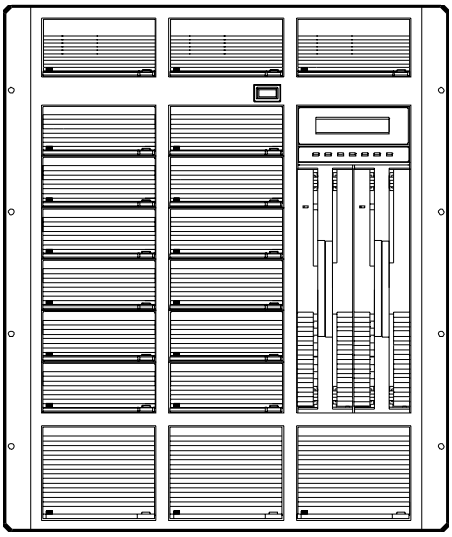
HP SureStore E Disk Array 12H

User's and Service Manual



HEWLETT® PACKARD

with AutoRAID™ Technology

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Typographical Conventions

NOTE! Notes contain important information.

CAUTION! Caution messages indicate procedures which, if not observed, could result in damage to your equipment or loss of your data.

WARNING! Warning messages indicate procedures or practices which, if not observed, could result in personal injury.

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TORX hardware is used in this product. TORX hardware requires the use of special drivers. In this manual, any reference to TORX hardware will be accompanied by the required driver size (for example, “T-15” or “T-25”). TORX is a product of the Camcar Division of Textron, Inc.

Table of Contents

Chapter 1. Product Description

This chapter describes the disk array models and configurations available. This chapter also shows how to install disk modules, controller modules, power modules, and fan modules into your disk array. In addition, this chapter shows how to connect the SCSI cabling to your disk array.

Models and Configurations Available

The disk array is an *AutoRAID* storage device that holds up to twelve disk modules in a single enclosure. Up to four disk array enclosures can be installed into a 1.6-meter cabinet, and up to six disk array enclosures can be installed into a 2.0-meter cabinet. The disk array is also available in a deskside cabinet configuration.

The base models available are:

- A3700A - HP SureStore E Disk Array 12H (Field Integrated Rackmount Configuration)
- A3700AZ - HP SureStore E Disk Array 12H (Factory Installed Rackmount Configuration)
- A3700AD - HP SureStore E Disk Array 12H (Deskside Cabinet Configuration)

Options

Options include the following items:

- Option 002 Third Power Module

- Option 104 Four 4.3-Gigabyte Disk Modules, (7200 rpm)
- Option 105 Five 4.3-Gigabyte Disk Modules, (7200 rpm)
- Option 108 Eight 4.3-Gigabyte Disk Modules, (7200 rpm)
- Option 112 Twelve 4.3-Gigabyte Disk Modules, (7200 rpm)

- Option 124 Four 9.1-Gigabyte Disk Modules, (7200 rpm)
- Option 125 Five 9.1-Gigabyte Disk Modules, (7200 rpm)
- Option 128 Eight 9.1-Gigabyte Disk Modules, (7200 rpm)
- Option 132 Twelve 9.1-Gigabyte Disk Modules, (7200 rpm)

- Option 144 Four 18.2-Gigabyte Disk Modules, (7200 rpm)
- Option 145 Five 18.2-Gigabyte Disk Modules, (7200 rpm)
- Option 148 Eight 18.2-Gigabyte Disk Modules, (7200 rpm)
- Option 152 Twelve 18.2-Gigabyte Disk Modules, (7200 rpm)

- Option 304 Four 36.4-Gigabyte Disk Modules, (7200 rpm)
- Option 305 Five 36.4-Gigabyte Disk Modules, (7200 rpm)
- Option 308 Eight 36.4-Gigabyte Disk Modules, (7200 rpm)
- Option 312 Twelve 36.4-Gigabyte Disk Modules, (7200 rpm)

- Option 164 Four 9.1-Gigabyte Disk Modules, (10,000 rpm)
- Option 165 Five 9.1-Gigabyte Disk Modules, (10,000 rpm)
- Option 168 Eight 9.1-Gigabyte Disk Modules, (10,000 rpm)

- Option 172 Twelve 9.1-Gigabyte Disk Modules, (10,000 rpm)

- Option 184 Four 18.2-Gigabyte Disk Modules, (10,000 rpm)
- Option 185 Five 18.2-Gigabyte Disk Modules, (10,000 rpm)
- Option 188 Eight 18.2-Gigabyte Disk Modules, (10,000 rpm)
- Option 192 Twelve 18.2-Gigabyte Disk Modules, (10,000 rpm)

- Option 314 Four 36.4-Gigabyte Disk Modules, (10,000 rpm)
- Option 315 Five 36.4-Gigabyte Disk Modules, (10,000 rpm)
- Option 318 Eight 36.4-Gigabyte Disk Modules, (10,000 rpm)
- Option 322 Twelve 36.4-Gigabyte Disk Modules, (10,000 rpm)

- Option 200 One 96-Megabyte Controller Module
- Option 203 Two 96-Megabyte Controller Modules

- Option 801 0.9 m SCSI Cable (high-density 68-pin to 68-pin)
- Option 802 2.5 m SCSI Cable (high-density 68-pin to 68-pin)
- Option 803 5.0 m SCSI Cable (high-density 68-pin to 68-pin)
- Option 804 10.0 m SCSI Cable (high-density 68-pin to 68-pin)
- Option 806 1.0 m SCSI Cable (high density LP 68-pin to 68-pin)
- Option 807 2.5 m SCSI Cable (high density LP 68-pin to 68-pin)
- Option 808 5.0 m SCSI Cable (high density LP 68-pin to 68-pin)
- Option 809 10.0 m SCSI Cable (high density LP 68-pin to 68-pin)
- Option 840 2.0 m SCSI Cable (high-density V Cable to 68-pin)
- Option 841 2.0 m V Cable VHDCI-VHDCI/68-pin (high density)
- Option 842 2.0 m V Cable VHDCI - VHDCI I/L Term/68-pin (high density)
- Option 843 2.0 m V Cable 68-pin HD- VHDCI /68-pin (high density)
- Option 844 2.0 m V Cable 68-pin HD- VHDCI I/L Term/68-pin (high density)

- Option 851 V-Class 10.0 m SCSI Cable (68-pin high-density Inline Term Cable), P/N A4801-63002
- Option 871 V-Class 2.0 m / 5.0 m SCSI Y-Cable (V Inline Term Cable 68-pin), P/N A4801-63012
- Option 873 V-Class 2.0 m / 3.0 m SCSI Y-Cable (V Inline Term Cable 68-pin), P/N A4801-63010
- Option 875 V-Class 5.0 m SCSI Cable (68-pin high-density Inline Term Cable), P/N A4801-63004

- Option B25 4.0 m V Cable VHDCI-VHDCI/68-pin (high density)
- Option B26 4.0 m V Cable VHDCI-VHDCI I/L Term/68-pin (high density)
- Option B27 4.0 m V Cable 68-pin HD-VHDCI/68-pin (high density)
- Option B28 4.0 m V Cable 68-pin HD-VHDCI I/L Term/68-pin (high density)

- Option ASJ Disk Array 12H Software Interface Kit for NT

Available Accessories

The following accessories are available:

- A3701A Deskside Cabinet Upgrade Kit
- A3702A Single 4.3-Gigabyte Disk Module, (7200 rpm)
- A3703A Single 9.1-Gigabyte Disk Module, (7200 rpm)
- A3710A Single 18.2-Gigabyte Disk Module, (7200 rpm)
- A5289A Single 36.4-Gigabyte Disk Module, (7200 rpm)
- A3713A Single 9.1-Gigabyte Disk Module, (10,000 rpm)
- A3714A Single 18.2-Gigabyte Disk Module, (10,000 rpm)
- A5292A Single 36.4-Gigabyte Disk Module, (10,000 rpm)
- A3702AM Four 4.3-Gigabyte Disk Modules, (7200 rpm)
- A3703AM Four 9.1-Gigabyte Disk Modules, (7200 rpm)
- A3710AM Four 18.2-Gigabyte Disk Modules, (7200 rpm)
- A5289AM Four 36.4-Gigabyte Disk Modules, (7200 rpm)
- A3713AM Four 9.1-Gigabyte Disk Modules, (10,000 rpm)
- A3714AM Four 18.2-Gigabyte Disk Modules, (10,000 rpm)
- A5292AM Four 36.4-Gigabyte Disk Modules, (10,000 rpm)
- A3706A Single 96-Megabyte Controller Module
- A3708A Power Module
- A3709B Fan Module
- A5329A Single Front Door Assembly (Quartz Gray Color, Optional)
- A5329AM Ten Front Door Assemblies (Quartz Gray Color, Optional)
- A5253A Disk Array 12H Software Interface Kit for NT
- C2905A Fast/Wide SCSI terminator
- Ultra-flexible 0.5 m SCSI Cable, part number 5064-2408
- Option 851 V-Class 10.0 m SCSI Cable (68-pin high-density Inline Term Cable), part number A4801-63002

