCSI bus termination from the module.
4. The *second cable* on any I/O module always connects to the *right connector.*

Cabling an UltraSCSI Subsystem

This section provides procedures for adding a second and third enclosure (expansions) to a subsystem. The first expansion enclosure connects to the master enclosure. A second expansion enclosure connects to either the master enclosure or the first expansion enclosure. Before beginning any cabling installation, complete the preliminary procedures in Table 5–3.

Caution

Not all array controllers support an UltraSCSI RAID subsystem with more than one enclosure. Refer to the array controller documentation to ensure the controller supports expanded configurations.

The DIGITAL UltraSCSI controller does not support connecting or disconnecting a SCSI bus cable when both data and power are present on the connector—a hot swap. Only connect or disconnect SCSI bus cables using the cold swap method.

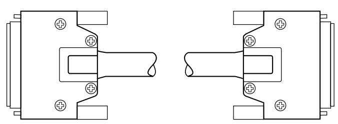
Table 5–3 Preliminary Cabling Procedures

1.	Determine how many enclosures will be connected to the master enclosure (0, 1, or 2).
2.	Determine if a second master enclosure will connect to the master enclosure or the first expansion enclosure.
3.	Determine the optimum route for each UltraSCSI bus cable.
4.	Use Table 5–4 to select the UltraSCSI cable for each segment—based upon the distances between the enclosures.

Caution

To ensure proper UltraSCSI bus operation, DIGITAL recommends a maximum cable length of 2 m (6.6 ft).

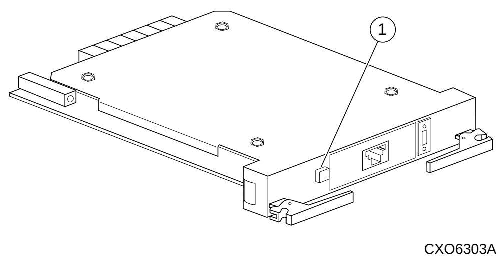
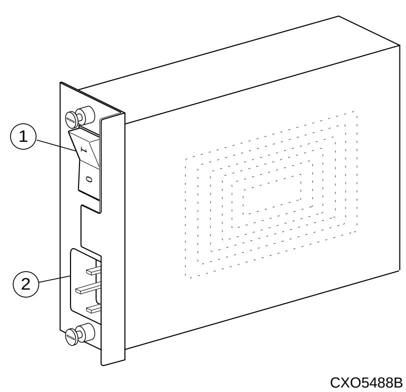
Table 5–4 UltraSCSI Bus Cables

Description	Length		Order Number
	Meters	Feet	
68-conductor SCSI cable with: 2 — VHDCI straight plug connectors with jack screws  CXO5702A	0.3	1.0	BN37A–0C
	0.5	1.6	BN37A–0E
	1.0	3.3	BN37A–01
	1.5	4.9	BN37A–1E
	2.0	6.6	BN37A–02

Shutting Down the Subsystem

To protect the data and devices, complete the procedures in Table 5–3 and Table 5–5 before beginning cable installation procedures for a two- or three-enclosure subsystem.

Table 5–5 Shutting Down the UltraSCSI Subsystem

1. Clear the cache module and shut down the array controller per the array controller documentation.
2. If there are no expansion enclosures, go to step 3. If there are expansion enclosures, press and hold the PVA standby power switch (CALLOUT 1) on an expansion enclosure until the master EMU initiates a power shut down on all enclosures.  3. Press and hold the PVA standby power switch (CALLOUT 1) on the master enclosure until the master EMU initiates a power shut down on the master enclosure.
4. If there are no expansion enclosures, go to step 5. If there are expansion enclosures, turn OFF all the ac input boxes for each expansion enclosure by pressing **O** on each ac power switch (CALLOUT 1). 5. Turn OFF all the ac input boxes for the master enclosure by pressing **O** on each ac power switch (CALLOUT 1). 

Cabling a Two-Enclosure Subsystem

Complete the procedures in Table 5–6 to connect the master enclosure to one expansion enclosure. Perform this procedure for the I/O modules on each SCSI bus, starting with SCSI bus 1 in Figure 5–3. Each SCSI bus requires one BN37A cable for a total of six cables.

Caution

Not all array controllers support an UltraSCSI RAID subsystem with more than one enclosure. Refer to the array controller documentation to ensure the controller supports expanded configurations.

Overtightening the I/O module spring-loaded mounting screws can damage the threads.

Table 5–6 Installing Two-Enclosure Subsystem Cables

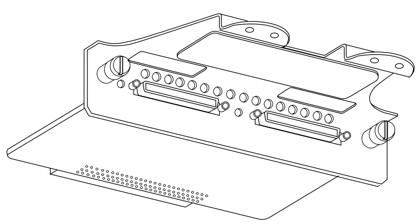
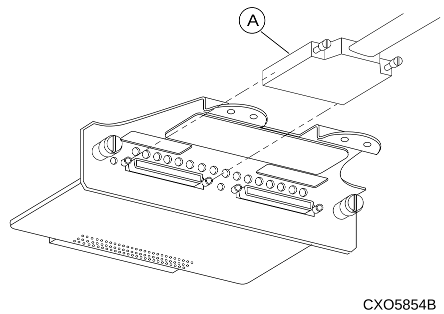
1.	Complete Table 5–5 to shut down the UltraSCSI subsystem.
2.	Use a screwdriver to loosen two spring-loaded mounting screws on the I/O module.
3.	Grasp the I/O module by the cable support bracket and pull it straight outward until removed from the enclosure shroud.  CXO5816A
4.	Repeat steps 2 and 3 for all the I/O modules.

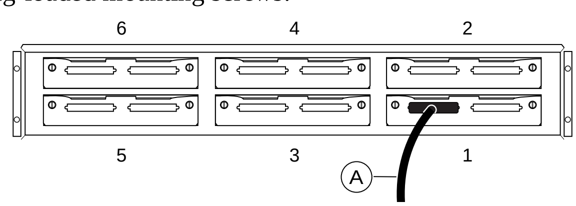
Table 5–6 Installing Two-Enclosure Subsystem Cables (Continued)

5. On the master enclosure I/O module, align the *Cable A* (CALLOUT A) connector with the left connector. Gently insert the cable connector into the module connector. Tighten both cable connector thumb screws to fully seat the connector.

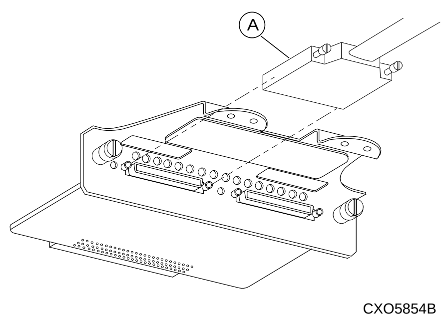


6. Install a wire tie through the holes on the cable support bracket and around the cable. Tighten the wire tie.

7. On the master enclosure, align the module that has Cable A (CALLOUT A) attached with the *Port 1* backplane connector. Gently insert the module and fully seat it. Use a screwdriver to tighten the spring-loaded mounting screws.

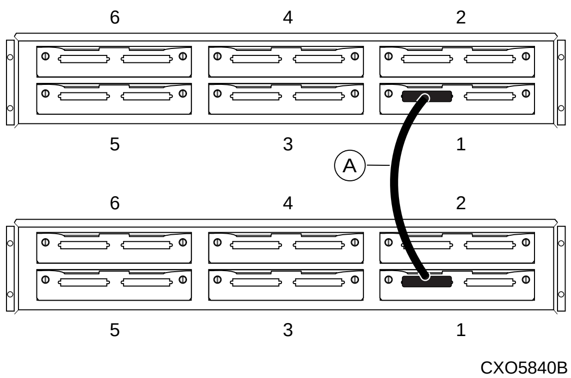


8. On the expansion I/O module, align the *Cable A* (CALLOUT A) connector with the *left* connector. Gently insert the cable connector into the module connector. Tighten both cable connector thumb screws to fully seat the connector.



9. Install a wire tie through the holes on the cable support bracket and around the cable. Tighten the wire tie.

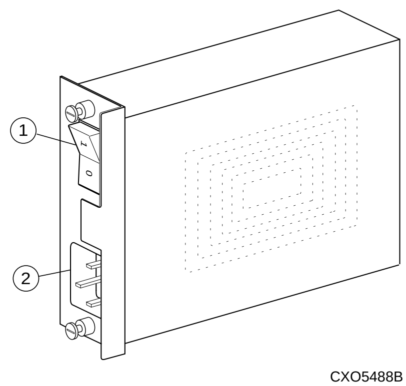
Table 5–6 Installing Two-Enclosure Subsystem Cables (Continued)

10.	On the expansion enclosure shroud, align the module that has Cable A (CALLOUT A) attached with the *Port 1* backplane connector. Gently insert the module and fully seat it. Use a screwdriver to tighten the spring-loaded mounting screws. 
11.	Repeat steps 5 through 10 for the remaining SCSI buses (ports 2 through 6).
12.	Turn ON the subsystem using Table 5–7 and verify that it is operating properly.

Turning On the Subsystem

Complete the procedures in Table 5–7 to turn ON the subsystem.

Table 5–7 Turning On the UltraSCSI Subsystem

1.	If there are no expansion enclosures, go to step 3.	
2.	Turn ON all the ac input boxes for each expansion enclosure by pressing **I** on each ac power switch (CALLOUT 1).	
3.	On the master enclosure, turn ON all the ac input boxes by pressing **I** on each ac power switch (CALLOUT 1).	
4.	Verify that the array controller places the subsystem into an operational state.	

Cabling a Three-Enclosure Subsystem

Complete the procedures in Table 5–8 to connect the master enclosure to two expansion enclosures. The second expansion enclosure connects to either the master enclosure or the first expansion enclosure. Table 5–8 connects the second expansion enclosure to the first expansion enclosure. Perform this procedure for the I/O modules on each SCSI bus, starting with SCSI bus 1 (identified in Figure 5–3). Each SCSI bus requires two BN37A cables for a total of 12 cables.

Caution

Not all array controllers support an UltraSCSI RAID subsystem with more than one enclosure. Refer to the array controller documentation to ensure the controller supports expanded configurations.

Overtightening the I/O module spring-loaded mounting screws can damage the threads.

Note

The procedure in Table 5–8 connects a second expansion enclosure to the first expansion enclosure. To connect the second expansion enclosure to the master enclosure, do the following:

- Substitute the first expansion enclosure for the master enclosure in steps 5 through 7.
- Substitue the master enclosure for the first expansion enclosure in steps 8 through 12.

Table 5–8 Installing Three-Enclosure Subsystem Cables

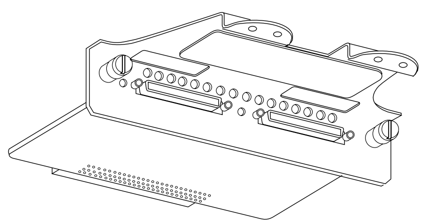
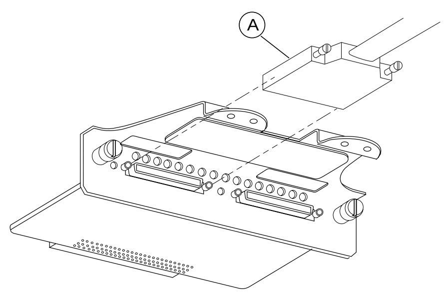
1.	Complete Table 5–5 to shut down the UltraSCSI subsystem.
2.	Use a screwdriver to loosen the two spring-loaded mounting screws on the I/O module.
3.	Grasp the I/O module by the cable support bracket and pull it straight outward until removed from the enclosure shroud.  CXO5816A
4.	Repeat steps 2 and 3 for all the I/O modules within the three enclosures.
5.	On the master enclosure I/O module, align the *Cable A* (CALLOUT A) connector with the left connector. Gently insert the cable connector into the module connector. Tighten both cable connector thumb screws to fully seat the connector.  CXO5854B
6.	Install a wire tie through the holes on the cable support bracket and around the cable. Tighten the wire tie.

Table 5–8 Installing Three-Enclosure Subsystem Cables (Continued)

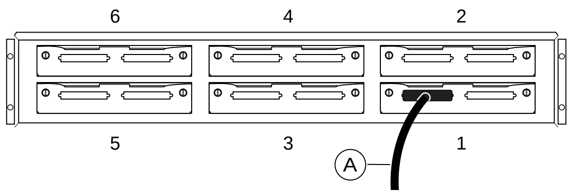
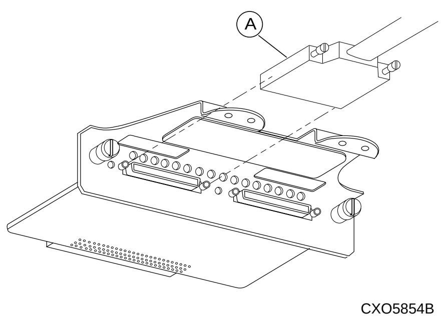
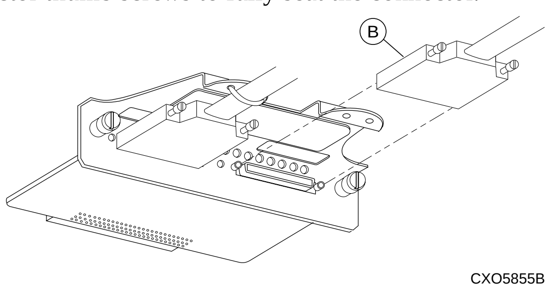
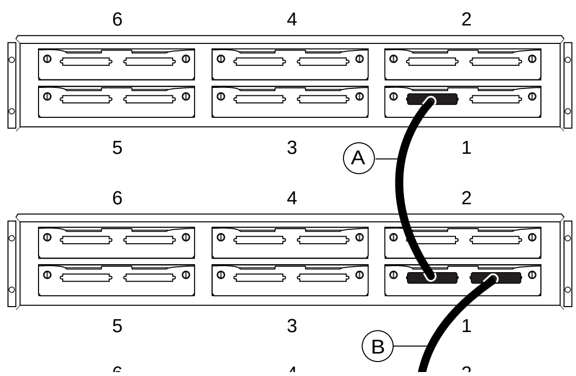
7.	On the master enclosure shroud, align the module that has Cable A (CALLOUT A) attached with the *Port 1* backplane connector. Gently insert the module and fully seat it. Use a screwdriver to tighten the spring-loaded mounting screws. 
8.	On the *first* expansion I/O module, align the *Cable A* (CALLOUT A) connector with the *left* connector. Gently insert the cable connector into the module connector. Tighten both cable connector thumb screws to fully seat the connector. 
9.	Install a wire tie through the holes on the cable support bracket and around the cable. Tighten the wire tie.
10.	Using the expansion I/O module in step 8, align the *Cable B* (CALLOUT B) connector with the *right* connector. Gently insert the cable connector into the module connector. Tighten both cable connector thumb screws to fully seat the connector. 