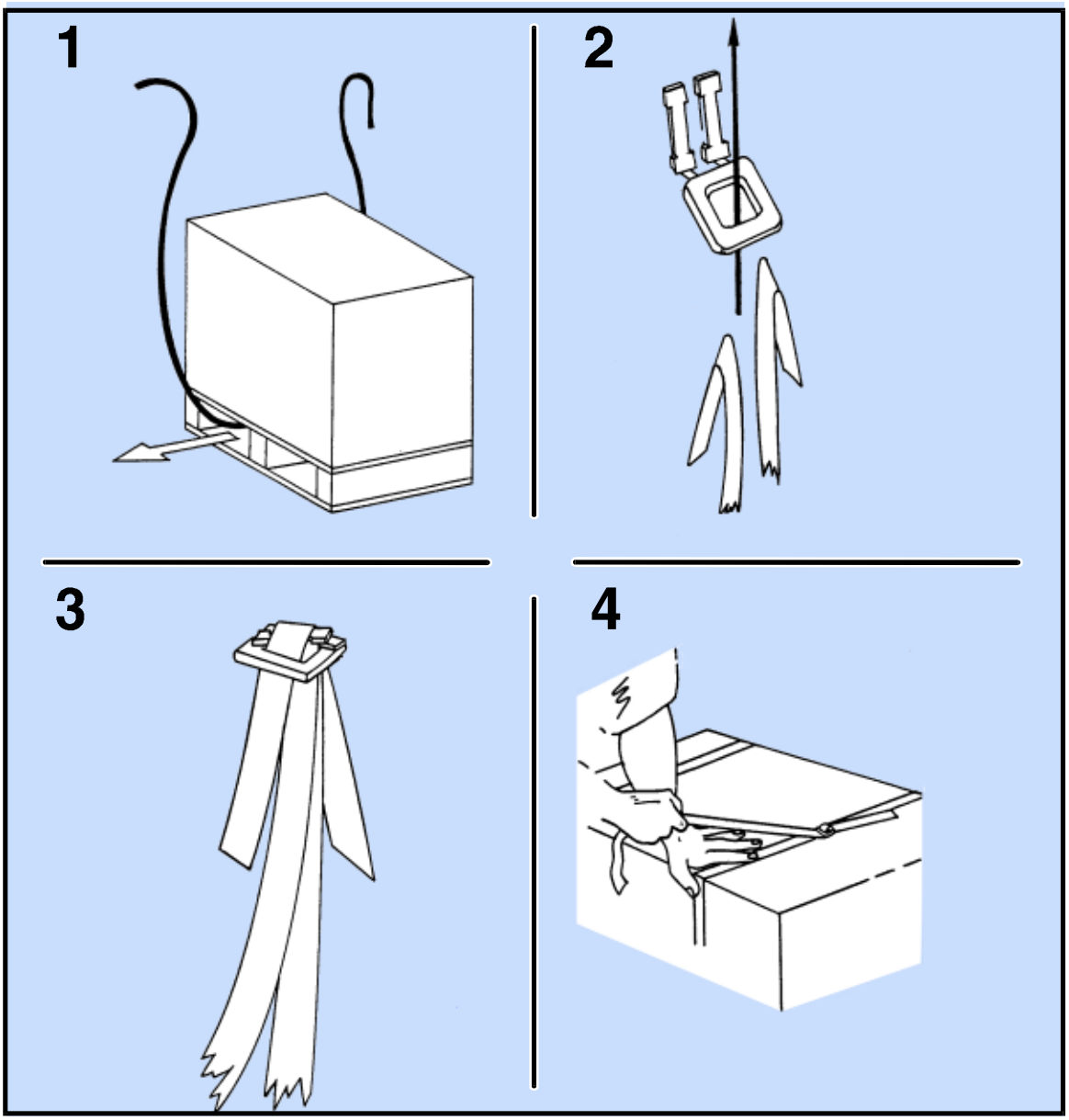
- Option 875 V-Class 5.0 m SCSI Cable (68-pin high-density Inline Term Cable), part number A4801-63004
- Option 873 V-Class 2.0 m / 3.0 m SCSI Y-Cable (V Inline Term Cable 68-pin), part number A4801-63010
- Option 871 V-Class 2.0 m / 5.0 m SCSI Y-Cable (V Inline Term Cable 68-pin), part number A4801-63012
- Option 841 2.0 m V Cable VHDCI-VHDCI/68-pin (high density), part number A3639-63015
- Option 842 2.0 m V Cable VHDCI - VHDCI I/L Term/68-pin (high density), part number A3639-63016
- Option 843 2.0 m V Cable 68-pin HD- VHDCI /68-pin (high density), part number A3639-63017
- Option 844 2.0 m V Cable 68-pin HD- VHDCI I/L Term/68-pin (high density), part number A3639-63018
- Battery Pack, part number 1420-0532
- ac power cords (options for different countries)
- Strapping Kit (for repackaging the disk array), part number C5445-80019

Unpacking and Repackaging the Disk Array

When you unpack your disk array, be careful to save all packaging items, including the strapping material. The strapping material will be needed if you ever have to ship or return your disk array.

Figure 1 shows the packing items and strapping material shipped with the disk array.

Figure 1. Repackaging the Disk Array for Shipment



Product Features

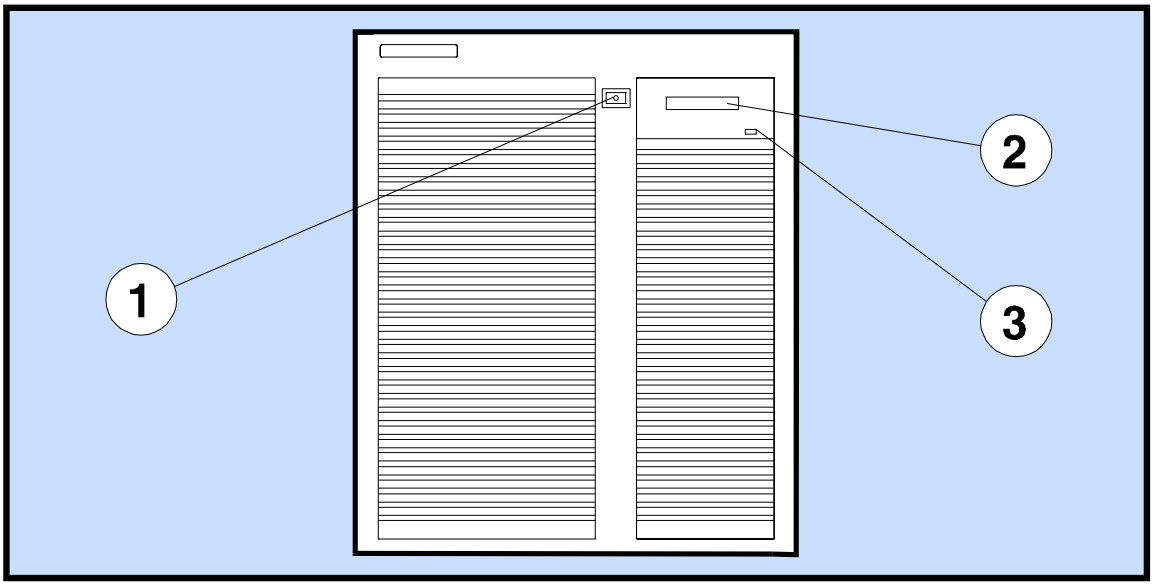
Figure 2 shows the front of the disk array.

Figure 3 shows the rear of the disk array.

Figure 4 shows the controls and indicators on the disk array.

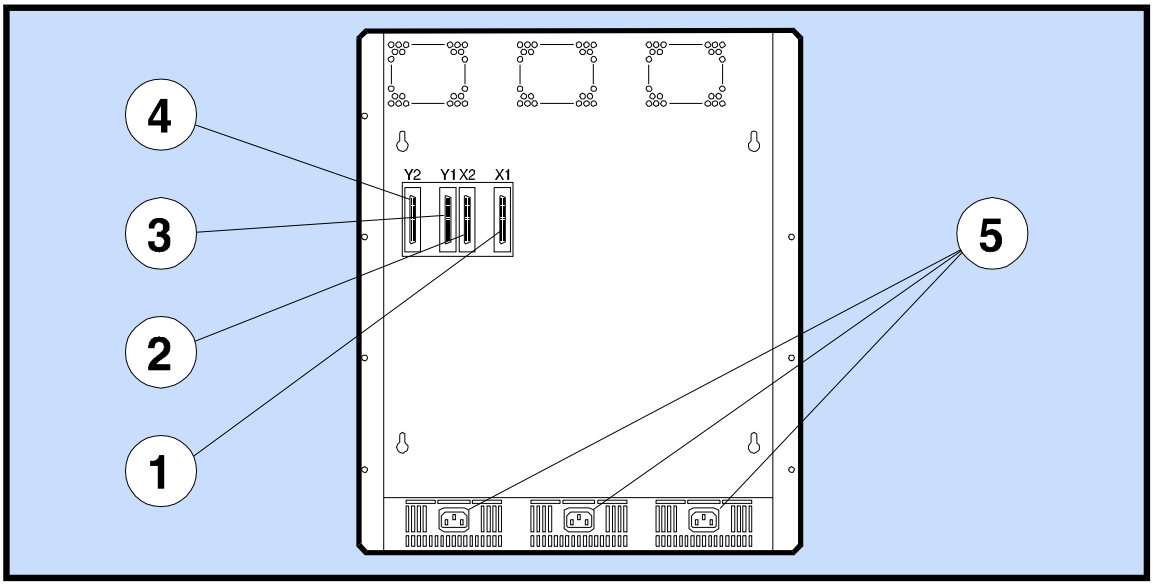
Figure 5 shows the slot numbers for the disk modules.

Figure 2. Disk Array Front Panel



1 – Power/Standby Switch 2 – Control Panel Display 3 – Control Panel Status Light