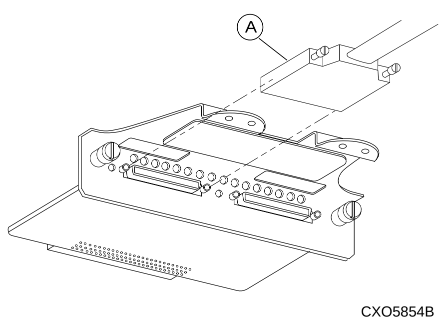
Table 5–8 Installing Three-Enclosure Subsystem Cables (Continued)

11. Install a wire tie through the holes on the cable support bracket and around the cable. Tighten the wire tie.

12. On the *first* expansion enclosure shroud, align the module that has Cable B (CALLOUT B) attached with the *Port 1* backplane connector. Gently insert the module and fully seat it. Use a screwdriver to tighten the spring-loaded mounting screws.

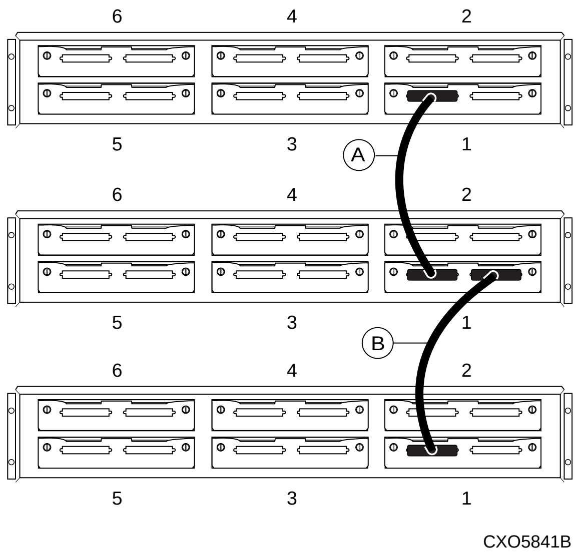


13. On the *second* expansion enclosure I/O module, align the *Cable B* (CALLOUT B) connector with the *left* connector. Gently insert the cable connector into the module connector. Tighten both cable connector thumb screws to fully seat the connector.



14. Install a wire tie through the holes on the cable support bracket and around the cable. Tighten the wire tie.

Table 5–8 Installing Three-Enclosure Subsystem Cables (Continued)

15.	On the *second* expansion enclosure shroud, align the module that has Cable B (CALLOUT B) attached with the *Port 1* backplane connector. Gently insert the module and fully seat it. Use a screwdriver to tighten the spring-loaded mounting screws. 
16.	Repeat steps 5 through 15 for the remaining SCSI buses (ports 2 through 6).
17.	Turn ON the subsystem using Table 5–7 and verify that it is operating properly.

Replacing an I/O Module

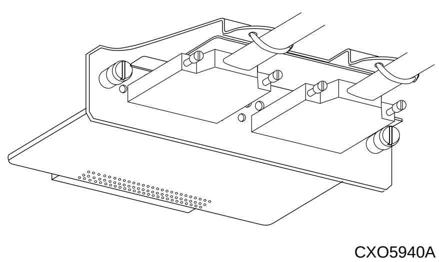
Complete the procedure in Table 5–9 to remove an I/O module.
Complete the procedure in Table 5–10 to install an I/O module.

Caution

To prevent interrupting a data transfer or losing data, shut down the subsystem before removing an I/O module.

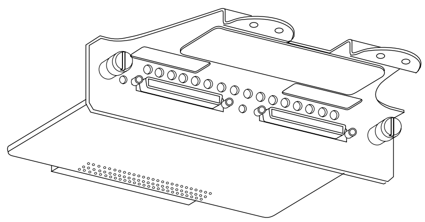
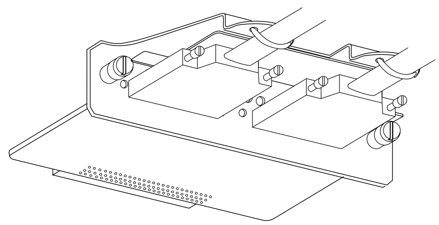
Overtightening the I/O module spring-loaded mounting screws can damage the threads.

Table 5–9 Removing an I/O Module

1.	Shut down the subsystem using Table 5–5.
2.	Use a screwdriver to loosen two spring-loaded mounting screws on the I/O module.
3.	Grasp the I/O module by the cable support bracket and pull it straight outward until removed from the enclosure shroud. 
4.	Cut the wire tie securing the *left* cable. Loosen the thumb screws and remove the cable.
5.	Label the *left* cable connector.
6.	If a *right* cable is attached, cut the wire tie securing the *right* cable. Loosen the thumb screws and remove the cable.
7.	Label the *right* cable connector.
8.	Place the I/O module into an electrostatic bag.

Single-Ended I/O Module

Table 5–10 Installing an I/O Module

1.	Verify that the I/O module being installing is a model DS–BA35X–MN.  CXO5816A **Note** Jumpers are factory installed—do not modify jumper settings.
2.	Align the cable with the *left* I/O module connector. Gently insert the cable connector into the module connector. Tighten both cable connector thumb screws to fully seat the connector.  CXO5940A
3.	Install a wire tie through the holes on the cable support bracket and around the cable. Tighten the wire tie.
4.	If attaching a cable to the *right* I/O module connector is necessary, repeat steps 2 and 3 using the *right* I/O module connector.
5.	Align the I/O module with the backplane connector in the enclosure shroud. Gently insert the module and fully seat it. Use a screwdriver to tighten the spring-loaded mounting screws.
6.	Turn ON the subsystem using Table 5–7 and verify that it is operating properly.

Replacing an Expansion Cable

Complete the procedure in Table 5–11 to remove an expansion cable.
Complete the procedure in Table 5–12 to install an expansion cable.

Caution

Not all array controllers support an UltraSCSI RAID subsystem with more than one enclosure. Refer to the array controller documentation to ensure that the controller supports expanded configurations.

To prevent interrupting a data transfer or losing data, shut down the subsystem before removing an I/O module.

Overtightening the I/O module spring-loaded mounting screws can damage the threads.

Table 5–11 Removing an Expansion Cable

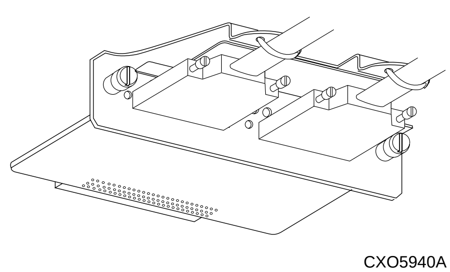
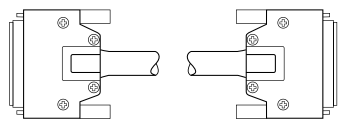
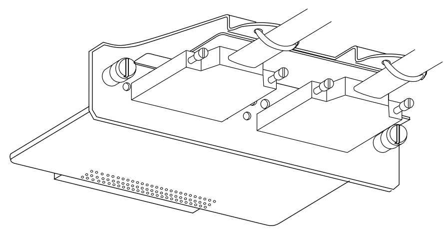
1.	Shut down the subsystem using Table 5–5.
2.	Use a screwdriver to loosen the two spring-loaded mounting screws on the I/O module connected to the cable that is being removed.
3.	Grasp the module by the cable support bracket and pull it directly to the rear and remove it from the enclosure shroud.
4.	Repeat steps 2 and 3 for the I/O module attached to the other end of the cable that is being removed.
5.	Cut the wire ties on that secure the cable to the I/O modules. Loosen the thumb screws and remove the cable. 

Table 5–12 Installing an Expansion Cable

1.	Verify that the expansion cable is the proper type and length per Table 5–4.  CXO5702A
2.	Align the cable with the *left* I/O module connector. Gently insert the cable connector into the module connector. Tighten both cable connector thumb screws to fully seat the connector.  CXO5940A
3.	Install a wire tie through the holes on the cable support bracket and around the cable. Tighten the wire tie.
4.	Repeat steps 2 and 3 for the other end of the cable. This end of the cable might connect to a *left* or *right* I/O module connector, depending on the enclosures involved.
5.	Align the I/O module with the backplane connector in the enclosure shroud. Gently insert the module and fully seat it. Use a screwdriver to tighten the spring-loaded mounting screws.
6.	Turn ON the subsystem and verify that it is operating properly.

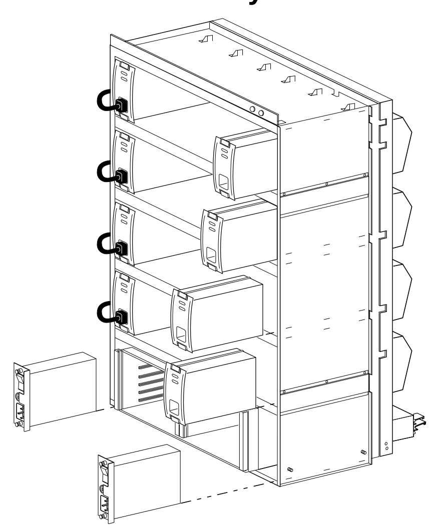
6

Power Distribution

This chapter describes the UltraSCSI RAID enclosure power distribution to include the following:

- Enclosure power system overview (see Figure 6–1)
- Power distribution configurations (standard, redundant, and optimum)
- Error condition reporting
- Replacement procedures (power supply and ac input box)

Figure 6–1 Enclosure Power System



Note

Proper operation of the controller cache modules requires ECBs. Refer to the array controller documentation for discussion on how to use the ECBs.

Power System Overview

In any RAID subsystem, the elimination of single points of failure is taken into consideration. Designing systems with redundant power capabilities is one way to eliminate single points of failure.

The following major components compose the power system:

- AC power sources
- AC input boxes
- Power cords
- Shelf power supplies

Note

The ac input box power cords are integral to the data center cabinets. For the departmental server cabinets, the *user-supplied* power cords are country-specific.

The drive SBB shelf ac power cords are integral parts of the UltraSCSI enclosures.

Power Configurations

For all StorageWorks products with the capability of using redundant power, the power configurations definitions follow a *n+x* format. In this format, *n* is the minimum number of power supplies required for operation and *x* is the number of redundant power supplies. Each UltraSCSI RAID enclosure requires a minimum of four (*n*) power supplies to operate and a specified number of power supplies for redundancy purposes.

Three configurations exist:

- Standard (n+1)
- Redundant (n+4)
- Optimum (n+4)

Standard (n+1)

This configuration has one redundant power supply for a total of *five* power supplies. A *single ac input box* distributes ac power to all five power supplies using power bus A. This configuration requires only *one ac power source*.

Redundant (n+4)

This configuration has four redundant power supplies for a total of *eight* power supplies. *Two ac input boxes* distribute ac power to four power supplies on power bus A and four power supplies on power bus B. This configuration requires only *one ac power source* that supplies ac power to both ac input boxes.

Optimum (n+4)

This configuration has four redundant power supplies for a total of *eight* power supplies. *Two ac input boxes* distribute ac power to four power supplies on power bus A and four power supplies on power bus B. This configuration requires *two ac power sources*, each supplying ac power to a different ac input box.

AC Power Source

The ac input box requires *one* of the following ac power sources:

- 100–120 V ac, 60 Hz, single-phase, 12A
- 220–240 V ac, 50 Hz, single-phase, 6A

Note

The optimum power configuration requires *two separate ac power sources*, one for each ac input box. These ac power sources cannot be on the same power distribution leg, use the same circuit breaker, nor the same ac wall receptacle. They must have a common ground.

AC Input Box

The ac power distribution is provided through the ac input box (see Figure 6–2) to the shelf power supplies. The ac power switch on each ac input box controls the **ac distribution** to the associated power bus (A or B). These ac input boxes are completely interchangeable and have no physical or electrical differences between them. AC input boxes do not have error indicators on them, nor do they generate any error signals. Without an optional second ac input box, an ac input box failure disables the enclosure.

Figure 6–2 AC Input Box

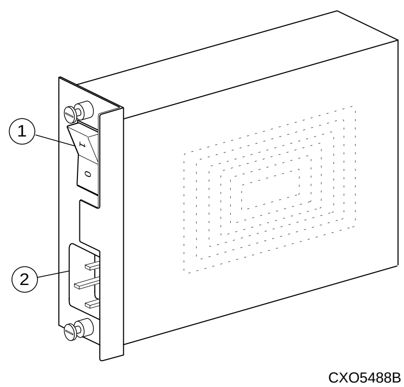


Figure CALLOUTS

1. AC power switch
2. AC power receptacle

Caution

The only compatible ac input box is the model DS–BA35X–HE; model BA35X–HE *cannot be used* in an UltraSCSI RAID enclosure.

Shelf Power Supplies

Each **shelf power supply** (see Figure 6–3) converts the incoming ac voltage into +5 V dc and +12 V dc and distributes these voltages throughout the RAID enclosure.

The maximum capacity for the UltraSCSI RAID enclosure is eight power supplies, four of which provide power redundancy.

The standard power configuration uses five power supplies, one of which provides power redundancy.

Caution

UltraSCSI RAID enclosures *require* shelf power supplies rated for at least 180 W, such as model DS–BA35X–HH. Other power supplies, such as the 150 W power supply, model BA35X–HF, *cannot be used*.

Figure 6–3 Shelf Power Supply

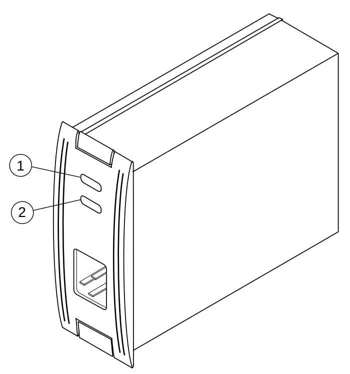


Figure CALLOUTS

1. Shelf status LED
2. Power supply status LED

AC Power Buses

AC power distribution to the UltraSCSI shelf power supplies is distributed over two power buses—bus A and bus B (see Figure 6–4). Each power bus has an ac power source, a separate ac input box, power supplies, and power cords.

Figure 6–4 Enclosure AC Power Buses

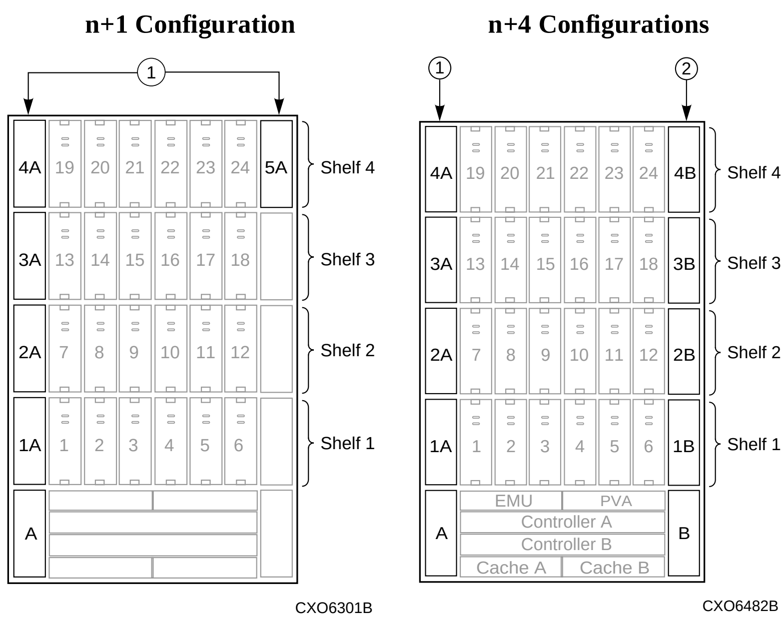


Figure CALLOUTS

1. Power bus A
2. Power bus B

Although the standard (n+1) power configuration can operate the subsystem via power bus A (CALLOUT 1), DIGITAL recommends using both power buses with two ac power sources—the *optimum* power configuration (n+4).

Power bus A (CALLOUT 1) uses black power cords and power bus B (CALLOUT 2) uses grey power cords. These colored cords indicate the power bus being used:

- AC input box **A** controls power bus A—power supply positions **1A** through **5A** (n+1 configuration in Figure 6–4)
- AC input box **B** controls power bus B— power supply positions **1B** through **4B** (n+4 configuration in Figure 6–4)

Power Distribution Configurations

This section describes the three power configurations for the UltraSCSI RAID enclosure.

Standard (n+1) Power Configuration

This power configuration provides *minimum* power supply redundancy. AC power distribution is provided over power bus A to five power supplies located in positions 1A through 5A (see Figure 6–5). Power bus A uses four black power cords on the left side of the enclosure and one black power cord on the upper right corner.

Figure 6–5 Standard Power Configuration

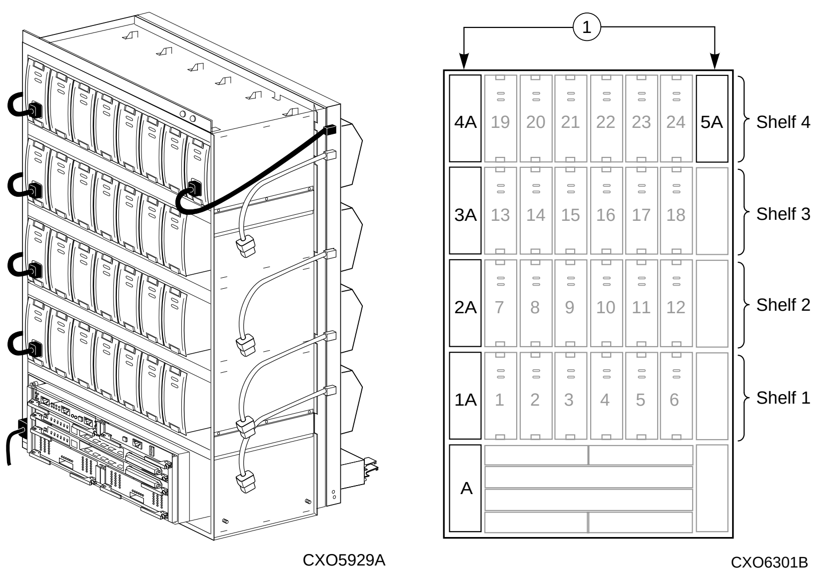


Figure CALLOUT

1. Power bus A

The standard power configuration has the following items:

1 — ac power source

5 — shelf power supplies (locations 1A through 5A)

1 — ac input box (location A)

Any o*n*e of the following power related error conditions *will* cause this UltraSCSI RAID enclosure to cease operation:

- Loss of the ac power source
- Failure of *two* shelf power supplies
- Failure of the ac input box

Redundant (n+4) Power Supply Configurations

This power configuration provides more power redundancy than the standard configuration. AC power distribution is provided over both power buses (A and B, CALLOUTS 1 and 2, respectively) as shown in Figure 6–6. Each bus has four power supplies for a total of eight.

Figure 6–6 Redundant Power Configuration

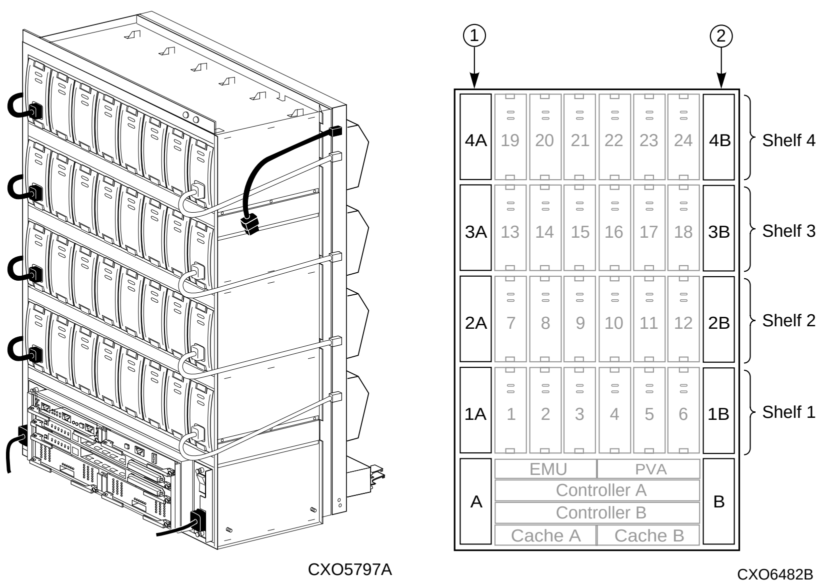


Figure CALLOUTS

1. Power bus A
2. Power bus B

AC input box A distributes the ac power through *four black* cords at the *left side* of the enclosure. AC input box B distributes the ac power through *four grey* cords on the *right side* of the enclosure.

To implement this configuration from an n+1 configuration, order the following additional components:

- 3 — power supplies (DS–BA35X–HH)
- 1 — ac input box (DS–BA35X–HE)

This power configuration provides data protection through maximum redundancy of all enclosure power system components. Any *one* of the following power-related error conditions *will* cause this UltraSCSI RAID enclosure to cease operation:

- Loss of the ac power source
- Failure of *five* shelf power supplies
- Failure of *both* ac input boxes

Optimum (n+4) Power Supply Configurations

The only difference between this configuration and the redundant (n+4) configuration is the use of *two separate* ac power sources. One ac power source provides power to ac input box A; the other ac power source provides ac power to ac input box B.

To implement this configuration from a standard n+1 configuration, order the following additional components:

- 3 — power supplies (DS–BA35X–HH)
- 1 — ac input box (DS–BA35X–HE)

To implement this configuration from n+1 or an n+4 configuration requires a second ac power source.

DIGITAL *recommends* using this power configuration to eliminate all single points of power failure. The optimum power configuration provides complete data protection with maximum redundancy of all enclosure power system components and the ac input power source. Any *one* of the following power related error conditions *will* cause this UltraSCSI RAID enclosure to cease operation:

- Loss of *both* ac power sources
- Failure of *both* ac input boxes
- Failure of *five* power supplies

- Failure of the ac power source for bus B and one power supply on bus A
- Failure of the ac power source on bus A and one power supply on bus B
- Failure of the ac input box on bus B and one power supply on bus A
- Failure of the ac input box on bus A and one power supply on bus B

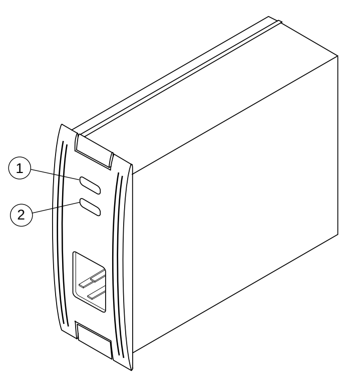
Error Condition Reporting

This section describes the power supply and ac input box error condition reporting.

Power Supply

The two green LEDs on each power supply (see Figure 6–7) display the blower, the power bus, and the individual power supply status. Normally, both of these LEDs are ON.

Figure 6–7 Power Supply Status LEDs



CXO4787B

Figure CALLOUTS

1. Shelf status LED
2. Power supply status LED

The green shelf status LED (CALLOUT 1) is ON when all the power supplies and all the blowers are operational. If any blower or power supply fails, this LED turns OFF.

The green power supply status LED (Callout 2) is On when the power supply is operating properly. If the power supply fails, both power supply LEDs (Callouts 1 and 2) turn Off.

Table 6–1 identifies the possible fault displays and provides a description of each state.


LED is On

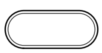
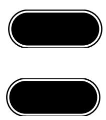
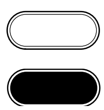
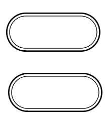

LED is Off

Table 6–1 Power Supply Status LED Displays

LED Display	Description and Possible Corrective Actions
	This power supply is functioning properly.
	A blower or power supply fault occurred: • Check the operating condition of each blower. Replace the defective blower. • Check all power supplies for one with both LEDs in the Off state. Replace this power supply.
	A power fault has occurred: 1. There is no ac power. Check the ac power source. 2. This power supply has failed. Replace the power supply.

AC Input Box

There are no ac input box status indicators. However, if all power supply status LEDs turn Off for a specific power bus, this indication points to an ac input box failure or possibly an ac power source failure.

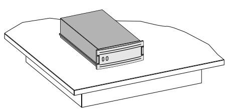
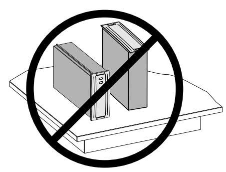
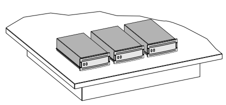
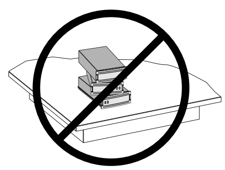
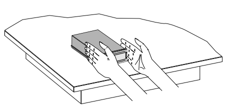
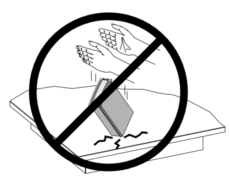
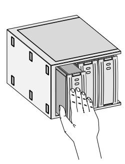
Replacing a Power Supply

This section describes how to properly handle power supply SBBs and the procedures for replacing a power supply.

Handling a Power Supply SBB

Table 6–2 defines the proper methods for handling a power supply SBB to prevent damaging it.

Table 6–2 SBB Handling Rules

Do . . .	Do NOT . . .
Set an SBB on its side.  CXO6549A	Set an SBB on its edge.  CXO6550A
Set SBBs side by side.  CXO6551A	Stack SBBs.  CXO6552A
Set an SBB down gently.  CXO6553A	Drop an SBB.  CXO6554A
Push an SBB into the shelf gently, but firmly.  CXO6555A	Force the SBB into the shelf.  CXO6556A

Procedures for Replacing a Power Supply

The basic procedure for removing and replacing shelf power supplies is the same as for replacing disk drives.

There are two methods for replacing shelf power supplies—the hot swap method and the cold swap method. Use the power supply status LED indication, either operational or nonoperational, to determine which swap method to use.

- The hot swap method is normally used to replace one shelf power supply without removing power from the enclosure.
- The cold swap method is normally used only during initial installation. This method requires making all devices inactive and removing ac power from the UltraSCSI RAID enclosure.

Complete the procedures in Table 6–3 and Table 6–4 to replace a shelf power supply.

Caution

To protect this sensitive electronic device from **electrostatic discharge (ESD)**, use the following precautions:

- Wear an ESD wrist strap.
- Do not touch the printed circuit board or the backplane connector.
- Do not lay the device on a work surface; place it on an electrostatic mat.
- Place the device in an electrostatic bag for shipment.

To prevent ESD damage to a power supply SBB, do not touch the SBB connector.

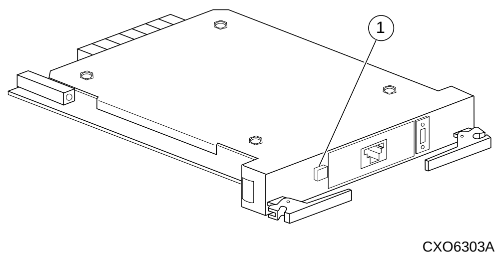
Table 6–3 Removing a Power Supply

1.	To perform a hot swap, go to step 9.
2.	To perform a cold swap, continue with step 3.
3.	Clear the cache module and shut down the array controller per the array controller documentation.

Table 6–3 Removing a Power Supply (Continued)

4. If there are no expansion enclosures, go to step 5.

   If there are expansion enclosures, press and hold the PVA standby power switch (CALLOUT 1) on an expansion enclosure until the master EMU initiates a power shut down on all enclosures.

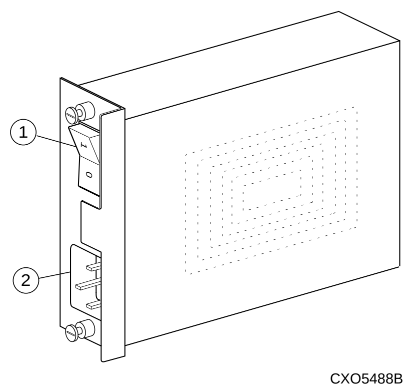


5. Press and hold the PVA standby power switch (CALLOUT 1) on the master enclosure until the master EMU initiates a power shut down on the master enclosure.

6. If there are no expansion enclosures, go to step 7.

   If there are expansion enclosures, turn OFF all the ac input boxes for each expansion enclosure by pressing **O** on each ac power switch (CALLOUT 1).

7. Turn OFF all the ac input boxes for the master enclosure by pressing **O** on each ac power switch (CALLOUT 1).



8. Disconnect the power cord from the front of the power supply.

Table 6–3 Removing a Power Supply (Continued)

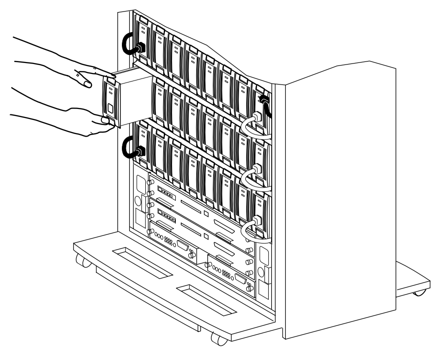
9. Press the two mounting tabs together to release the power supply from the shelf. Using both hands, pull the power supply out of the shelf.	 CXO-4314A-MC
10. Place the power supply into an electrostatic bag.	
11. Lay the power supply on its side on a flat surface.	