Figure 3. Disk Array Rear Panel



1 – Controller X SCSI Connector 1

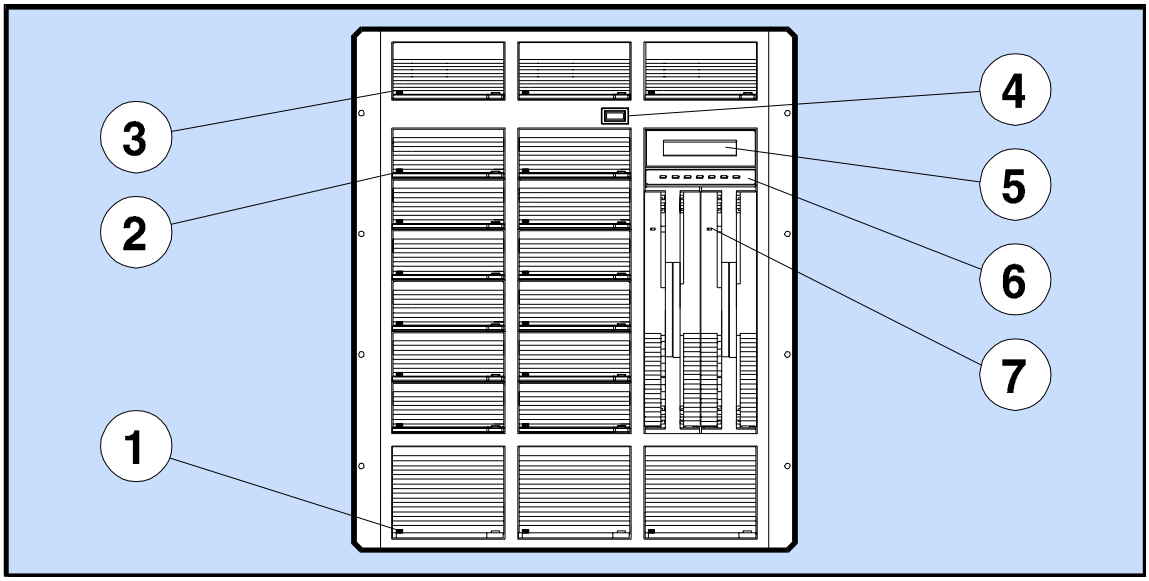
2 – Controller X SCSI Connector 2

3 – Controller Y SCSI Connector 1

4 – Controller Y SCSI Connector 2

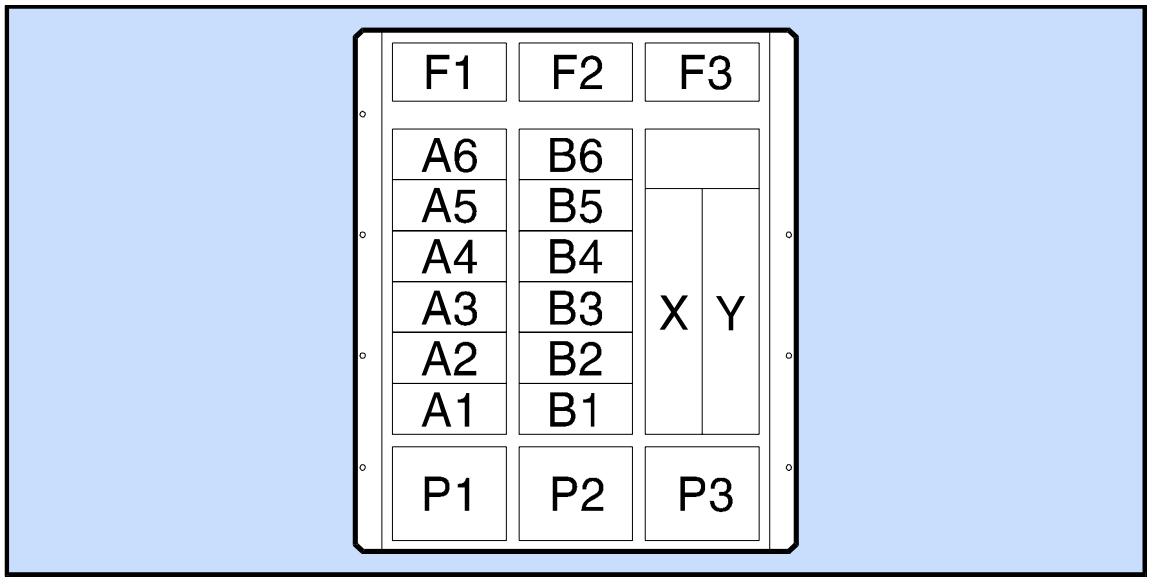
5 – P1-P3 AC Power Connectors

Figure 4. Disk Array Controls and Indicators



1 – Power Module Status Light
2 – Disk Module Status Light
3 – Fan Module Status Light
4 – Power/Standby Switch
5 – Control Panel Display
6 – Control Panel Status Light
7 – Controller Module Status Light

Figure 5. Disk Module Slots



F1–F3 = Fan modules

P1–P3 = Power modules

A1–A6 and B1–B6 = Disk modules

X and Y = Controller module(s)

Connecting Power Cords

You should connect power cords to all ac power connectors (see Figure 3). Disk array availability is enhanced if each power cord is connected to a separate ac branch circuit.

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

Installing Modules

This chapter shows how to install modules into the disk array.

NOTE! To improve enclosure cooling and balance the load on the internal SCSI buses, the disk modules should be installed from left to right and from top to bottom. Disk module SCSI addresses are automatically preset by the backplane inside the disk array enclosure upon insertion.

Disk, Power, and Fan Modules

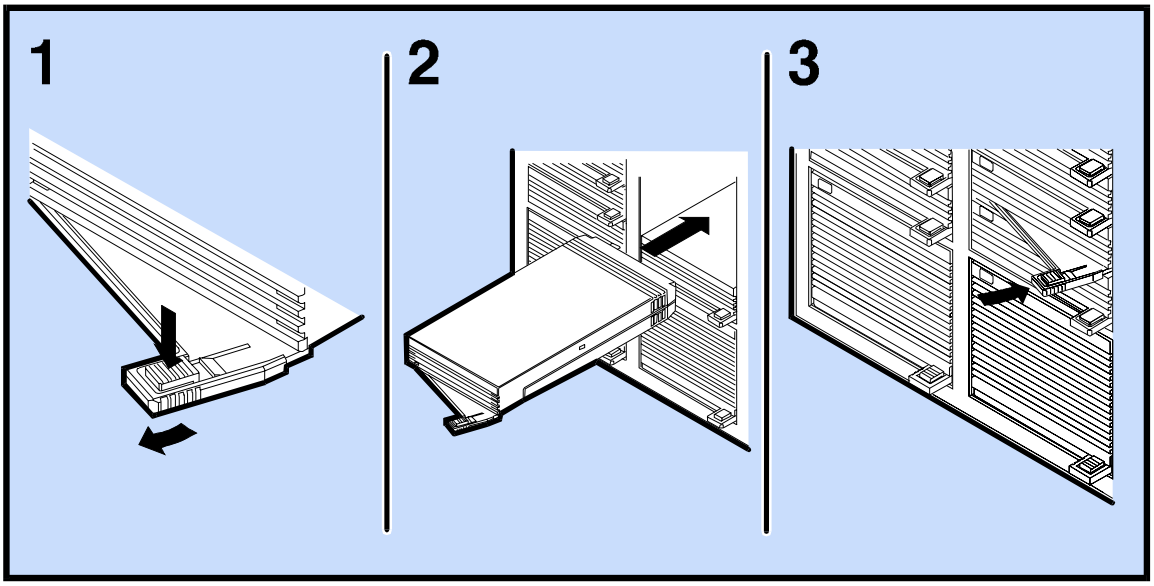
Use the same installation procedure to install power modules and fan modules. See Figure 5 to determine where to install the module. Figure 6 shows how to install a disk module. To install a disk, power, or fan module, open the front door and follow these steps:

CAUTION! The module lever must be pulled all the way out or the module will jam in the slot upon insertion. Also, always handle the disk modules carefully when they are out of the disk array enclosure, since they are susceptible to shock and vibration.

When removing a disk module, pull it only part of the way out of the enclosure first, then wait 30 seconds for the disk spindle to spin down before fully removing the disk module. This will avoid damaging gyroscopic effects between the disk surfaces and heads.

1. Pull out the module lever.
2. Insert the module into the disk array.
3. Push in the module lever to lock the module in place.

Figure 6. Installing a Disk Module



Controller Module

NOTE! If two or more controller modules are connected (daisy chained) to the same SCSI bus (whether in the same disk array enclosure or across two or more disk array enclosures), each controller module on the same SCSI bus must have its own unique SCSI address, which is set by the control panel on the front of the disk array (refer to “Operating the Control Panel”).

To install a controller module:

CAUTION! Before installing a controller module, ensure all of the pins on the controller connector are straight. Bent pins will cause the controller module to fail, and the array will not function properly. Also, do not attempt to install the controller module upside-down.

1. Pull the controller module levers all the way out (see Figure 7, View 1).
2. Insert the controller module into the disk array, while pushing on both sides of the controller module (see Figure 7, View 2).
3. When the enclosure engages the levers, press the center of the levers with the palm of your hand until they lock securely into place. You should hear an audible click when the levers lock (see Figure 7, View 3).

NOTE! When using a single controller, the controller should be installed in slot “x”. Although either slot can be assigned to be the primary array controller, slot “x” is the default when only one array controller is installed.

Suppressing Single-Controller Warning Messages

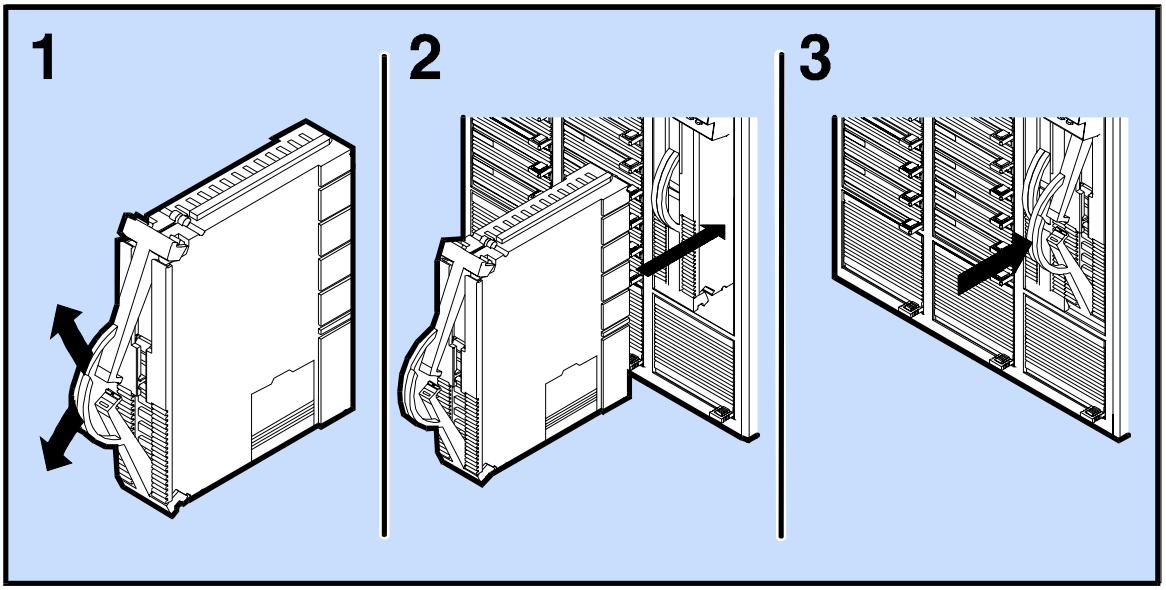
When a single controller disk array is powered on for the first time, the control panel may display a "System Warning" error message, which occurs because only one controller is installed. By default, the disk array assumes that there should be two controllers installed, and therefore it will generate single-controller error messages until you suppress them.