Table 6–4 Installing a Power Supply

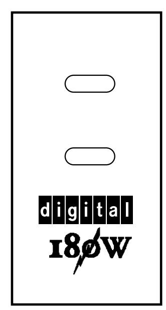
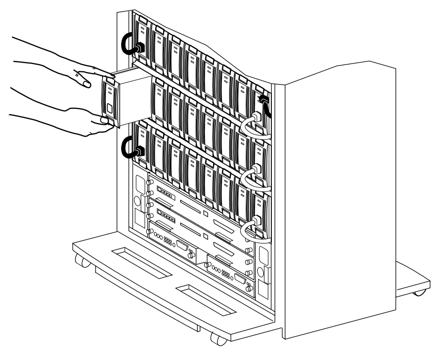
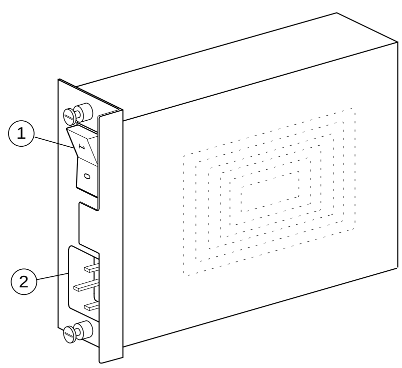
1. Check the bezel label to verify that the power supply being installed is a 180 W power supply.	 CXO5926A
2. Lay the power supply on its side on a flat surface.	

Table 6–4 Installing a Power Supply (Continued)

<table>
<tr><td>3.</td><td>Insert the power supply into the guide slots and push it in until the bezel mounting tabs engage the shelf, fully seating the power supply.

CXO-4314A-MC</td></tr>
<tr><td>4.</td><td>Connect the power cord to the power supply.</td></tr>
<tr><td>5.</td><td>For a cold swap method, go to step 6 to turn ON the subsystem.</td></tr>
<tr><td>6.</td><td>If there are no expansion enclosures, go to step 7.
If there are expansion enclosures, turn ON all the ac input boxes for each expansion enclosure by pressing I on each ac power switch (CALLOUT 1).</td></tr>
<tr><td>7.</td><td>On the master enclosure, turn ON all the ac input boxes by pressing I on each ac power switch (CALLOUT 1).


CXO5488B</td></tr>
<tr><td>8.</td><td>Verify the array controller places the subsystem into an operational state.</td></tr>
<tr><td>9.</td><td>Verify that both power supply status LEDs are ON.</td></tr>
</table>

Replacing an AC Input Box

Complete the procedure in Table 6–5 to remove an ac input box.
Complete the procedure in Table 6–6 to install an ac input box.

WARNING!

Only qualified service personnel can replace an ac input box.

To prevent the possibility of injury or death as a result of electrical shock:

- **Always disconnect the ac power cord before removing an ac input box.**
- **Never touch the backplane connector or circuit board.**
- **Always install the ac input box before connecting the ac power cord.**

Table 6–5 Removing an AC Input Box

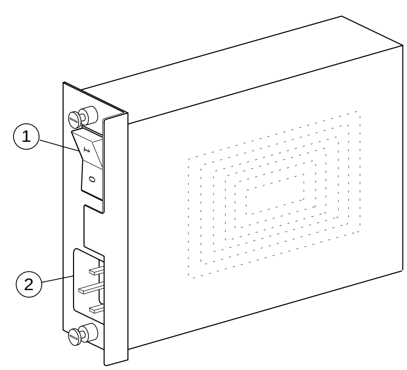
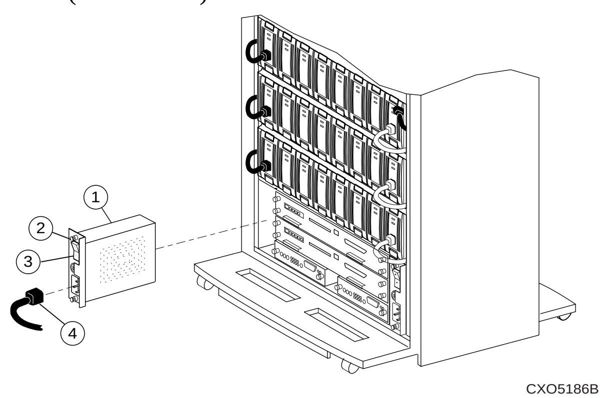
1.	For redundant and optimum (n+4) power configurations, verify that all eight power supplies are operational and then go to step 3.
2.	For a standard (n+1) power configuration, clear the cache module and shut down the array controller per the array controller documentation.
3.	Turn OFF the ac input box being replaced by pressing the **O** on the ac power switch (CALLOUT 1). 

Table 6–5 Removing an AC Input Box (Continued)

4. Disconnect the ac power cord (CALLOUT 4) from the ac input box (CALLOUT 1).
5. Loosen the two retaining screws (CALLOUT 2) and remove the ac input box (CALLOUT 1).



6. Place the ac input box into an electrostatic bag.

Table 6–6 Installing an AC Input Box

1. Verify that the ac input box being installed is a model DS–BA35X–HE.
2. On the ac input box being installed, press **O** on the ac power switch (CALLOUT 1).

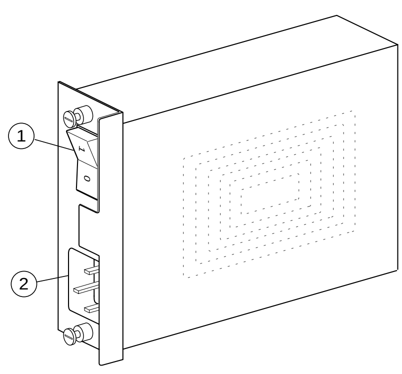
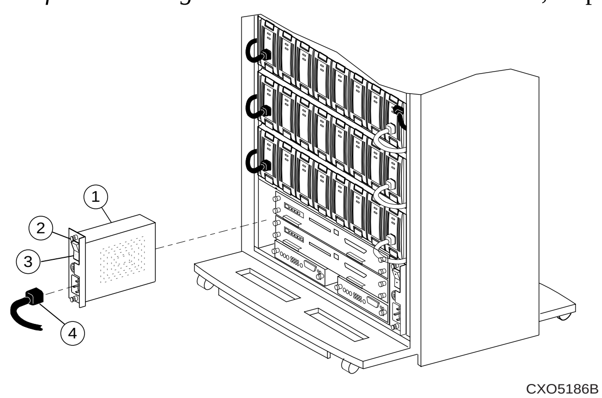
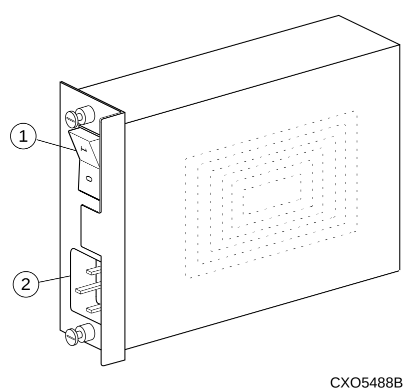


Table 6–6 Installing an AC Input Box (Continued)

3. Align the ac input box (CALLOUT 1) with either slot A or slot B in the lower *left* or lower *right corner* of the RAID enclosure, respectively.



4. Push in on the ac input box to fully seat it.
5. Tighten the two retaining screws (CALLOUT 2).
6. Connect the ac power cord (CALLOUT 4) from the ac power source to the ac input box (CALLOUT 1).
7. If necessary, repeat steps 1 through 6 to install a second ac input box.
8. Turn ON each ac input box by pressing the **I** on the ac power switch (CALLOUT 1).



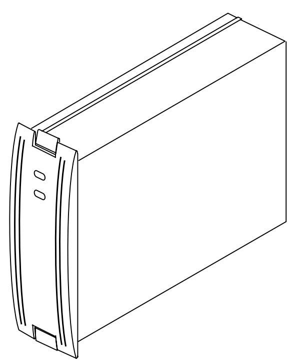
9. Verify that all power supply status LEDs turn ON.

7

Storage Devices

This chapter describes the procedures for handling, addressing, identifying, and replacing disk drive SBBs (see Figure 7–1) in an UltraSCSI RAID enclosure. Error conditions and the associated LED displays are also described.

Figure 7–1 Typical Disk Drive SBB



CXO-4562A-MC

Caution

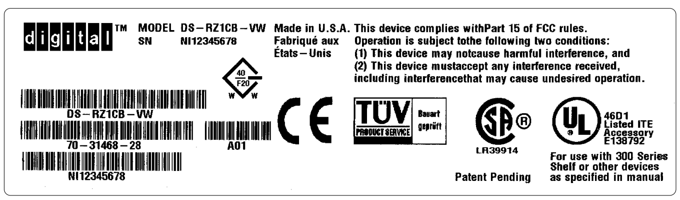
The DIGITAL UltraSCSI RAID enclosure supports 3.5-inch disk drive SBBs. This enclosure *does not support* tape drives, solid state disks, optical disk drives, CD-ROMs, or 5.25-inch devices.

For a list of supported devices, refer to the operating system-specific release notes.

Identifying a Storage Device

To determine the model number of a storage device (disk drive SBB), look at the regulatory label (see Figure 7–2) on the side of the SBB or at the disk drive SBB bezel label.

Figure 7–2 Typical Drive SBB Regulatory Label



CXO5916A

A typical drive SBB bezel label (see Figure 7–3) includes the following device information:

- Device type
- SCSI bus type
- User-defined information, such as:
  - LUN # (logical unit number)
  - ID # (device ID)
  - CH # (**channel** number)

Figure 7–3 Typical Drive SBB Bezel Label

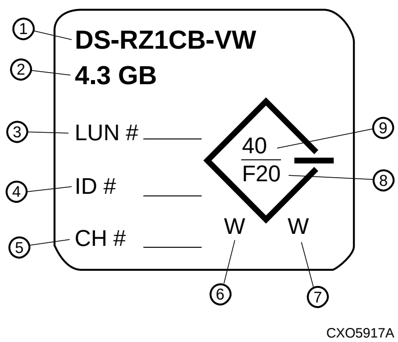


Figure CALLOUTS

1. Device model number
2. Device storage capacity
3. User-assigned SCSI LUN
4. User-assigned SCSI identification number (**target ID**)
5. User-assigned array controller channel number—the array controller port or SCSI bus number
6. SCSI bus device width:

   N — an 8-bit device (narrow)

   W — a 16-bit device (wide)
7. StorageWorks shelf type (wide or narrow) compatibility:

   N — device is 8-bit shelf compatible (narrow)
   W — device is 16-bit shelf compatible (wide)
   N/W — device is 8- and 16-bit shelf compatible
8. Bus speed expressed in *megabits* per second (Mb/s):

   S — Slow device. For example: S5 = 5 Mb/s

   F — Fast device. For example: F10 = 10 Mb/s or F20 = 20 Mb/s
9. Maximum rate at which this device transfers data—expressed in *megabytes* per second (MB/s)

Disk Drive SBB Device Addressing

Determining the disk drive SBB device address is a function of the following:

- PVA SCSI ID switch setting (0, 2, or 3)
- Shelf number containing the disk drive SBB

Disk Drive SBB Status Reporting

The array controller monitors the status of the disk drive SBBs. If a fault occurs, the fault and the disk drive SBB device address (SCSI target ID) are reported to the array controller or host for processing. The disk drive status LEDs define the status of individual disk drive SBBs.

Each disk drive SBB has two LED indicators (see Figure 7–4) that display the SBBs status. These LEDs have three states: ON, OFF, and FLASHING.

Figure 7–4 Disk Drive Status LEDs

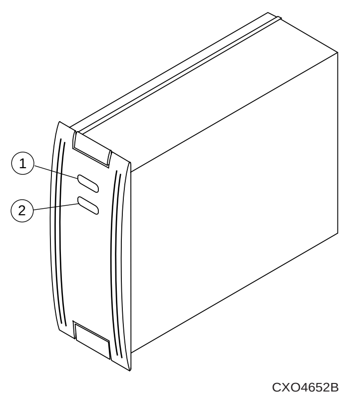


Figure CALLOUTS

1. Device activity LED
2. Device fault LED

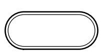
- The green device activity LED (CALLOUT 1) is ON or FLASHING when the disk drive SBB is active.
- The amber device fault LED (CALLOUT 2) indicates an error condition when it is either ON or FLASHING. The array controller controls this LED. The device fault LED also FLASHES when the array controller issues a “locate” command.

Caution

Removing a disk drive SBB when the upper LED is ON or FLASHING might compromise data integrity.

LED is ON

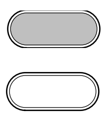
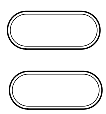
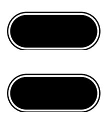
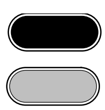
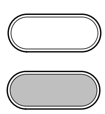
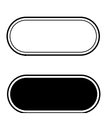
LED is FLASHING



LED is OFF

See Table 7–1 for definitions of the LED displays.

Table 7–1 Disk Drive Status LED Displays

LED Display	Description and Possible Corrective Actions
	The disk drive SBB is operating properly.
	The disk drive SBB is operating normally. The unit is inactive and no fault is present.
	The disk drive SBB is probably not responding to control signals. DIGITAL recommends replacing this storage SBB.
	The disk drive SBB is active and in **spin-down** status because of a fault. DIGITAL recommends replacing the disk drive SBB after the device has spun down.
	Two conditions are possible: 1. In response to a fault bus message, the array controller is spinning down the device. DIGITAL recommends replacing the disk drive SBB after the device has spun down. 2. A signaling response to a user initiated array controller “locate” command.
	The disk drive SBB is inactive and spun down. Replace the disk drive SBB.

Guidelines for Replacing a Disk Drive SBB

This section describes the SBB connector and items to consider when replacing a disk drive SBB.

The SBB Connector

The StorageWorks SBB connectors ensure that the disk drive SBBs operate reliably, even when replaced many times.

The disk drive SBB has a 96-pin receptacle DIN connector that provides positive mating with the SBB enclosure plug connectors. This connector is designed to ensure that dc power is present:

1. *Before* the SCSI bus connection is made.
2. *After* the SCSI bus connection is broken.

This feature protects the integrity of the SCSI data bus and avoids introducing noise on the bus that could either distort data or cause the bus to “hang.”

The SBB connector is a simple, highly reliable mechanism that supports 200 SBB replacement cycles. A replacement cycle consists of removing and replacing an SBB. Over the active product life of 5 years, this is the equivalent of 40 replacement cycles per year, or approximately 1 cycle every 9 days. The replacement cycle limit applies equally to enclosure connectors and **device connectors**.

Replacing an SBB more often than the recommended cycle causes the gold contact coating to wear away and destroy the integrity of the connection. This product does not support environments that require a greater number of replacement cycles, because this is considered improper treatment or use (paragraph 9.4b of *U.S. Standard Terms and Conditions*). Products or connectors damaged due to a higher number of replacement cycles are not eligible for return under warranty or standard service plans. DIGITAL markets a specific family of removable storage elements for higher replacement cycle environments. Contact your DIGITAL Account Representative for more information.

Prerequisites for Replacing a Disk Drive SBB

Replacing a disk drive SBB is a relatively simple procedure. However, there are several things to consider.

When an array controller initializes a storage device, it establishes the device's physical location, the device address, and the LUN. Physically moving the device causes the bus to become erratic.

Use the disk drive SBB bezel label to identify the device model, LUN, device address, array controller bus, and other device specific characteristics.

Caution

To protect this sensitive electronic device from ESD, use the following precautions:

- Wear an ESD wrist strap.
- Do not touch the printed circuit board or the backplane connector.
- Do not lay the device on a work surface; place it on an electrostatic mat.
- Place the device in an electrostatic bag for shipment.

Disk Drive SBB Replacement Methods

There are three methods for replacing disk drive SBBs: hot swap, **warm swap**, and cold swap. Before replacing a device, determine the appropriate replacement method based upon the capabilities of the array controller.

Caution

The methods for replacing DIGITAL array controllers and cache modules are device dependent. Refer to the array controller documentation or release notes for detailed instructions.

Hot Swap

When performing a hot swap, power and data are present on the disk drive SBB backplane connector.

Caution

Although the HSZ70 series array controllers support hot swap, other controllers do not. Refer to the array controller documentation to determine which array controller-supported swap method to use.

If you are not *positive* that your SCSI controller supports hot swap, DIGITAL recommends using warm swap to protect data integrity.

Use hot swap to remove and replace disk drive SBBs from a system that is online and active.

Warm Swap

When performing a warm swap, power is present on the disk drive SBB plug connector and there is no data on the bus. *Before* performing a warm swap, **quiesce** the bus at the array controller and observe the green activity status LED on the disk drive SBB to ensure that *it is not* FLASHING.

Caution

Perform a warm swap only when the green device activity LED is OFF.

Cold Swap

When performing a cold swap, neither power nor data is present on the disk drive SBB plug connector. This requires turning OFF the enclosure power in all the UltraSCSI RAID subsystem enclosures.

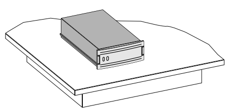
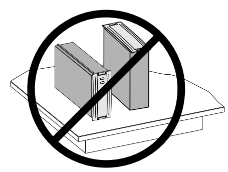
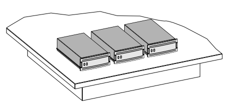
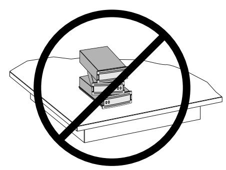
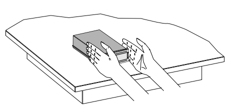
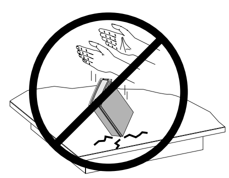
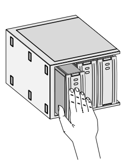
Replacing a Disk Drive SBB

This section describes how to properly handle disk drive SBBs and the procedures for replacing a disk drive SBB.

Handling a Disk Drive SBB

Table 7–2 defines the proper methods for handling a disk drive SBB to prevent damage.

Table 7–2 SBB Handling Rules

Do . . .	Do NOT . . .
Set an SBB on its side.  CXO6549A	Set an SBB on its edge.  CXO6550A
Set SBBs side by side.  CXO6551A	Stack SBBs.  CXO6552A
Set an SBB down gently.  CXO6553A	Drop an SBB.  CXO6554A
Push an SBB into the shelf gently, but firmly.  CXO6555A	Force the SBB into the shelf.  CXO6556A

Procedures for Replacing a Disk Drive SBB

Complete the procedure in Table 7–3 to remove a disk drive SBB. When initially installing disk drive SBBs in an enclosure or installing a single disk drive SBB, complete the procedure in Table 7–4.

Table 7–3 Removing a Disk Drive SBB

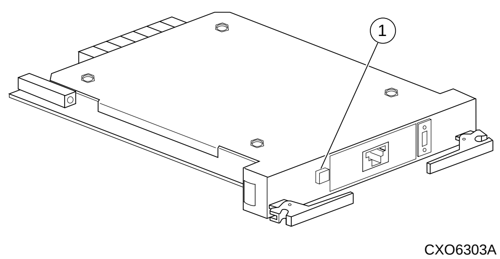
1.	To perform a hot swap, go to step 8.
2.	To perform a warm swap, quiesce the SCSI bus using array controller documentation, then go to step 8.
3.	To perform a cold swap, shut down the subsystem using array controller documentation.
4.	If there are no expansion enclosures, go to step 5. If there are expansion enclosures, press and hold the PVA standby power switch (CALLOUT 1) on an expansion enclosure until the master EMU initiates a power shut down on all enclosures. 
5.	Press and hold the PVA standby power switch (CALLOUT 1) on the master enclosure until the master EMU initiates a power shut down on the master enclosure.

Table 7–3 Removing a Disk Drive SBB (Continued)

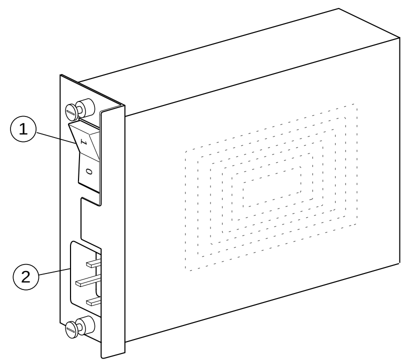
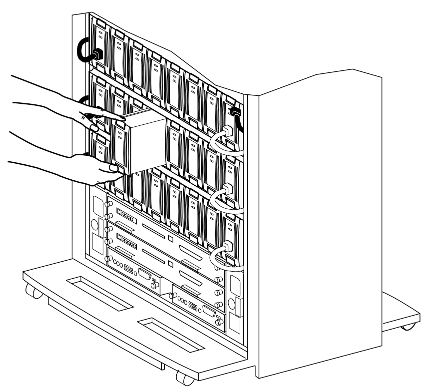
6. If there are no expansion enclosures, go to step 7. If there are expansion enclosures, turn OFF all the ac input boxes for each expansion enclosure by pressing **O** on each ac power switch (CALLOUT 1). 7. Turn OFF all the ac input boxes for the master enclosure by pressing **O** on each ac power switch (CALLOUT 1).	 CXO5488B
8. Press the disk drive SBB mounting tabs together to release the SBB.	
9. Use both hands and pull the disk drive SBB out of the shelf.	 CXO-5338A-MC
10. Place the disk drive SBB into an electrostatic bag.	

Table 7–4 Installing a Disk Drive SBB

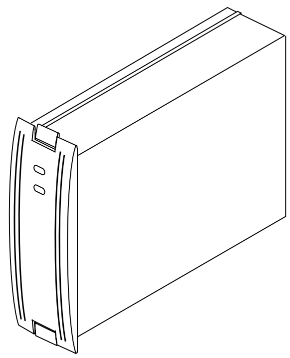
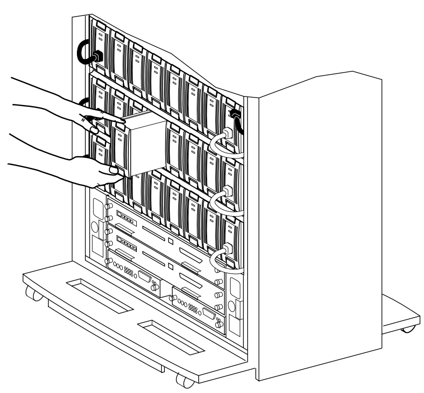
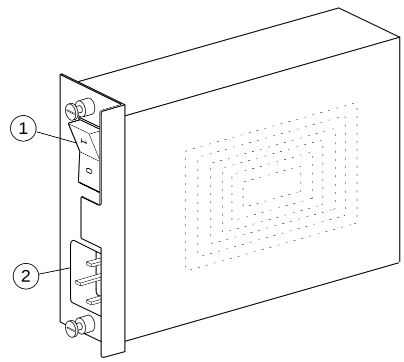
1. Verify that the disk drive SBB is the correct model and fill in bezel label information for this disk drive.	 CXO-4562A-MC
2. If assembling an UltraSCSI enclosure, go to step 8.	
3. For a hot or warm swap, insert the disk drive SBB into the guide slot and push it in until the mounting tabs engage the shelf, fully seating the disk drive SBB. 4. After installing the disk drive SBB during a hot swap, go to step 14.	 CXO-5338A-MC
5. If performing a warm swap, refer to array controller documentation to restart the subsystem, then go to step 14.	

Table 7–4 Installing a Disk Drive SBB (Continued)

6. If performing a cold swap, determine if there are expansion enclosures. If there are no expansion enclosures, go to step 7.

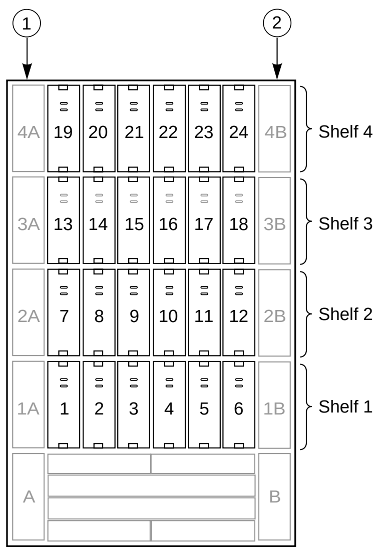
   If there are expansion enclosures, turn OFF all the ac input boxes for each expansion enclosure by pressing **O** on each ac power switch (CALLOUT 1).

7. On the master enclosure, turn OFF all the ac input boxes by pressing **O** on each ac power switch (CALLOUT 1) and then go to step 14.



CXO5488B

8. Install all the disk drive SBB devices, starting in the lower left corner in shelf 1 (devices 1 through 6) and advancing to the right.

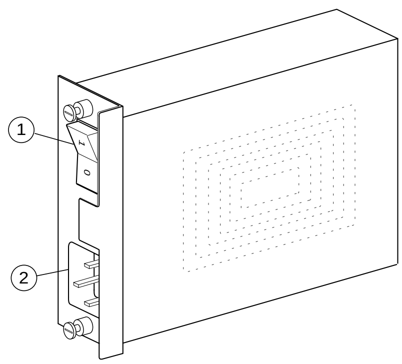


CXO5811B

9. Starting from the left, install all the disk drive SBB devices in shelf 2 (devices 7 through 12).

10. Starting from the left, install all the disk drive SBB devices in shelf 3 (devices 13 through 18).

Table 7–4 Installing a Disk Drive SBB (Continued)

11. Starting at the left end, install all the disk drive SBB devices in shelf 4 (devices 19 through 24).
12. If performing a cold swap, determine if there are expansion enclosures. If there are no expansion enclosures, go to step 13. If there are expansion enclosures, turn ON all the ac input boxes for each expansion enclosure by pressing **I** on each ac power switch (CALLOUT 1). 13. On the master enclosure, turn ON all the ac input boxes by pressing **I** on each ac power switch (CALLOUT 1).  CXO5488B
14. Verify that the amber device fault LED is OFF. **Note** When the SCSI bus is active and the disk drive SBB has power, the green device activity LED is either ON, FLASHING, or OFF. The amber device fault LED is OFF.

8

Enclosure Blowers

Ensuring proper UltraSCSI RAID enclosure operation requires establishing and maintaining the proper operating environment. Meeting the temperature and humidity ranges specified in Appendix A involves using air conditioning to establish and maintain the proper *external*, that is, *ambient*, environment. Failure to achieve these goals might cause components to malfunction and compromise data integrity.

The eight blower assemblies on the rear of the enclosure (see Figure 8–1) are an integral part of the enclosure and ensure that the components remain cool. These blowers are arranged in two banks of four blowers each. Air flow provided by these blowers is sufficient for proper operation of the UltraSCSI subsystem.

Enclosure Blowers

Figure 8–1 Enclosure Blower Assembly Locations

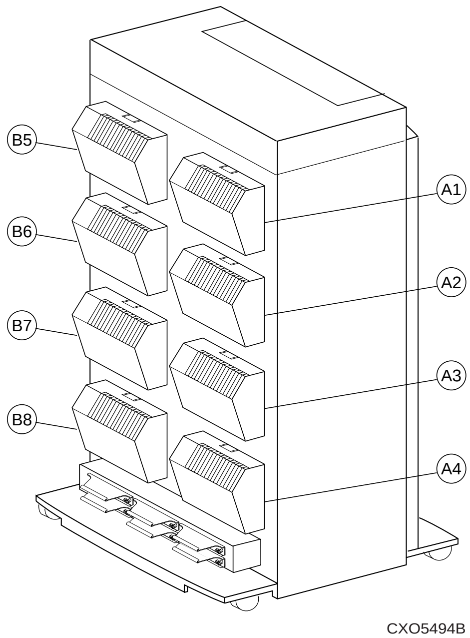


Figure CALLOUTS

Bank A

A1. Blower 1

A2. Blower 2

A3. Blower 3

A4. Blower 4

Bank B

B5. Blower 5

B6. Blower 6

B7. Blower 7

B8. Blower 8

Enclosure temperature sensors (see Chapter 3) detect overtemperature conditions or blower malfunctions and alert the user to the problem. Simultaneously, the EMU causes all operational blowers to operate at high-speed, increasing air flow through the enclosure to increase cooling.

- If an overtemperature condition is caused by either the intake air temperature or exhaust air temperature (backplane) being too high, the EMU initiates routines that can cause a power shut down.
- Removing a blower significantly changes the air flow pattern within the enclosure. The EMU initiates a routine that causes a power shut down to occur after approximately 8 minutes.
- If two or more nonoperating blowers (that is, not operating or rotating too slowly*)* are *in the same blower bank* (see Figure 8–1), the EMU initiates a routine that causes a power shut down to occur after approximately 8 minutes.

- If a blower error condition is caused by *only one defective blower per blower bank* (see Figure 8–1), the EMU does not initiate a power shut down.

Function and Operation

Cooling enclosure components is accomplished by pulling air in through the front of each component, over the internal circuitry, through the backplane, and exhausting it out the rear of the enclosure. The +12 V dc is required for blower operation and is available on each of the backplane blower connectors. Blower status and speed control signals are also on these connectors and are routed to the EMU and PVA.

A blower guide pin ensures connector alignment when installing a blower. A combination of blower connector and mounting tabs provides positive mating of the blower with the blower plenum.

If an error condition involving the blowers, intake air temperature, or exhaust air temperature exists, the EMU can cause all blowers to switch into high-speed, increasing air flow through the enclosure. Conditions that might cause this change in blower speed include:

- Removing a blower
- A blower operating too slowly
- A stalled blower
- The intake (EMU) air temperature is within 4°C (7°F) of the sensor_1 setpoint. For example, if the setpoint is 35°C (95°F), the blowers will switch to high-speed at 31°C (88°F).
- The exhaust (backplane) air temperature is within 4°C (7°F) of the sensor_1 or sensor_2 setpoint. For example, if the setpoint is 35°C (95°F), the blowers will switch to high-speed at 31°C (88°F).

Caution

The only StorageWorks dual-speed blower that is compatible with this UltraSCSI RAID enclosure is model DS–BA35X–MK. *Do not* use the BA35X–MD dual-speed blower as a replacement.