If a "System Warning" error message is displayed on the front panel, you must first verify that it is caused by the detection of a single controller. Use the control panel keys to verify the source of the message by using the following key sequence:

KEY	DISPLAY
CANCEL CANCEL	"System Warning"
MENU	"Language"
–	"View Settings"
ENTER	"System State: System Warning"
+	"Warning: Single Controller"

To avoid future single-controller warning messages, you can suppress them using the `arraymgr` ARM command line utility. The `arraymgr` utility is described in further detail in the *System Administrator's Guide*, which is shipped with each disk array.

Figure 7. Installing a Controller Module



SCSI Cabling Requirements

The following are the SCSI cabling requirements that must be considered before connecting SCSI cables to the disk array:

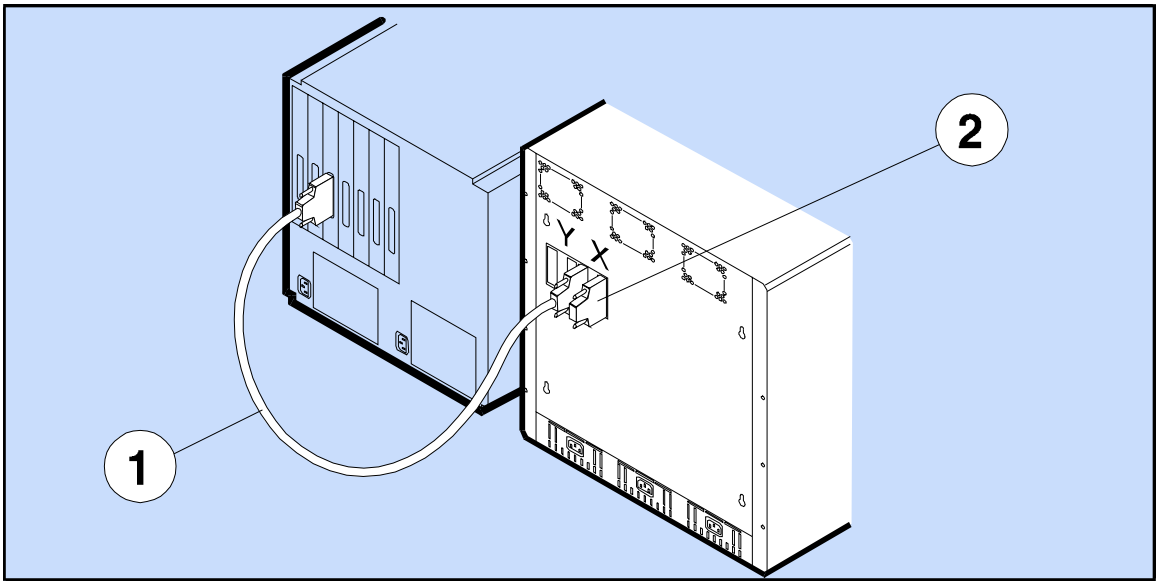
1. The external bus connected to the disk array must be a SCSI-2 wide differential device cable with 68-pin high-density external SCSI connectors.
2. Each SCSI bus must be terminated with a passive differential SCSI terminator on the last device. Therefore, for dual controller disk array configurations, you will need two passive differential terminators, one for each bus.
3. Each disk array contains an equivalent of 0.5 meters of internal SCSI cabling per bus.
4. The total combined length of internal SCSI cabling plus external SCSI cabling must not exceed 25 meters.

Connecting SCSI Cabling

NOTE! Before connecting SCSI cables, press the power/standby switch to the standby (out) position. It may take a moment for the disk array to fully shut down.

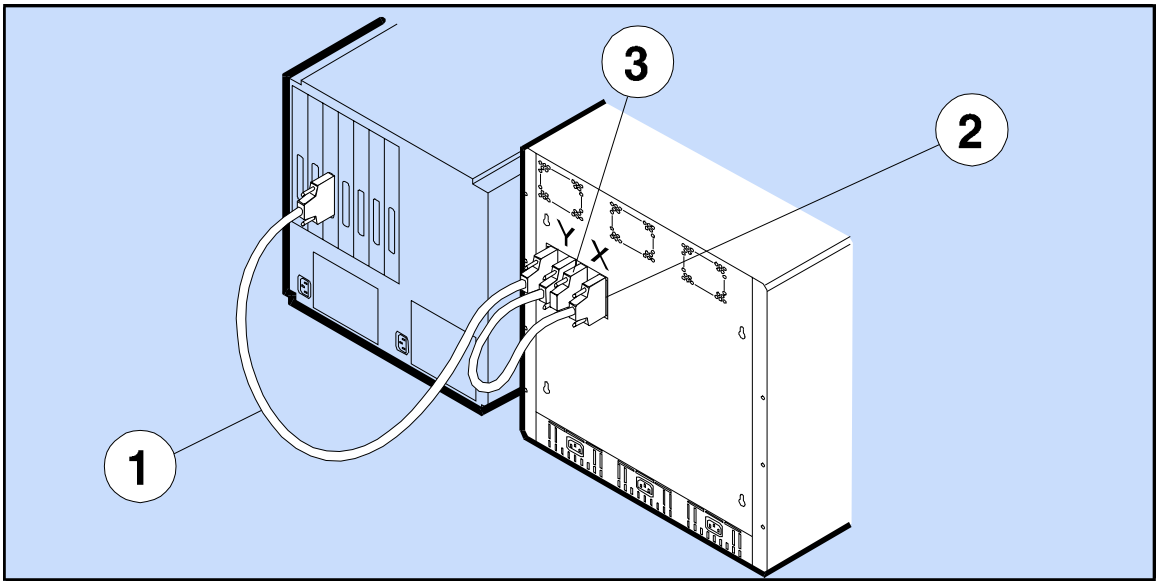
SCSI cables are available in standard lengths. Each controller must have a different SCSI ID, even when using dual controller configurations. To change controller SCSI IDs, refer to the chapter titled, “Operating the Control Panel.”

Figure 8. SCSI Cabling for 1 Disk Array, 1 Controller, 1 SCSI Bus



1 – SCSI 68-pin to 68-pin Cable (HBA to X2) 2 – SCSI Passive Differential Terminator (X1)

Figure 9. SCSI Cabling for 1 Disk Array, 2 Controllers, 1 SCSI Bus

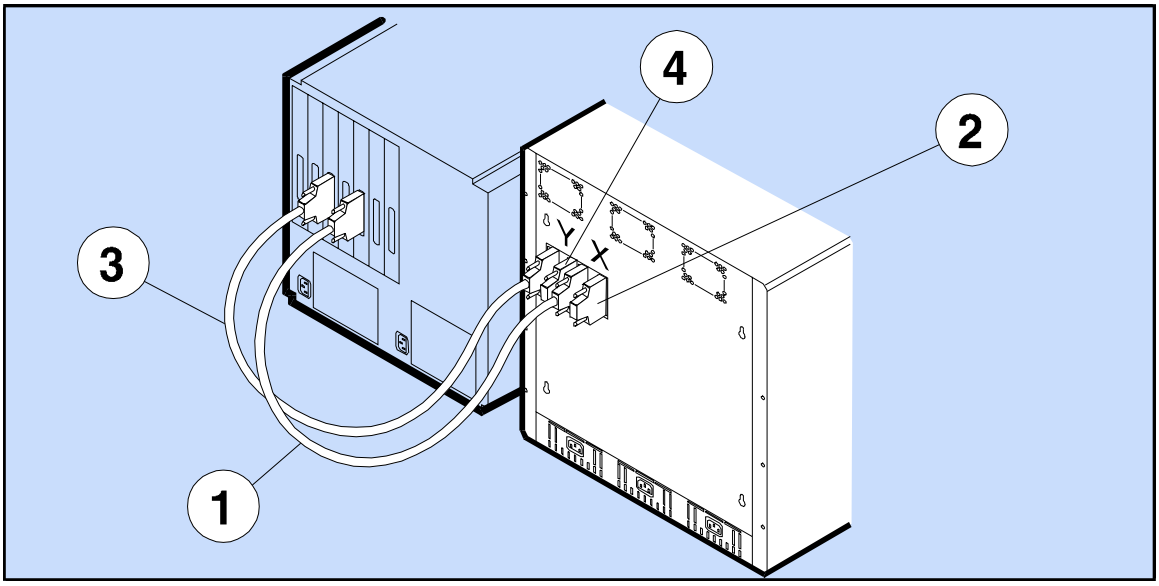


1 – SCSI 68-pin to 68-pin Cable (HBA to Y2)

2 – SCSI 68-pin to 68-pin Cable (Y1 to X1)

3 – SCSI Passive Differential Terminator (X2)

Figure 10. SCSI Cabling for 1 Disk Array, 2 Controllers, 2 SCSI Buses



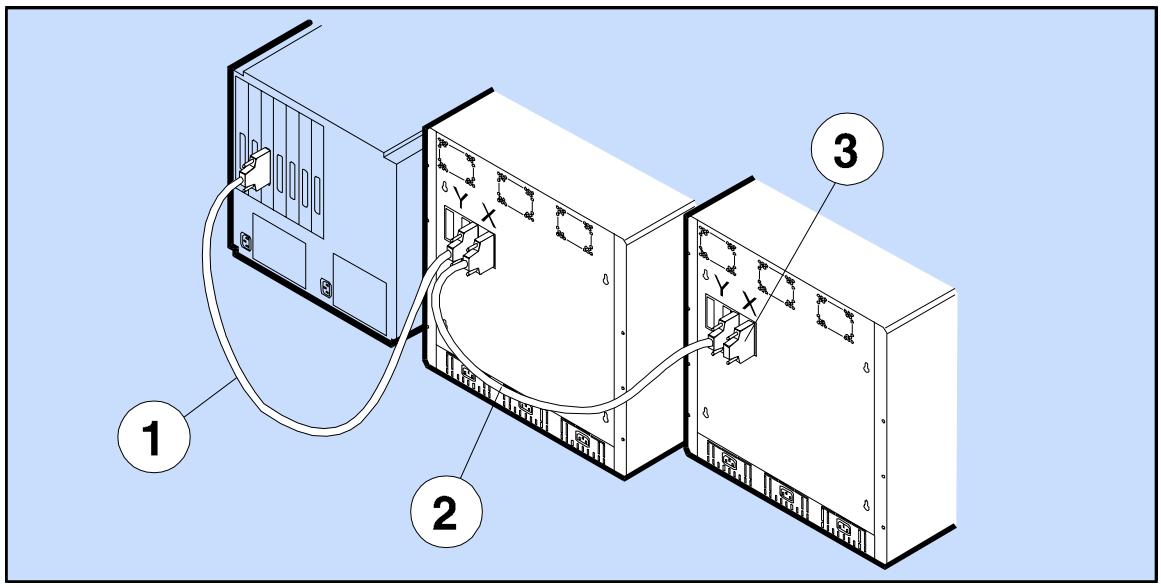
1 – SCSI 68-pin to 68-pin Cable (HBA1 to X2)