Error Condition Reporting

The EMU LEDs display both blower and overtemperature error conditions. See Chapter 3 for blower error conditions and recommended corrective actions.

Replacing a Blower

When there is a malfunctioning blower, the remaining blowers operate at high-speed to increase air flow through the components—enough air to permit continued operation without corrupting or losing data. However, DIGITAL recommends replacing a defective blower immediately. If a blower is removed and not replaced within approximately 8 minutes, the array controllers will shut down and then the EMU will turn OFF the dc power distribution to protect enclosure components.

Caution

Some array controllers bypass the standby power mode functionality from the PVA standby power switch. Refer to the array controller documentation for availability of this feature.

Complete the procedures in Table 8–1 and Table 8–2 to replace a blower. Blowers are hot swap components.

Caution

Operating an UltraSCSI enclosure with a blower removed significantly changes the air flow pattern and reduces air flow through the components. If a blower is removed and not replaced within approximately 8 minutes, the array controllers will shut down and then the EMU will turn OFF the dc power distribution.

Table 8–1 Removing a Blower

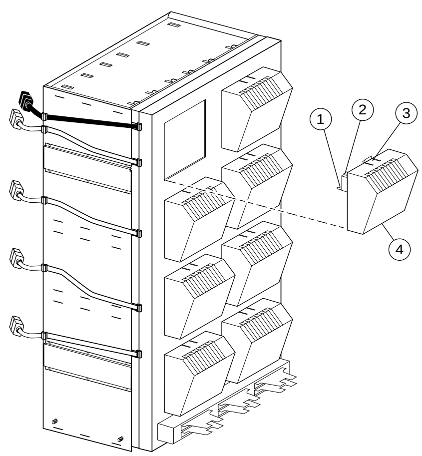
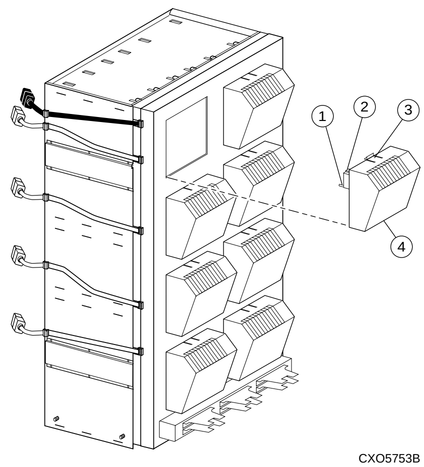
<table>
<tr><td>1.</td><td>Use both hands to firmly press the upper and lower blower mounting tabs (CALLOUTS 3 and 4) together to release the blower.</td><td>
</td></tr>
<tr><td>2.</td><td colspan="2">Pull the defective blower straight out.</td></tr>
<tr><td>3.</td><td colspan="2">Place the blower into an electrostatic bag.</td></tr>
</table>

Table 8–2 Installing a Blower

1.	Verify that the blower is a model DS–BA35X–MK.
2.	Orient the replacement blower to align its connector (CALLOUT 2) and guide pin (CALLOUT 1) with the backplane blower connector. 
3.	Push the blower straight in, until the upper and lower mounting tabs (CALLOUTS 3 and 4) snap into place.
4.	If dc power is applied to the enclosure, verify that the blower starts operating.

Appendix A

UltraSCSI Enclosure Specifications

This appendix defines the physical, electrical, and environmental specifications for a DIGITAL StorageWorks UltraSCSI enclosure with 24 disk drives and all its major electronic components. See Figure A–1 and its associated CALLOUT numbers on the following page.

Figure A–1 UltraSCSI RAID Enclosure Major Components

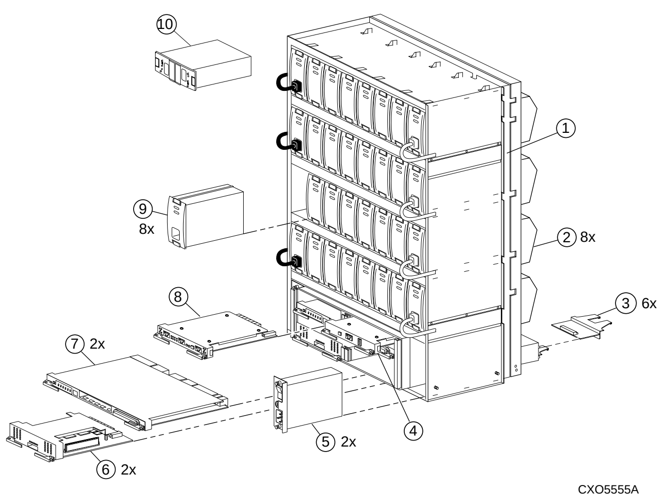


Figure CALLOUTS

1. HA–2450CU enclosure
2. Blowers (8 each)
3. I/O modules (6 each)
4. PVA (1 each)
5. AC input box (2 each)
6. Cache module (2 each)
7. Array controller (2 each)
8. EMU (1 each)
9. 180 W power supply (8 each)
10. ECB (2 each)

Note

The operating and servicing physical specifications as well as the electrical specifications for the UltraSCSI RAID enclosure are cabinet- and configuration-specific.

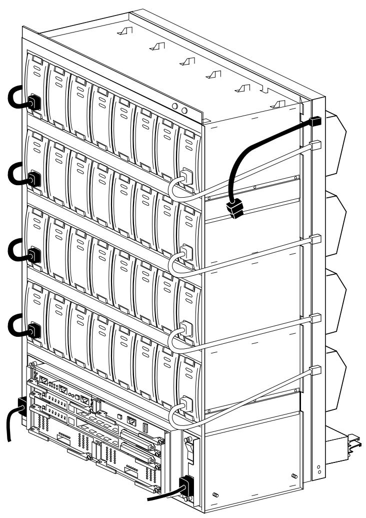
Physical and Electrical Specifications

The following specifications apply to a single UltraSCSI RAID enclosure (see Figure A–2) *with all of the components installed*.

Figure A–2 UltraSCSI Enclosure

Shipping Dimensions

Height	1156 mm (45.5 in)
Width	978 mm (38.5 in)
Depth	737 mm (29 in)
Weight	135 kg (298 lb)



Installed Dimensions

Height	749 mm (29.5 in)
Width	435 mm (17.125 in)
Depth	432 mm (17 in)
Weight	102 kg (225 lb)

Heat Dissipation

3070 BTUs/hr

Power

110–240 V ac, 50/60 Hz, single phase, 12 A/6 A

Operating Environments

Table A–1, Table A–2, and Table A–3 provide the environmental specifications for the controller shelf.

Table A–1 Optimum Operating Environment

Condition	Specification
Temperature	18–24°C (64–75°F) with an average rate of change of 3°C/h maximum and a step change of 3°C/h or less
Relative humidity	40–60% (noncondensing) with a step change of 10% or less (noncondensing)
Altitude	Up to 2400 m (8000 ft)
Air quality	Not to exceed a maximum of 500,000 particles, 0.5 micron or larger, per cubic foot of air
Nominal airflow	50 cubic ft/min
Heat dissipation	3070 BTUs/h

Table A–2 Minimum Operating Environment

Condition	Specification
Temperature	10–40°C (50–104°F) Reduce rating by 1.8°C for each 1000 m altitude (1°F for each 1000 ft of altitude)
Relative humidity	10–85% at a maximum wet bulb temperature of 32°C (90°F) and a minimum dew point of 2°C (36°F)
Altitude	Up to 2400 m (8000 ft)
Air quality	Not to exceed a maximum of 500,000 particles, 0.5 micron or larger, per cubic foot of air
Nominal airflow	40 cubic ft/min
Heat dissipation	3070 BTUs/h

Table A–3 Shipping Environment

Condition	Specification
Temperature	–40°C to +66°C (–40°F to +150°F)
Relative humidity	10–80% noncondensing
Altitude	4900 m (16,000 ft)

SBB Thermal Stabilization

For proper operation upon *initial power application*, maintain the DIGITAL SBB storage device temperature within the range of 18–29°C (65–85°F). See Table A–4 for condition statements.

Caution

Always thermally stabilize a disk drive SBB in the operating environment before installing or operating it. Otherwise, applying power can damage the disk drive.

Table A–4 SBB Thermal Stabilization

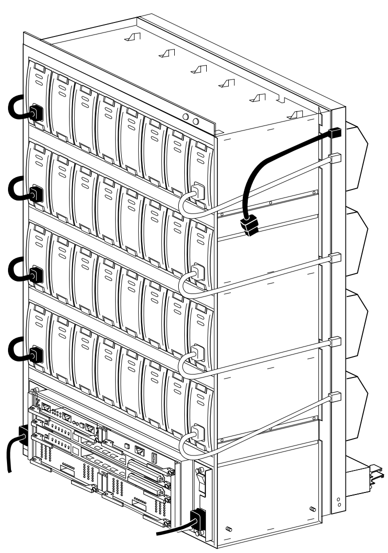
Condition			Then You Must…		
When there is *condensation* on the outside of the SBB…			Thermally stabilize the device and the SBB in the operating environment for 6 hours or until the condensation is no longer visible, whichever is longer. Do not install a storage device until it stabilizes.		
When there is *no condensation* on the outside of the SBB…			Thermally stabilize the device for the amount of time specified in the chart below.		
Storage Temperature Range			**Storage Temperature Range**		
°C	**°F**	**Stabilize for**	**°C**	**°F**	**Stabilize for**
60 to 66	140 to 151	3 hours	0 to 9	32 to 48	1 hour
50 to 59	122 to 138	2 hours	–10 to –1	14 to 30	2 hours
40 to 49	104 to 120	1 hour	–20 to –11	–4 to 12	3 hours
30 to 39	86 to 102	30 minutes	–30 to –21	–22 to –6	4 hours
18 to 29	64 to 84	None	–40 to –31	–40 to –24	5 hours
10 to 17	50 to 63	30 minutes			

Appendix B

Assembling an UltraSCSI RAID Subsystem

Assembling an UltraSCSI RAID subsystem (see Figure B–1) requires sequentially installing the components in a DS–BA370 series rack-mountable enclosure. The UltraSCSI RAID enclosure arrives as either a departmental server cabinet (a pedestal with a factory installed enclosure) or an empty enclosure that requires mounting within a data center cabinet (SW600 series).

Figure B–1 UltraSCSI RAID Subsystem



Installation Sequence

The basic installation sequence is the same for all UltraSCSI RAID subsystems, whether they use one, two, or three DS–BA370 enclosures. To reduce the possibility of multiple interacting problems, the preferred assembly sequence is as follows:

1. Assemble and test the master enclosure.

Note

Prior to power application and testing, a minimum compliment of power components require installation, such as the standard (n+1) configuration (see Chapter 6).

2. Assemble the first expansion enclosure.
3. Connect the first expansion enclosure to the master enclosure and test the subsystem operation.
4. Assemble the second expansion enclosure.
5. Connect the second expansion enclosure to either the master enclosure or the first expansion enclosure and test the subsystem operation.

The assembly procedures for an enclosure are almost identical to those described elsewhere in this publication. Therefore, rather than repeating the procedures, the following sections primarily address special assembly considerations. The recommended sequence for assembling an UltraSCSI RAID enclosure is as follows:

WARNING!

A full enclosure weighs more than 102 kg (225 lb). To prevent personal injury:

- **Always mount an empty enclosure into a cabinet prior to installing devices.**
- **Use at least two people to lift, align, and insert the enclosure into a cabinet.**

1. Mount an empty UltraSCSI RAID enclosure in the data center cabinet using cabinet documentation. Departmental server cabinets arrive prepared for component installation.
2. Install the EMU and the EMU communication cables as required.
3. Install the PVA.
4. Install the disk drive SBBs.
5. Install the I/O modules and UltraSCSI bus cables as required.
6. Install the array controllers and cache modules.
7. Install the ECBs per array controller documentation.
8. Install the power system.
9. Connect subsystem cabling.
10. Configure the subsystem using configuration rules described in Chapter 2.

Installing the EMU

Each UltraSCSI enclosure requires an EMU for proper operation. In an expansion configuration, connect an EMU-EMU communication cable between the master EMU and all expansion EMUs. Complete the following procedure to install an EMU.

Complete the procedure in Table 3–10, steps 1 through 4, to install an EMU.

Installing the PVA

Each UltraSCSI enclosure requires a PVA for proper operation.

Complete the procedure in Table 4–7, steps 1 through 4, to install a PVA.

Installing the Disk Drive SBBs

Install the disk drive SBBs sequentially in the UltraSCSI enclosure using the procedure in Table 7–4, steps 1, 2, and 8 through 11.

Installing the I/O Modules and Expansion Cables

Six single-ended I/O modules (DS–BA35X–MN) mount on the lower rear enclosure shroud (see CALLOUT 1 in Figure B–2). Expansion cables attach to these I/O modules for an expanded subsystem, connecting one or two additional enclosures to the master enclosure.

Figure B–2 I/O Module Locations

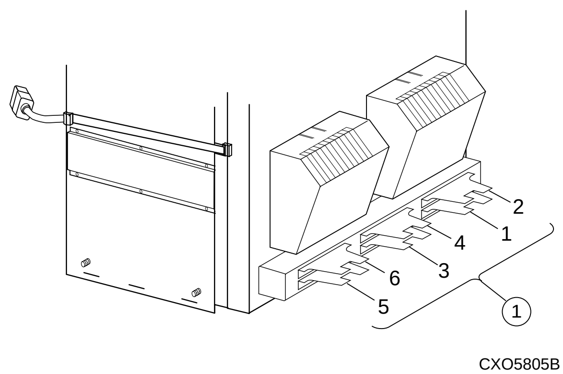


Figure CALLOUT

1. SCSI bus ports (1–6) for I/O modules (1–6), respectively

For a single enclosure subsystem, complete the procedures in Table 5–10 to install I/O modules in the enclosure.

Caution

Not all array controllers support more than one enclosure. Refer to the array controller documentation to verify that it supports more than one enclosure.

In an expanded subsystem, refer to Table 5–3 for preliminary cabling procedures. Then, complete the procedures in Table 5–6 to install a two-enclosure subsystem or Table 5–8 to install a three-enclosure subsystem.

Installing Array Controllers and Cache Modules

The master enclosure contains the array controllers and cache modules. ECBs cannot be installed within the enclosure. In a departmental server cabinet, install the ECBs in the top cover. In a data center cabinet (SW600 series), install the ECBs within an ECB shelf mounted inside the cabinet.

Caution

Two sets of array controllers and cache modules can be installed within an UltraSCSI RAID subsystem. By default, the enclosure that contains these components becomes the master enclosure and must always use PVA address 0.

Note

For detailed array controller, cache module, and ECB installation procedures and cabling, refer to the array controller documentation.

Figure B–3 identifies where the two controllers and two cache modules are located.

Figure B–3 Array Controller and Cache Module Locations

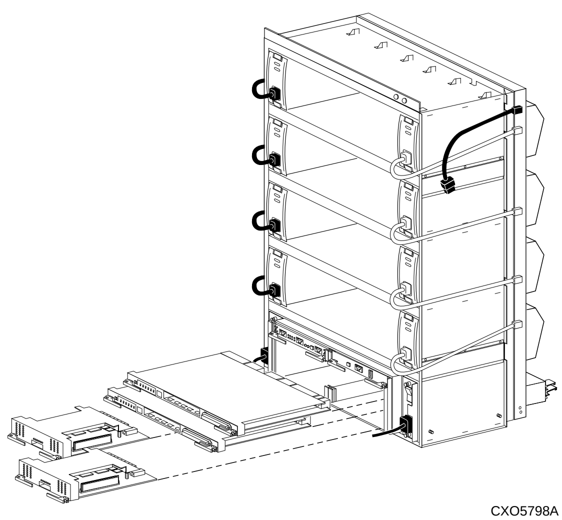


Table B–1 describes the mechanical procedures for installing array controllers and cache modules. Following installation, configure the subsystem using procedures contained in the following publications:

- Array controller documentation
- Operating system-specific release notes

Note

For single array controller and cache set configurations, Controller A must be configured with Cache A or Controller B must be configured with Cache B.

Table B–1 Installing Array Controllers and Cache Modules

1.	Align the array controller with the Controller A slot (CALLOUT 3) in the enclosure.

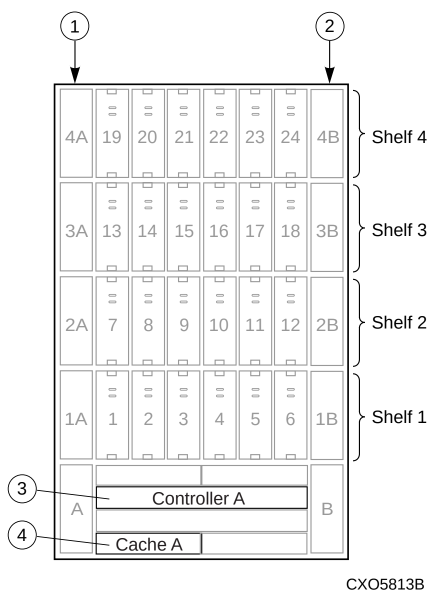
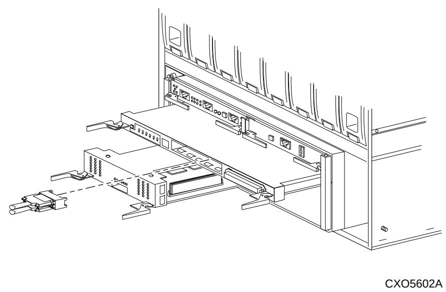


Table B–1 Installing Array Controllers and Cache Modules (Continued)

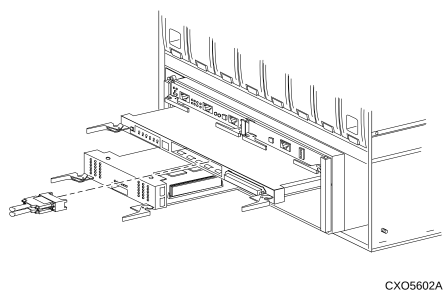
2. Insert the array controller into the Controller A slot and push it in until the extractor latches engage the enclosure.



3. Simultaneously push in both extractor latches to firmly seat the array controller.

4. Align the cache module with the Cache A slot (CALLOUT 4 in step 1) in the enclosure.

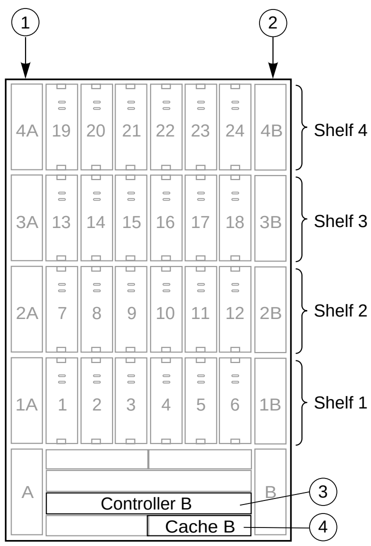
5. Insert the cache module into the Cache A slot and push it in until the extractor latches engage the enclosure.



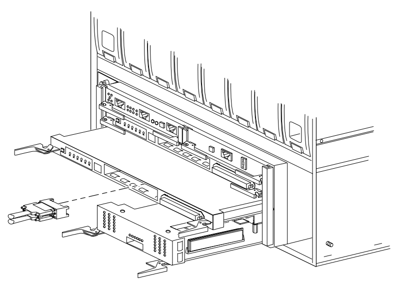
6. Simultaneously push in both extractor latches to firmly seat the cache module.

Table B–1 Installing Array Controllers and Cache Modules (Continued)

7. If a second array controller and cache module set is required, repeat steps 2 through 7 using Controller B and Cache B slots (CALLOUTS 3 and 4) shown below.



CXO5812B

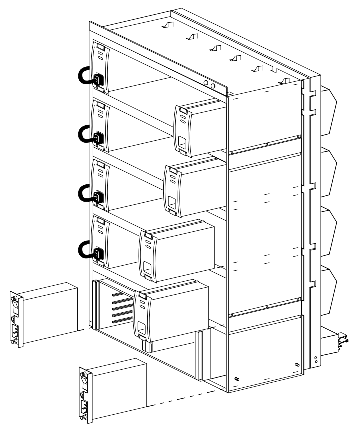


CXO5603A

Installing the Power System

The ac input boxes and shelf power supplies comprise the enclosure power system (see Figure B–4).

Figure B–4 Enclosure Power System



Caution

To protect this sensitive electronic device from ESD, use the following precautions:

- Wear an ESD wrist strap.
- Do not touch the printed circuit board or the backplane connector.
- Do not lay the device on a work surface; place it on an electrostatic mat.
- Place the device in an electrostatic bag for shipment.

To prevent ESD damage to a power supply SBB, do not touch the SBB connector.

The sequence for installing the power system is as follows:

1. Install the shelf power supplies using Table 6–4, steps 1 through 4.
2. Install the ac input boxes using Table 6–6, steps 1 through 7.

Connecting Subsystem Cables

Cabinet user documentation describes the cable routing, location, and function. The cables involved might include:

- Controller-to-controller
- Controller-to-host
- ECB-to-cache module

For a detailed description of the cable connection procedures and cable routing, refer to the following publications:

- Array controller documentation
- *DIGITAL StorageWorks UltraSCSI RAID Cabinet Subsystem (DS–SW600 Series) Installation and User's Guide*
- Pedestal documentation

Configuring the Subsystem

Refer to Chapter 2 for configuring the subsystem. Apply configuration rules that pertain to the UltraSCSI subsystem being assembled.

Turn ON the subsystem using Table 2–2.

Appendix C

Installing EMU Microcode

The microcode resident in the EMU memory controls all the UltraSCSI RAID enclosure (DS–BA370 series) EMU operations. Proper operation of the subsystem requires that all EMUs have the same revision level microcode. Upon system startup, the master EMU polls the expansion EMUs to ensure that they have the correct microcode. When microcodes are a different revision level, the master EMU automatically downloads the latest microcode revision over the EMU communications bus.

Microcode Upgrades

Microcode upgrades can be downloaded from a personal computer (PC) to the master EMU. To download the microcode, the PC is connected to the center UART connector and a communications program, such as PROCOMM PLUS®, is used.

Note

If PROCOMM PLUS is not used, the prompts, displays, and responses might be different from those presented in this document. Refer to the communications program user documentation for the proper procedures and results.

Prerequisites

The following items are required to upgrade the EMU microcode using the EMU UART connector:

- EMU microcode file (for example, FLSH_011.HEX)
- PC
- Communications program, such as PROCOMM PLUS
- DIGITAL adapter cable, part number 17–04697–01, with the following connectors:
  - — 9-pin RS232
  - — 8-pin RJ45

Preliminary Procedure

Complete the procedure in Table C–1 prior to starting the installation procedure.

Table C–1 Preliminary Procedures

1.	Shut down the software for each controller and eject its personal computer memory card industry association (PCMCIA) card.
2.	Connect the 9-pin RS232 connector to a PC COM port connector.
3.	Connect the 8-pin RJ45 connector to the master EMU center UART connector.
4.	Configure the communications software parameters as follows: **Parameter** — **Value** Baud rate — 38,400 Baud Data bits — 8 Parity — None Stop bits — 1 Protocol — Raw ASCII CR/LR conversion — None XON/XOFF — None Connection — Direct (no modem) Flow control — None

Table C–1 Preliminary Procedures (Continued)

5.	Use the PROCOMM PLUS Setup Utility to establish the following parameters for modem and protocol options: **Modem Options** **General Options** Auto baud detect — OFF Send init if CD high — NO **Protocol Options** **General Options** Abort xfer if CD lost — NO **ASCII Protocol Options** Character pacing (millisec) — 0 Line pacing (1/10 second) — 0 Pace character — 0 Strip 8th bit — NO CR translation (upload) — NONE LF translation (upload) — NONE
6.	Insert the microcode disk into the disk drive. Copy the EMU microcode file into a PC directory (for example, C:\FLSH_011.HEX).
7.	Start the communications program.

Preparing the EMU

Complete the procedure in Table C–2 to prepare the EMU for loading the microcode.

Table C–2 Preparing the EMU

1.	On the master enclosure, press and hold-in the alarm control switch while removing the EMU from the enclosure. The PVA audible alarm sounds, indicating that there is no EMU in the enclosure, and continues to sound until the EMU is reinserted.
2.	While still holding-in alarm control switch, insert the EMU into the enclosure and firmly seat it. The PVA audible alarm turns OFF. The temperature (amber), power (green), and eight blower (amber) LEDs will be ON.
3.	Continue holding in the alarm control switch until: • The blower LEDs are OFF. • The PC monitor displays the following message: `Waiting for receiver ready`
4.	Release the alarm control switch.

Loading the Microcode

From the PC, initiate the upload function by completing the procedure in Table C–3.

Table C–3 Loading the Microcode

1.	When using PROCOMM PLUS, press the `Send File Key`.
2.	Select `Raw ASCII` from the protocol list.
3.	Enter the microcode path and filename (for example, C:\FLSH_011.HEX).
4.	When the EMU microcode download starts, all blower LEDs are ON and the PC displays a series of messages *similar* to those shown in Table C–4.

Table C–4 Typical PC Monitor Display

Display Text	Comments
`SW 370 EMU (ROM) Version V01.02` `Copyright © 1997, Digital Equipment Corporation`	EMU successfully completed boot.

`+++ Attempting to load FLASH image from UART +++`
`Download Parameters`
`  Raw ASCII, 38400 Baud, 8 data bits, no stop bits`
	Communications program parameters.

`Waiting for receiver ready`	All the EMU blower LEDs are ON. Ready to start transfer.
No visible activity for 30 to 60 seconds	
`+++ Loaded image copied to Upper FLASH +++`	Communications program has uploaded microcode to EMU.
`+++ Copying Upper FLASH image to Lower FLASH +++`	EMU transferring new microcode.
`+++ Lower FLASH is valid +++` `+++ Upper FLASH is valid +++`	New microcode verification complete.

`SW370 EMU (Flash) Version 1.1`
`SW370 EMU Protocol Version 1.0`
`Copyright © 1997, Digital Equipment Corporation`
`EMU Hardware Rev 0`
	EMU initializing.

`This is CAB 000`
`Bus 0 or 1 I/O mod changed, old 0000, new 0002`
`Bus 2 or 3 I/O mod changed, old 0000, new 0002`
`Bus 4 or 5 I/O mod changed, old 0000, new 0002`
`Power OK changed, old 0000, new 0002`
`Error sum changed, old 0000, new 0002`
`SubStat 0 changed, old 0000, new 0002`
`Supplies present change, old 0000, new 0002`
`All B fans present`
`All A fans present`
`Fan OK changed, old 0000, new 0002`
`Err sum changed, old 0000, new 0002`
`Power OK changed, old 0000, new 0002`
`Power OK changed, old 0000, new 0002`
	Sample EMU status report.

Restarting the Controller

Complete the procedure in Table C–5 to restart the controller after the microcode upgrade is loaded.

Table C–5 Restarting the Controller

1.	Remove the 8-pin RJ45 connector from the EMU UART connector.
2.	On each controller, press and hold-in the reset button and reseat its PCMCIA card.
3.	Release the reset button.
4.	Verify that each array controller reinitializes.

Glossary

This glossary defines terms pertaining to the DS-BA370 series UltraSCSI RAID enclosure. It is not a comprehensive glossary for all DIGITAL StorageWorks products.

ac distribution

The method of distributing ac power within a StorageWorks shelf, enclosure, or cabinet.

ac input box

A device that receives ac power from the PDU and distributes the ac power to all shelf power supplies connected to the ac input box power bus.

ac power controller

See **ac input box**.

active

The disk drive SBB is spinning up, or down, or transferring data to or from the array controller.

adapter

See **SCSI bus signal converter**.

Glossary

ambient air temperature

The temperature of the air surrounding the cabinet, enclosure, shelf, or SBB that dissipates the heat generated by the device.

See also **intake air temperature**.

array controller

See **controller**.

backplane

The electronic printed circuit board mounted in the rear of the shelf. This board contains the disk drive SBB, power supply, and **terminator connectors**.

blowers

An airflow device mounted in a StorageWorks shelf.

bus expander

Devices that couple bus segments together without any impact on the SCSI protocol, or the software. These devices include both single-ended to differential and single-ended to single-ended bus extenders. The term expander is a general term that includes “extender,” “repeater,” and “isolator.”

bus extender

See **bus expander**.

bus segment

A SCSI bus segment consists of all the conductors and connectors required to attain signal line continuity between every driver, receiver, and two terminators for each signal. It is not necessary that a SCSI bus segment contain any **initiators** or targets, but it must have at least two devices attached. (Drivers and receivers can be part of extenders as well as part initiators and targets.)

Bus segments can be either single-ended or differential. The terminator properties determine the bus segment type. Devices that do not have the same transceiver type as the terminators cannot operate in the segment defined by the terminators.

Caution

The device transceiver type (single-ended or differential) must match the bus segment type. Devices that do not meet this condition cannot operate.

The allowed length of a bus segment depends on the electrical loading, transmission media type, and data transfer rate. In many cases, heavier loading, smaller wires, and higher speeds demand shorter lengths. Increasing the number of devices on a given length of the bus, by using longer stubs or higher capacitance devices, produces loading.

cabinet

See **data center cabinet** and **departmental server cabinet**.

cache module

A fast storage buffer.

Callout *n*

A textual reference to a numbered callout in a figure.

CE–Mark

A European Economic Community (EEC) certification label that identifies electronic devices authorized for sale within member nations.

CE–Mark Class A

Similar to, but more stringent than the **FCC Class A** certification, this certification label appears on electronic devices that are for use in a commercial environment. A CE–Mark **certified device** can also be used in the United States.