2 – SCSI Passive Differential Terminator (X1)

3 – SCSI 68-pin to 68-pin Cable (HBA2 to Y2)

4 – SCSI Passive Differential Terminator (Y1)

Figure 11. SCSI Cabling for 2 Disk Arrays, 2 Controllers, 1 SCSI Bus

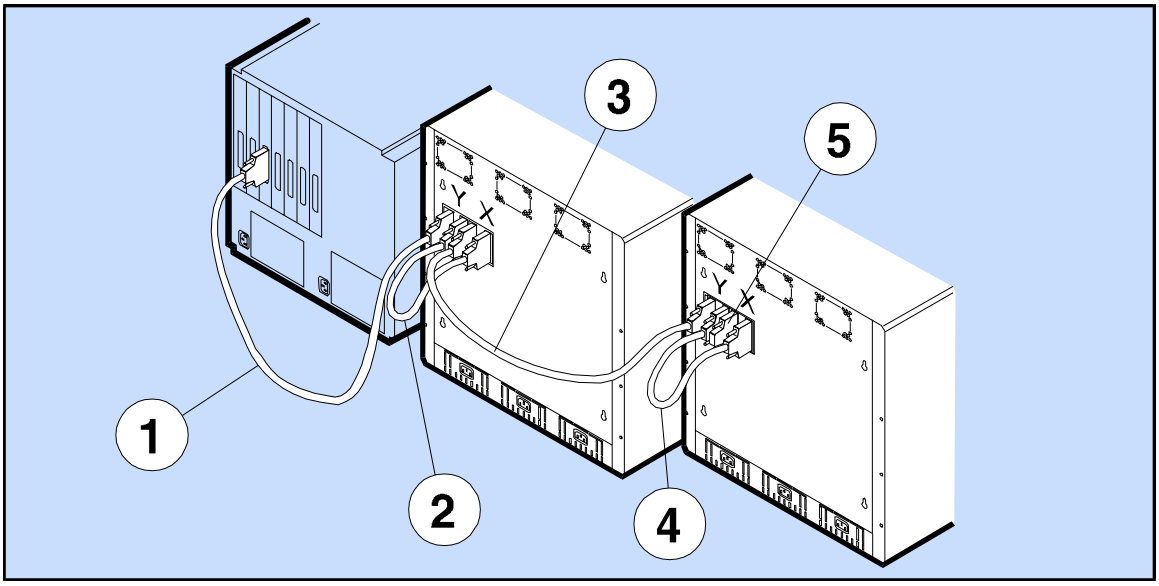


1 – SCSI 68-pin to 68-pin Cable (HBA to X2)

2 – SCSI 68-pin to 68-pin Cable (X1 to X2)

3 – SCSI Passive Differential Terminator (X1)

Figure 12. SCSI Cabling for 2 Disk Arrays, 4 Controllers, 1 SCSI Bus



1 – SCSI 68-pin to 68-pin Cable (HBA to Y2)

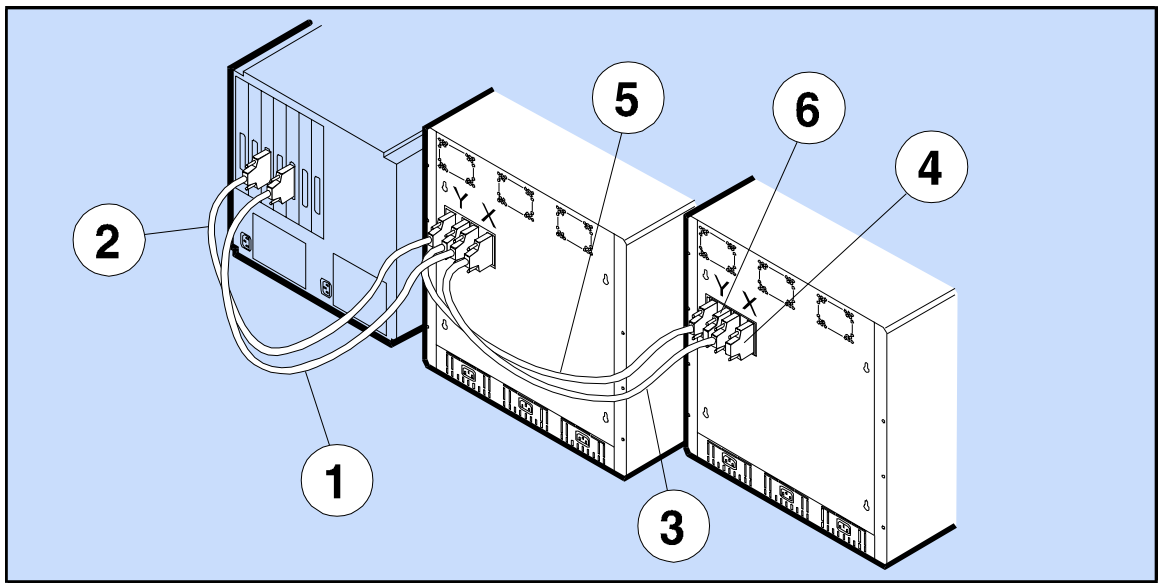
2 – SCSI 68-pin to 68-pin Cable (Y1 to X1)

3 – SCSI 68-pin to 68-pin Cable (X2 to Y2)

4 – SCSI 68-pin to 68-pin Cable (Y1 to X1)

5 – SCSI Passive Differential Terminator (X2)

Figure 13. SCSI Cabling for 2 Disk Arrays, 4 Controllers, 2 SCSI Buses



1 – SCSI 68-pin to 68-pin Cable (HBA1 to X2)

2 – SCSI 68-pin to 68-pin Cable (HBA2 to Y2)

3 – SCSI 68-pin to 68-pin Cable (X1 to X2)

4 – SCSI Passive Differential Terminator (X1)

5 – SCSI 68-pin to 68-pin Cable (Y1 to Y2)

6 – SCSI Passive Differential Terminator (Y1)

Fibre Channel (FC) SCSI Multiplexer (MUX) Connection

Fibre channel host connection is available through a Fibre Channel (FC) SCSI Multiplexer (MUX). Configurations of the FC are detailed in the HP 9000 Enterprise Servers Configuration Guide. For information regarding the Fibre Channel technology, refer to the *Fibre Channel SCSI Multiplexer Service and User Manual*, part number A3308-90005.

Switching Power On

To turn on the disk array power:

1. Lift the power/standby switch door up or open the front door (see Figure 2, Item 1).
2. Press the power/standby switch to the power (in) position (see Figure 4, Item 4).
3. During and after all the disk modules have spun up and passed self-test, the control panel will display power on sequence test numbers. Once the power-on sequence is finished, the control panel will display the word “Ready.”

NOTE! If the controller batteries are not fully charged, you may need to wait a few minutes for the “Ready” message to be displayed.

Switching Power Off

WARNING! When the power/standby switch is in the standby position, the dc power output circuits are off within the power supplies, but the ac power input circuits are still active.

To switch off the disk array power:

1. Lift the power/standby switch door up or open the front door (Figure 2, Item 1).
2. Press the power/standby switch to the standby (out) position (Figure 4, Item 4).

CAUTION! When the disk array power is turned off, the control panel will display a “Shutting Down” message. Shutdown is not complete until ALL lights are OFF and the display panel shows the “Shutdown Complete” message.

Chapter 2. HP SureStore E Disk Array 12H Controller

This chapter explains how to install batteries, download firmware into a disk array controller, and how to replace an array controller.

About Battery Packs

If your disk array goes without power, the controller batteries are capable of retaining data in NVRAM for a minimum of one week. Always perform a successful Shutdown before replacing the batteries. For further protection, battery packs should be replaced one at a time, so that there is always at least one battery providing power for memory backup. If the disk array power is to be turned off for an extended period of time (more than five days), then the NVRAM memory maps should be saved to disk (by successful Shutdown) and both battery packs should be disconnected to prevent damage to the battery packs and the controller.

Installing Controller Batteries

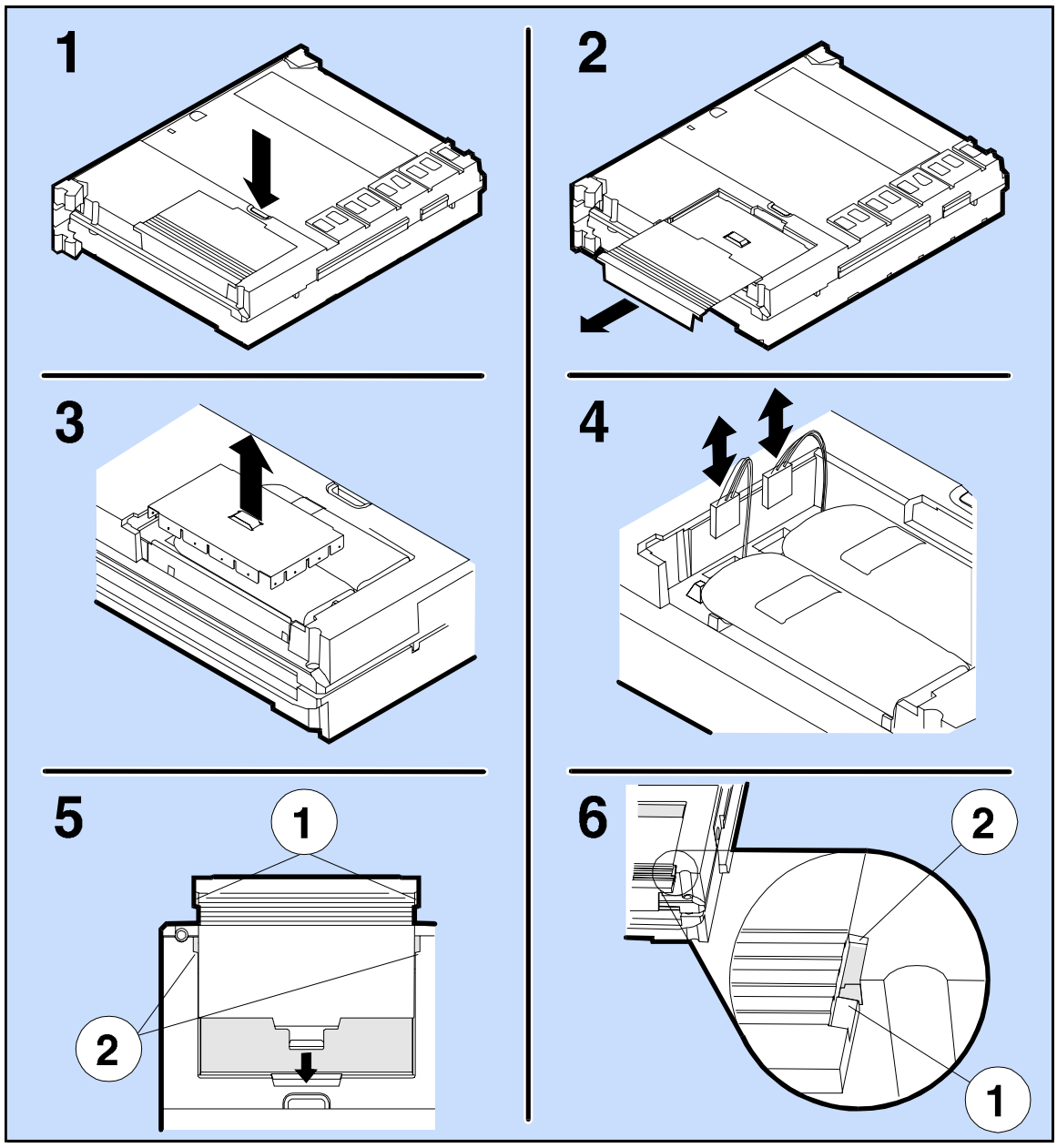
Two battery packs, part number 1420-0532, must be installed in each controller module before the module can be used. Two battery packs are shipped with each new controller module. In the disk array shipping carton, the batteries are located in a cardboard sleeve next to the array controller. If you are replacing a failed controller module, first remove and use the battery packs from the failed controller module in the new controller module. To install the controller battery packs, do the following (see Figure 14):

1. If the battery cover latch is not already removed, press down on the battery cover latch.
2. If the battery cover latch is not already removed, remove the battery cover latch and then remove the RFI shield (if necessary, you can use a flat-bladed screwdriver to remove the RFI shield).
3. Install both battery packs, and connect the cables as shown.
4. Reinstall the RFI shield and the battery cover latch.

CAUTION! Make sure you reinstall the battery cover latch carefully, so each of the locking tabs (see Figure 14, View 5, Items 1 and 2) slide beneath the battery compartment. If the battery cover latch is not secured properly, it could prevent the removal of the controller module once it is installed in the disk array enclosure.

After new battery packs are installed, and the array controllers are installed and powered on, about one minute is required before the “Battery Discharged” message on the control panel disappears. About twelve hours are required to fully charge new battery packs. During this time, a “Battery Charging” message will be displayed on the control panel.

Figure 14. Installing the Controller Batteries



Replacing Controller Batteries

This procedure is different than installing batteries the first time the disk array is used, since replacing batteries assumes that you have valuable data stored on your disk array. Many factors affect battery life, including not only time of battery use, but also time of battery storage. Controller batteries should be replaced every three years, or sooner if the display module indicates a constant "Battery Discharged" message.

To replace controller batteries, do the following (see Figure 14):

CAUTION! If the disk array power is on, you should always perform a successful Shutdown using the control panel to avoid loss of data before replacing a controller battery. If a message appears on the control panel display indicating that the Shutdown did not complete successfully, the disk array WILL LOSE DATA if you remove the batteries. In this case, you should perform the following steps:

1. **Install a second (functional) controller.**
2. **Wait about two minutes for the data to be posted from the controller with the bad batteries to the second controller. The "Ready" message appears at this time.**
3. **Remove the controller with the bad batteries, and install new batteries.**

The controller batteries are Ni-Cad (Nickel Cadmium) type batteries. When replaced, these batteries must be recycled or disposed of properly. Replace batteries only with the same type.

1. Press down on the battery cover latch.
2. Remove the battery cover latch and RFI shield (if necessary, you can use a flat-bladed screwdriver to remove the RFI shield).
3. Disconnect the cable from the controller PCA to ONE of the battery packs.
4. Replace the first battery pack with a new battery pack, and reconnect the cable.
5. Disconnect the cable from the controller PCA to the other battery pack.
6. Replace the second battery pack with a new battery pack, and reconnect the cable.
7. Reinstall the RFI shield and the battery cover latch.

Downloading Array Controller Firmware

When two controllers are installed in the disk array enclosure (dual controllers), both controllers must have the same version of firmware. If you update (or download) new firmware, the new firmware is copied to both controllers. When a controller is replaced, however, the replacement controller may have a later version of firmware than the currently installed controller.

If the installed controllers have different versions of firmware, you will get an error message on the display panel that says, "Firmware Needed." In this case, you must copy the desired version of firmware from one controller to the other. Copy Firmware always copies from the PRIMARY to the SECONDARY controller. Firmware can be copied using ARMServer (`download -m`) or the front panel (Copy Firmware). You can also download the desired version of firmware from a file to both array controllers simultaneously using the ARMServer (AutoRAID Manager).

NOTE! The Download utility is described in further detail in the *System Administrator's Guide*, which is shipped with each disk array.

Before Beginning Firmware Download

Before you begin any of the following download procedures, have the following ready:

- Get `<array-id>` using ARMServer (`arraydsp -i`) or front panel (View Settings, Array S/N). You may also use the raw device file that is connected to the array.

NOTE! Alphabetic characters in the Array Serial Number are CASE SENSITIVE! Once you have the Array S/N, it may be easier to define the long serial number string as an alias. To create an alias for the Array S/N of 000000057D22, for example:

On HP-UX or MPE systems: # export <id>=000000057D22 (use $id in place of `<array-id>`)

On Windows NT systems: C:\>set <id>=000000057D22 (use %id% in place of `<array-id>`)

- Obtain the desired version of firmware and determine its `<codefilename>` (filename) and location (path). If you are downloading firmware, you must know the source of your firmware. The firmware could be on an installed controller, on a replacement controller, or from a file. Make sure you know which controller contains the desired version of firmware. If the desired version of firmware is not on any controller but is in a file, make sure you know the location (path) to the file and its filename.

Other Considerations About the Firmware Download Process

NOTE! For Windows NT Systems: Since the Download utility does not support long directory names, it is better to change to the directory where the firmware is located first, and then the `<codefilename>` is simply the filename of the firmware. Otherwise, a path with a directory named "Program Files" will have to be entered as its MS-DOS directory name equivalent, for example:

```
download –C c:\Progra~1\AutoRAID\Fw\Model_12H_HP26.fw 000000057D22
```

- If the array does not show up using ARMServer (`arraydsp –i`), you may have to re-connect to "see" the array using the ARMServer (`arraydsp –R`) command, which scans the bus for all arrays. This command can take a few seconds to execute. Once re-connected, you will "see" the array again.

Firmware Download Procedure

See the flowcharts (Figure 15 and Figure 16) to determine which download procedure to follow. Pick the appropriate procedure.

NOTE! This procedure assumes that the Model 12 and HP SureStore E Disk Array 12H controllers have been updated to at least HP25 and HP24 firmware revisions, respectively. If they have not been updated to these versions of firmware, then refer to the service notes indicated below to update the array before continuing.

- **A3515A-03, A3516A-03, and A3516Z-01 HP AutoRAID Disk Array for the Model 12**
- **A3700A-01, A3700-AD-01, and A3700AZ-01 HP AutoRAID Disk Array for the HP SureStore E Disk Array 12H**

NOTE! It is required that a backup of the array be performed before downloading the firmware.

CAUTION! Follow all the procedures exactly as described. If you fail to follow the procedures exactly, you could lose data!

CAUTION! In upgrading to HP40 or later firmware for the purpose of using 36-Gigabyte disk drives, it is important that the controller firmware be upgraded before adding the 36-Gigabyte disk drives, as any data written on those disk drives using any controller firmware previous to version HP40 will be lost!