CE–Mark Class B

Similar to, but more stringent than the **FCC Class B** certification, this certification label appears on electronic devices that are for use in either a home or a commercial environment. A CE–Mark certified device can also be used in the United States.

certified device

A storage device tested in a specific configuration and found to be in compliance with either an FCC or a CE certification standard. DIGITAL certifies these devices to operate in a specific shelf, enclosure, or cabinet.

channel

Another term for a SCSI bus.

CLI

Command line interpreter. The operator interface to HSx series array controller software.

cold swap

A method of device replacement that requires that power be removed from one or more shelves in a cabinet thereby affecting other devices. Use this method during initial installation or StorageWorks subsystem upgrades, or when conditions preclude using either the “warm swap” or “hot swap” method.

See also **warm swap** and **hot swap**.

command line interpreter

See **CLI**.

connector

Any connector that is physically part of a cable assembly attached to backplanes or other nondevice connectors.

controller

(1) A hardware-software device that manages communications on behalf of host systems over the SCSI bus to devices. Controllers typically differ by the type of interface to the host and provide functions beyond those the devices support. (2) A standalone device that connects a host adapter to the storage SCSI bus. This device provides RAID functionality, typically has multiple SCSI bus ports, performs the lower layers of the SCSI protocol, and normally operates in the initiator role.

See also **array controller** or **SCSI bus controller**.

converter

See **SCSI bus signal converter**.

data center cabinet

The largest of the StorageWorks cabinets, such as the SW800 series that can contain as many as 24 drive SBB shelves. These cabinets include either a 50 Hz or 60 Hz cable distribution unit (CDU), internal ac power cords, and cooling fans.

departmental server cabinet

The series of smaller StorageWorks cabinets for mounting shelves, controllers, storage devices, and power control devices to form subsystems.

device

The targets, initiators, hubs, **converters,** and bus expanders, and similar devices interconnected to form a SCSI bus. Connectors, expanders, and hubs do not use a SCSI bus ID.

See also **nodes**.

device connector

Any connector physically part of a SCSI device.

differential SCSI bus

A bus in which the voltage potential difference between two wires determines the signal level.

disk drive

A storage device supporting random access to fixed size blocks of data.

dual redundant configuration

An array controller configuration consisting of controller A and controller B mounted in the same controller shelf. When controller A fails, controller B assumes control over the devices.

ECB

External cache battery. A device that provides backup power to a cache module for sustaining memory retention.

electromagnetic interference

See **EMI**.

electrostatic discharge

See **ESD**.

EMC

Electromagnetic compatibility.

EMI

Electromagnetic interference. The impairment of a signal by an electromagnetic disturbance.

EMU

Environmental monitoring unit. The device that monitors the status of the UltraSCSI RAID enclosure to include power, intake air temperature, blower status, and so forth, detects error and fault conditions, displays these conditions, reports the conditions to the user and the array controller, and, in some cases, implements corrective actions.

enclosure connector

Any connector that is physically part of an enclosure (for example, pedestal, deskside enclosure, cabinet, and so forth).

environmental monitoring unit

See **EMU.**

ESD

Electrostatic discharge. The discharge of a potentially harmful static electric voltage as a result of improper grounding.

expansion enclosure

An UltraSCSI RAID enclosure connected to the master enclosure with UltraSCSI bus cables. Each subsystem can have a maximum of two expansion enclosures. Set the expansion PVA SCSI bus address switch to either:

2 — Establishing SCSI bus device addresses 8, 9, 10, and 11

3 — Establishing SCSI bus device addresses 12, 13, 14, and 15

external cache battery

See **ECB.**

Fast 10

An improvement in SCSI technology from SCSI-1 to SCSI-2 (Fast 10). Fast 10 improvements made over SCSI-1 include the following:

- Maximum transfer rate increase from 5 Mb/s to 10 Mb/s
- A maximum wide transfer rate of 20 MB/s

Fast 20

See **UltraSCSI**.

FCC

Federal Communications Commission. The federal agency responsible for establishing standards and approving electronic devices within the United States.

FCC Class A

This certification label appears on electronic devices for use only in a commercial environment within the United States. A CE–Mark certified device can be used in the United States in the same environment as the equivalent FCC certification.

FCC Class B

This certification label appears on electronics for use in either a home or a commercial environment within the United States. A CE–Mark certified device can be used in the United States in the same environment as the equivalent FCC certification.

Federal Communications Commission

See **FCC.**

filler panel

A panel used to cover open unused areas in cabinets or shelves for either EMI suppression, air flow control, or cosmetic purposes.

host

The primary or controlling computer (in a multiple computer network) to which storage is attached.

host adapter

A device that connects the host system I/O bus (for example, a PCI bus) to the storage SCSI bus. A host adapter performs the lower layers of the SCSI protocol and normally operates in the initiator role.

host computer

See **host**.

host controller

A device that connects the host system I/O bus (for example, a PCI bus) to the storage SCSI bus. A host controller provides RAID functionality, typically has multiple SCSI bus ports, performs the lower layers of the SCSI protocol, and normally operates in the initiator role.

host port adapter

A host controller device that adapts the host system I/O bus to the array controller SCSI bus configuration.

hot swap

A method of device replacement whereby the complete system remains online and active during device removal or insertion. The device being removed or inserted is the only device that cannot perform operations during this process.

See also **cold swap** and **warm swap**.

HSOF

Hierarchical Storage Operating Firmware. HS-family controller software contained on a removable ROM card (PCMCIA).

ID

Identifier—as used in SCSI bus ID, target ID or device ID.

initiator

A SCSI device (usually a host system) that requests another SCSI device (a target) to complete an operation.

I/O module

Input/output module. A SCSI enclosure or drive SBB shelf device that integrates a single-ended SCSI bus with either an 8-bit single-ended, 16-bit single-ended, or 16-bit differential SCSI bus. This module is also a SCSI **bus extender**.

input/output module

See **I/O module.**

intake air temperature

The temperature of the air entering the cabinet, enclosure, shelf, or SBB.

See also **ambient air temperature**.

LED

Light emitting diode. A source of light on an indicator panel.

logical bus

A single-ended, physical bus connected to a differential physical bus by a SCSI bus signal converter.

maintenance terminal

The operator terminal used to identify an HSOF family controller, to enable its host paths, to define its subsystem configuration, and to check its status. The HS-family maintenance terminal accepts any terminal conforming to EIA–423. Use the maintenance terminal to configure a storage subsystem.

master enclosure

The UltraSCSI RAID enclosure that includes the HSZ series controllers and cache modules. There is only one master enclosure in each UltraSCSI RAID subsystem. The SCSI bus address switch setting is always 0. Using address 0 automatically assigns SCSI bus device addresses 0, 1, 2, and 3 to the devices.

Mb/s

Megabits per second. The bus speed at which the number of bits are transferred.

MB/s

Megabytes per second. The bus width (8- or 16-bit), the number of bytes per word (1 or 2, respectively), and the bus clock frequency determines the transfer rate in MB/s.

megabits per second

See **Mb/s**.

megabytes per second

See **MB/s.**

node

A SCSI bus target or initiator that uses a SCSI bus ID. For example, disk drives, tape drives, array controllers, and adapters all have a SCSI bus ID and are nodes. Hubs, expanders, and converters are devices and do not have a SCSI bus ID. An UltraSCSI bus can have a maximum of 16 nodes (SCSI bus addresses 0 through 15). A narrow bus can have a maximum of eight nodes (SCSI bus addresses 0 through 7).

overtemperature

A condition where a temperature is above a specified limit and can cause equipment failure if not corrected.

pedestal

The common name for a deskside expansion unit.

See **departmental server cabinet.**

physical bus

Two SCSI terminators separated by cables, connectors, and backplane circuitry.

port

(1) A logical route for data in and out of an array controller. A port can contain one or more channels, all of which contain the same type data. (2) The hardware and software that connects a host controller to a Computer Interconnect (CI™), SCSI, or DIGITAL standard system interconnect (DSSI™) bus.

power verification and addressing assembly

See **PVA.**

PVA

Power verification and addressing assembly. The module whose primary functions are (1) to allow the user to select the enclosure UltraSCSI bus ID, (2) to enable the user to place the subsystem in a standby power mode and return it to an operational status, (3) in conjunction with the associated EMU, ensures that critical power functions are monitored.

quiesce

To make a bus inactive or dormant. For example, the user must quiesce SCSI bus operations when warm swapping a disk drive SBB.

radio frequency interference

See **RFI**.

RAID

Redundant array of independent disks. A set of storage techniques devised to increase the performance and availability of a storage subsystem.

redundant power supply configuration

A capability of StorageWorks cabinet and shelves to ensure that there is no single point of power failure. (1) For a cabinet, two ac power sources and two distribution units or ac input boxes distribute primary and redundant ac power to shelf power supplies. (2) For a shelf, the primary and redundant shelf power supplies ensure that the dc power is available even when there is a failure of one supply, one ac source, or one distribution unit or ac input box.

RFI

Radio frequency interference. The impairment of a signal by an unwanted radio signal or radio disturbance.

SBB

StorageWorks building block. The basic building block of the product line. Any device conforming to shelf mechanical and electrical standards installed in either a 3.5-inch or 5.25-inch carrier is considered to be an SBB, whether it be a storage device, a power supply, or other device.

SCSI

Small computer system interface. This ANSI interface defines the physical and electrical parameters of a parallel I/O bus used to connect computers and a maximum of seven devices.

SCSI bus ID

The bit-significant representation of the SCSI addressing referring to one of the signal lines numbered 0 through 7 for an 8-bit bus or 0 through 15 for a 16-bit bus. Also known as SCSI device ID and target ID.

SCSI bus signal converter

(1) A connecting device that permits the attachment of accessories or provides the capability to mount or link units. (2) The device that connects a differential SCSI bus to a single-ended SCSI bus. (3) The device that extends the length of a differential or single-ended SCSI bus.

SCSI device

A host computer adapter, a peripheral array controller or an intelligent peripheral that can be attached to the SCSI bus.

SCSI domain

A SCSI domain is a **logical bus** consisting of at least one bus segment, at least one initiator, and at least one target. Domains with multiple bus segments are enabled through the use of bus extenders. Domains are limited by device addressability. Domains are limited to a maximum of 16 initiators and targets without the use of LUN bridges.

SCSI ID

See **SCSI bus ID**.

SCSI port

(1) Software. The channel that controls communications to and from a specific SCSI bus in the system. (2) Hardware. The name of the logical socket at the back of the system unit to which a SCSI device is connected.

shelf power supply

A power supply that provides +5 V dc and +12 V dc to the StorageWorks shelves. These power supplies convert either an ac input (120 V ac) or dc (48 V dc) voltage into the required output voltages.

single-ended SCSI bus

A bus in which the voltage of a single wire in relation to ground determines each signal’s logic level.

small computer system interface

See **SCSI**.

spin-down

A process that begins when power is removed from a storage device and data transfer halts, and ends when the device is stopped and can be moved. In the case of disk drives, the heads are retracted and the media is stopped.

See also **spin-up**.

spin-up

A process that begins when power is applied to a storage device, and ends when the device is determined to be operational and ready for data transfer operations.

See also **spin-down**.

standard power configuration

A power configuration in which there is only one ac power source and cabinet distribution unit, power distribution unit, or ac input box to condition the input ac power.

STERMPOWER

Terminator power on a single-ended SCSI bus.

See **TERMPOWER**.

storage array

An integrated set of storage devices.

See also **storage sets**.

storage sets

A grouping of disk drives that make up a new distinct container.

See also **storage array**.

storage subsystem

The array controllers, storage devices, shelves, cables, and power supplies that form a mass storage subsystem.

StorageWorks

The DIGITAL set of enclosure products that allows customers to design and configure their storage subsystem. Components include power, packaging, and interconnections in a StorageWorks shelf. SBBs and array controllers are integrated therein to form storage subsystems. System-level enclosures to house the shelves and standard mounting devices for SBBs are also included.

StorageWorks building block

See **SBB**.

supported device

(1) A device that has been fully evaluated in an “approved” StorageWorks configuration (that is, shelf, cabinet, power supply, cabling, and so forth) and is in complete compliance with country-specific standards (for example, FCC, CE–Mark, CSA, TÜV, VDE, and so forth) and with all DIGITAL standards. (2) A device supported by an array controller or host operating system.

target

A SCSI device that performs an operation requested by an initiator.

target ID

See **SCSI bus ID**.

terminators

The interconnect components that form the ends of the transmission lines in bus segments. A **SCSI domain** must have at least one segment and therefore at least two terminators. The terminators ensure that inactive SCSI bus signals are in a known state.

There are two basic types of terminators—active and passive:

- Single-ended bus segments use active, linear terminators
- Differential bus segments use passive (linear totem pole) terminators *except* for special cases where the electrical transmission lines are very short and only one termination or pull-up is required.

terminator connector

Any connector physically part of a **terminator**. It is not uncommon for terminators to have both stub and bus path connectors.

TERMPOWER

Termination power. The electrical current power required for SCSI bus terminators. This power can be supplied by an external SCSI bus, the shelf power supply, or an ac-to-dc power converter.

See also **STERMPOWER**.

topology

The physical arrangement and relationship of interconnected nodes and SCSI buses in a network. A legal topology must satisfy all the requirements of the associated SCSI bus (Fast 10, UltraSCSI, and so forth).

trilink connector

A 3-way SCSI connector.

UltraSCSI

An improvement in SCSI technology invented in 1993 by the Digital Equipment Corporation (now Compaq Computer Corporation) StorageWorks Engineering Group. Subsequently, the ANSI SCSI standards committee issued standard X3T10 for UltraSCSI.

The UltraSCSI improvements over Fast SCSI include the following:

- Maximum transfer rate increases from 10 Mb/s to 20 Mb/s
- Maximum wide bus bandwidth increases from 20 MB/s to 40 MB/s
- VHDCI cables and connectors are significantly thinner and smaller

See also **Fast 20**.

UltraSCSI domain

A single, logical UltraSCSI bus composed of multiple diverse bus segments.

See also **bus segment**.

UltraSCSI RAID enclosure

A 24-drive SBB RAID shelf, such as the DS–BA370 series.

UltraSCSI RAID subsystem

One or more UltraSCSI RAID enclosures mounted in either a pedestal or a cabinet. Each subsystem requires a master enclosure. Adding one or two expansion enclosures to any single-enclosure subsystem creates an expanded subsystem.

VHDCI

Very high density cable interconnect. A 68-pin interface cable with connectors on 0.8 mm centers. Required for UltraSCSI operation.

warm swap

A method of device replacement whereby the complete system remains online during device removal or insertion. During device insertion or removal, the bus might halt for a brief period of time. System booting or code loading cannot occur until insertion of the replacement device. There is no noticeable impact on user applications that are not dependent upon the devices on the affected SCSI bus.

See also **cold swap** and **hot swap**.