Figure 15. Downloading Controller Firmware Flowchart

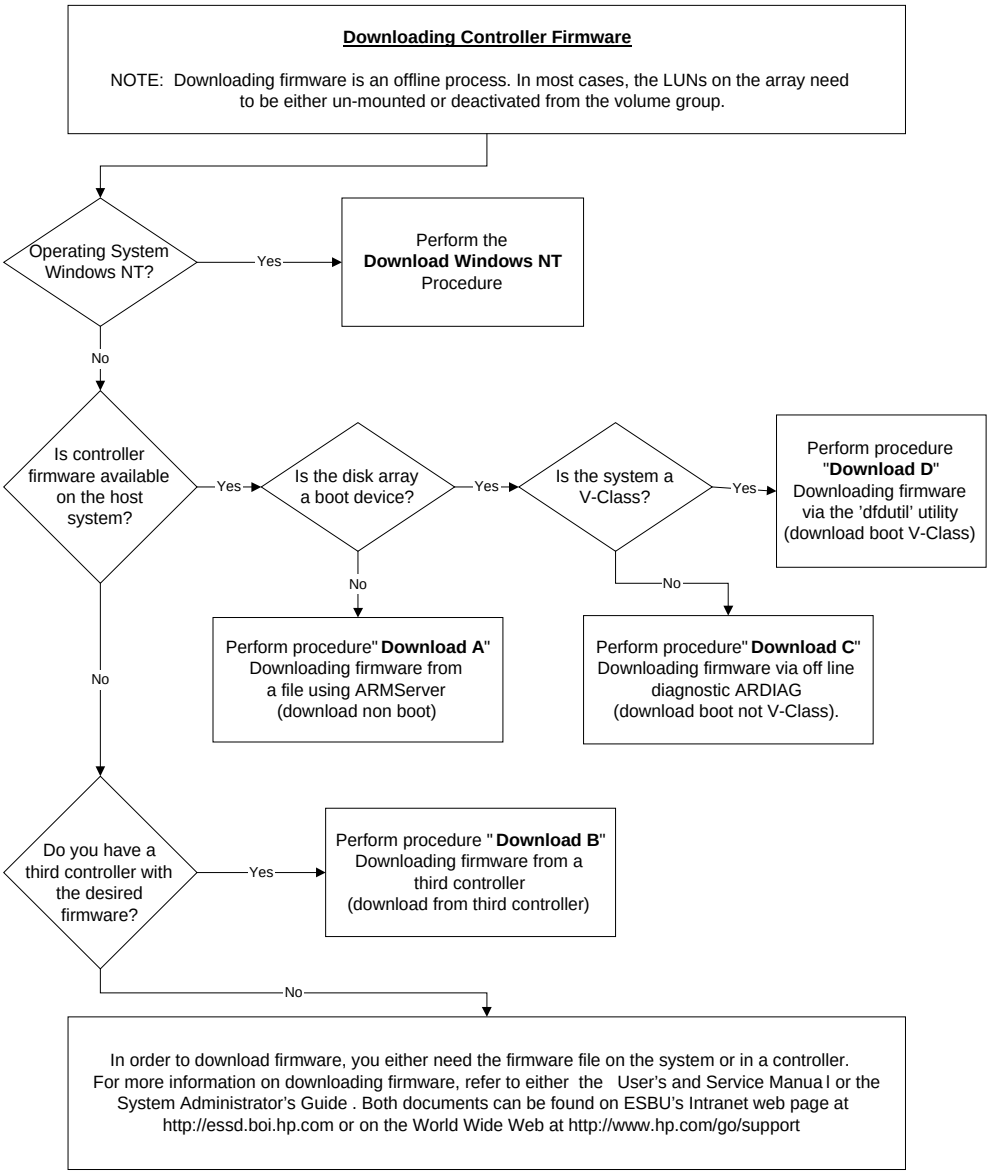
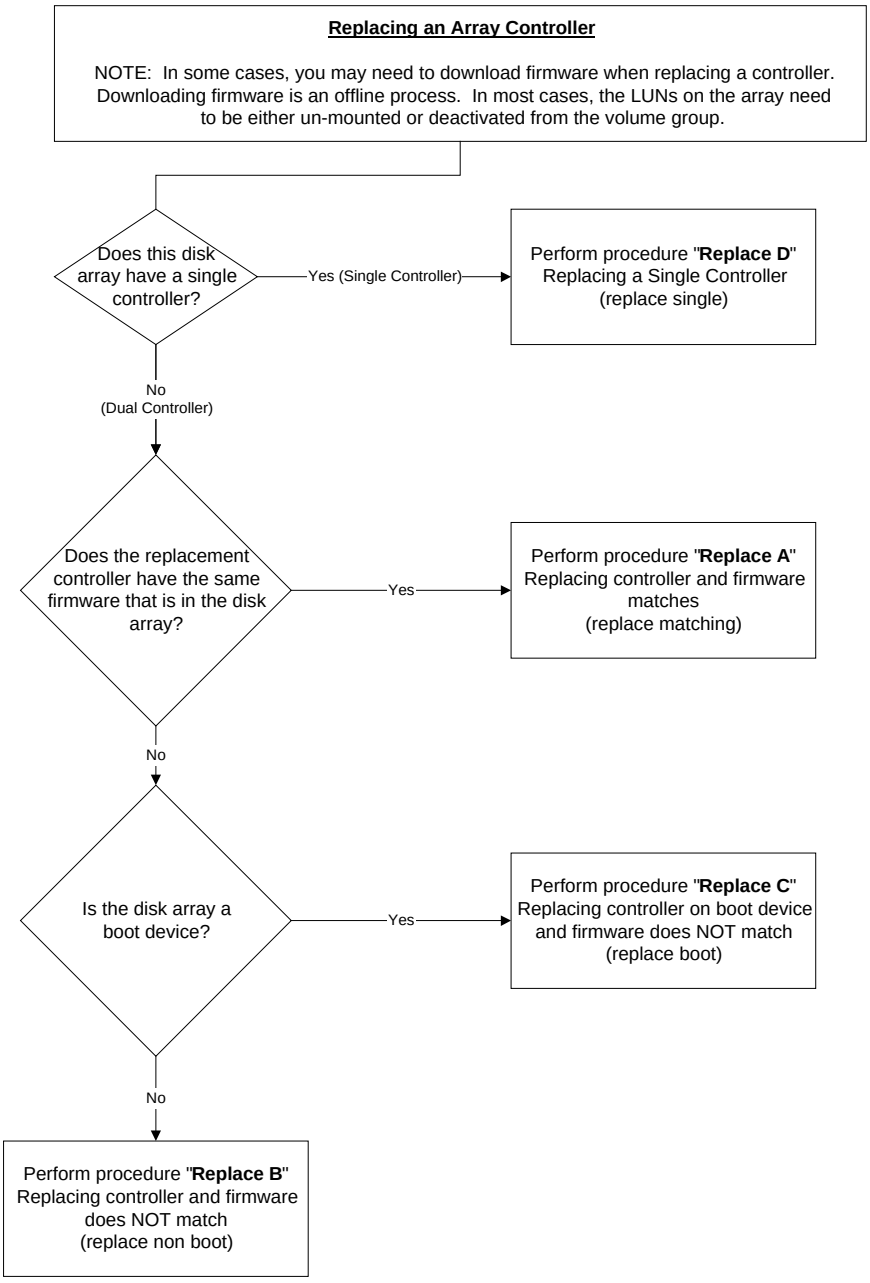


Figure 16. Replacing an Array Controller Flowchart



Links to Downloading Firmware:

Download Windows NT

Download A) Downloading Disk Array Firmware from a File Using ARMServer (AutoRAID Manager)

Download B) Downloading Disk Array Firmware from a “Third” Controller Using the Front Panel

Download C) Downloading Disk Array Firmware from a File Using Off-Line Diagnostics (ARDIAG)

Download D) Downloading Disk Array Firmware from a File on a V-Class system using dfdutil Utility

Links to Replacing an Array Controller:

Replace A) Replacing an Array Controller (Version of Firmware on the Replacement Array Controller Matches Version of Firmware on the Installed Array Controllers)

Replace B) Replacing an Array Controller In an Array that IS NOT used as a boot device and the Version of Firmware on the Replacement Array Controller DOES NOT Match Version of Firmware on the Installed Array Controllers.

Replace C) Replacing an Array Controller in an Array that is Used as a Boot Device (Version of Firmware on the Replacement Array Controller DOES NOT Match Version of Firmware on the Installed Array Controllers)

Replace D) Replacing an Array Controller in an Array with one controller installed.

Download Windows NT

AutoRAID Manager includes a separate utility for downloading controller firmware. This utility, `WinDownload,` simplifies the process of downloading new firmware to the controller in your disk array.

The WinDownload utility is used only for downloading firmware to the disk array controllers. Firmware can also be downloaded to the disk modules using the ARM `download` command line utility described in the *System Administrator's Guide*, which is shipped with each disk array.

The download process shuts down the disk array while the firmware is being downloaded, so the disk array will be inaccessible while the download is in progress.

CAUTION! In multi-host configurations, other hosts must not access the disk array while the download is in progress. Data can be lost if write requests are made to the disk array while a download is in progress.

Do not attempt to download controller firmware to a disk array that is serving as the NT boot device. If you attempt to do so, the operating system will crash.

To download controller firmware:

1. Alert users that data on the disk array will be inaccessible during the download.
2. From the **Start** menu, select **Programs|AutoRAID Manager|WinDownload**
3. Select the disk array you want to upgrade with new firmware.
4. Click **Select Firmware File**
5. Select the firmware file to be downloaded to the disk array. The latest version of firmware is installed in the `AutoRAID\FW` folder during setup. If the desired firmware file is in another location, locate and select it .
6. Click **Download**

   The download process will begin. The process can take up to 5 minutes to complete. When the download is complete the disk array will be brought back on line, ready to process I/Os from the host.

Download A) Downloading Disk Array Firmware from a File Using ARMServer (AutoRAID Manager)

CAUTION! Controller firmware HP4x and any later versions have a different data map format in NVRAM memory. Once you have HP48 or later, you can not "downgrade" to any firmware version prior to HP4x without first completely backing up all data on the array, including any meta-data, e.g., LUN and LVM configuration. After you have "downgraded" the firmware and formatted the array, all meta-data and real data will need to be restored from backup.

Assumptions: Use this procedure if the desired version of firmware is available from the host system, and you want to update the firmware on the installed array controllers.

1. Get `<array-id>` using ARMServer (`arraydsp -i`) or front panel (View Settings, Array S/N). You may also use the raw device file that is connected to the array.
2. Obtain the desired version of firmware and determine its `<codefilename>` (filename) and location (path).
3. Quiet (quiesce) or stop all I/Os, deactivate volume set, unmount file systems, stop traffic to the array.
4. Shutdown the array using ARMServer (`arraymgr -s shut <array-id>`) or front panel (Shutdown). The following table shows the proper front panel commands to shutdown the array:

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
–	"View Settings"
–	"Shutdown"
ENTER	"Confirm"
ENTER	"Shutting Down"
	then "Shutdown Complete"

5. Download the firmware (`download -C <codefilename> <array-id>`).

6. Verify updated firmware revisions on both controllers using ARMServer (`arraydsp -c <array-id>`) or front panel. The following table shows the proper front panel commands to verify the firmware on the array:

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Ready"
+	"Primary Cntrl: __"
+	"SCSI ID x:__"
+	"SCSI ID y __
+	"Firmware: HP__"

7. If ARMServer issues a "switch controller" command, you may have to repeat step 5 (download).

NOTE! In some older versions of ARMServer, the download command had a problem recognizing the primary array controller. This happens when the primary array controller SCSI ID is a higher number than the secondary array controller SCSI ID. If this problem occurs, the download command will issue a "switch controller" command and then stop. When this happens, issuing the download command again causes the download to complete properly.

8. The disk array will display the "Ready" state when the download command has completed.

Download B) Downloading Disk Array Firmware from a "Third" Controller Using the Front Panel (This is not the preferred method! Use this procedure only if the disk array firmware is NOT available from the host.)

CAUTION! Controller firmware HP4x and any later versions have a different data map format in NVRAM memory. Once you have HP4x or later, you can not use this procedure to "downgrade" to any firmware version prior to HP4x.

NOTE! This procedure is not recommended if you have a single controller installed in your array.

Assumptions: Use this procedure to download firmware if you are unable to use the host computer or the AutoRAID Manager (ARMServer). This procedure is used to update firmware using an array controller as the source of the new firmware.

1. Obtain a "third" controller with the desired version of firmware.
2. Reset (disconnect and then re-connect) both batteries on third controller at the same time to erase NVRAM.
3. Quiet (quiesce) or stop all I/Os, deactivate volume set, unmount file systems, stop traffic to the array.
4. The front panel display should say "Ready". Check the "System State" on the front panel display. It should say "System State: Ready". Also check to see which controller is set to primary. The primary controller is _____.

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Ready"
+	"Primary Cntrl: __"

5. Shutdown the array using the front panel.

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
-	"View Settings"
-	"Shutdown"
ENTER	"Confirm"
ENTER	"Shutdown Complete"

After shutdown has completed, push the on/off button to the off position completing the shutdown. This will turn off power to all modules.

6. Disconnect all disk drive modules from the back plane. You do not need to remove them completely. Just pull them out so that the cam handle is fully extended.
7. Remove the controller that was noted as primary in one of the previous steps.
8. Install the "third" controller into slot X. This may mean that you have to move the existing controller into slot Y.
9. Push the on/off button to the on position and allow the array to complete its initialization process. After the initialization has completed, the front panel should say "Not Enough Disks". Check the system state using the key strokes below. The System state should be "Not Enough Disks" with a "Firmware Needed" warning.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Warning: Firmware Needed"

10. Verify if the primary controller currently installed has the desired firmware using the front panel display. The following table shows the proper front panel commands to view which controller is the primary array controller, and what version of firmware is on the primary array controller.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Warning: Firmware Needed"
+	"Primary Cntrl: X"
+	"SCSI ID x: ___"
+	"SCSI ID y: ___"
+	"Firmware: HP__"

11. Copy the firmware from the primary controller to the secondary controller using the front panel:

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
+	"Cntrl Changes"
ENTER	"SCSI ID"
–	"Copy Firmware"
ENTER	"Confirm"
ENTER	"Copying Firmware", then "Firmware Loading", then array will initialize then "Offline SCSI ID"

12. The front panel display should say "Not Enough Disks". Check the "System State" on the front panel display. It should say "Not Enough Disks" with no other warnings.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Primary Cntrl: X"

13. Verify that both controllers have the desired firmware using the front panel. The following table shows the proper front panel commands to view the firmware revision installed:

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Primary Cntrl: X"
+	"SCSI ID x: ___"
+	"SCSI ID y: ___"
+	"Firmware: HP__"

14. Push on/off button to off position and wait for the array to turn off
15. Remove the "third" controller that was obtained is step 1. It should be in controller slot X.
16. Move the controller that is in slot Y into controller slot X.
17. Take the previously removed (original) controller and reset (disconnect and then re-connect) its batteries both at the same time.
18. Install this previously removed (original) controller in the now empty controller slot Y.
19. Push the on/off button to the on position and allow the array to complete its initialization process. After the initialization has completed, the front panel should say "Not Enough Disks". Check the system state using the key strokes below. The system state should be "Not Enough Disks" with a "Firmware Needed" warning.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Warning: Firmware Needed"

20. Verify if the primary controller currently installed has the desired firmware using the front panel display. The following table shows the proper front panel commands to view which controller is the primary array controller, and what version of firmware is on the primary array controller.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Warning"
+	"Warning: Firmware Needed"
+	"Primary Cntrl: X"
+	"SCSI ID x: Offline"
+	"SCSI ID y: Offline
+	"Firmware: HP__"

21. Copy the firmware from the primary controller to the secondary controller using the front panel:

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
+	"Cntrl Changes"
ENTER	"SCSI ID"
–	"Copy Firmware"
ENTER	"Confirm"
ENTER	"Copying Firmware", then "Firmware Loading", then array will initialize then "Offline SCSI ID"

22. The front panel display should say "Not Enough Disks". Check the "System State" on the front panel display. It should say "Not Enough Disks" with no other warnings.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Primary Cntrl: X"

23. You are now at a point in which the drives need to be re-installed. The drives were disconnected earlier to further protect the NVRAM. The NVRAM is very important. NVRAM stores all configuration and meta-data that point or map drive location information to real data. If this procedure has been successful up to this point, the correct NVRAM memory maps are located in both controllers and also in the disk drive modules.

If the NVRAM is located in both the controllers and the disk drive module correctly (there were no errors encountered during this procedure) Then do the following:

- Push on/off button to the off position
- Plug in all drive modules
- Push on/off button to the on position and wait for the initialization to complete.

If you are unsure that the NVRAM is correct in both controllers, there were errors, especially errors like No Address Map or NVRAM errors. Then do the following:

- Push on/off button to the off position
- Remove both controllers from slot X and Y and reset (disconnect and then re-connect) both batteries at the same time on each controller.
- Re-install both controllers. It doesn't matter which controller goes into which slot at this time.
- Plug in all drive modules
- Push on/off button to the on position and wait for the initialization to complete.

24. The front panel display should say "Ready". Check the "System State" on the front panel display. It should say "Ready".

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Ready"

25. If the array does not show up using ARMServer (`arraydsp -i`), you may have to re-connect to "see" the array using the ARMServer (`arraydsp -R`) command, which scans the bus for all arrays. This command can take a few seconds to execute. Once re-connected, you will "see" the array again.

Download C) Downloading Disk Array Firmware from a File Using Off-Line Diagnostics (ARDIAG)

Assumptions: Use this procedure if the desired version of firmware is available on a tape or other such media that can boot with the offline diagnostic environment (ODE). Do not use this procedure if the system is on a V class computer.

CAUTION! Controller firmware HP4x and any later versions have a different data map format in NVRAM memory. Once you have HP4x or later, you can not "downgrade" to any firmware version prior to HP4x without first completely backing up all data on the array, including any meta-data, e.g., LUN and LVM configuration. After you have "downgraded" the firmware and formatted the array, all meta-data and real data will need to be restored from backup.

NOTE! HP-qualified personnel only: For more information on ARDIAG, refer to the web address: http://essd.boi.hp.com/products/DiskArrays/autoraid/ARMdoclist.htm
click on "Off-Line Diagnostic Command Specification".

1. Obtain a bootable LIF file. You can get the LIF file from the web:

On the World Wide Web:

- http://www.hp.com/go/support
  - click next on "Enterprise Storage"
  - click next on "HP Enterprise Disk Arrays"
  - click next on "SureStore E Disk Arrays"
  - click next on "Disk Array 12H"
  - click GO on "Software/Firmware" beneath "Software & Drivers"

or, inside the HP firewall (HP-qualified personnel only):

- http://essd.boi.hp.com
- click on “Products”
- click on “Disk Arrays”
- click on “Disk Array 12H”
- click on “AutoRAID firmware”
- left click on “ARDlif_HPxx” (xx = the controller firmware revision you want to download)
- save the file using “save as” to your system

Once you have the ARDlif file, copy it to a tape using the following command:

dd if=ARDlif of=/dev/rmt/{tapedrive} bs=2k

2. On the machine you want to download and while the operating system is running get the following information:

Perform an “ioscan -fnCdisk” and “ioscan –fnCtape” to locate the arrays and the tape device and note their location.

Tape device hardware address _____

Tape device location (i.e., /dev/rmt/…): _____

Disk array(s) bus number(s): _____

Firmware file name needed to download _____
(This file should be in the ARDlif file)

Primary controller _____

If you are unsure which controller is the primary, verify from the front panel. Use the information below to discover which controller is the primary.

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Ready"
+	"Primary Cntrl: __"

3. Once this is complete, you can use this tape as a boot tape to run ARDIAG on any PA-RISC system using an AutoRAID product as a boot device. Shutdown HP-UX system and reboot the system from the tape.
4. At "Interact with IPL (y or n)?", answer "y".
5. At ISL>, type "ODE ARDIAG".
6. Enter the password at this point.
7. ARDIAG will scan the array busses and report those on the screen (each bus will be referenced by an index number).
8. At the "Please enter a range of the disk array busses you want to check," select only the range (by index number) that the array(s) is on. If you select the default range (index numbers of all busses found), this process could take 5+ minutes.

9. After checking the array busses, ARDIAG will search for firmware files on the tape and report those to you as well. The firmware files located on the tape will present you a table that looks like the following:

File name	Intended Product ID	Revision	Size
C3586AHPxx	HPC3586A disk array	HPxx	1048576
C5447AHPxx	HPC5447A disk array	HPxx	2097152

Now to set the environment variables:

10. Run the DISPMAP command. This command allows you to display all available AutoRAID disk arrays (controllers) on the system. Note the Test Disk # of the controller you've identified as the primary (by its path in ioscan).
11. Type TESTDISK_ # (where _ is a space and # is the Test Disk # from DISPMAP). Your returned message will read "Array state is ready".
12. Run the DISPMECH command. This command allows you to display physical mechanisms within a selected AutoRAID disk array. Note the Test Level # of the FRU you want to download the firmware to (i.e., Cntrl X).
13. Type TESTLEVEL_ # (where _ is a space and # is the Test Level # from DISPMECH). Your returned message will read "TESTLEVEL=# (where # is the number you selected).
14. At this point, you can run the INQUIRY command to verify that you have selected the primary controller. If you did not select the primary controller, use the TESTDISK and TESTLEVEL commands as detailed above to change to the primary controller.

To Download:

15. Type DOWNLOAD. You'll be presented with two options:

    1 - Download a firmware image file to the primary controller with an automatic update of same firmware to the secondary controller.

    2 - Update the secondary controller with the same firmware as the primary controller.

    Select option #1.

16. Enter the firmware filename that is on the tape to download. Type "?" to redisplay the firmware files.
17. At "Do you want to do the update?", enter "y". DO NOT INTERRUPT THIS PROCESS OR THE DEVICE COULD BE RENDERED INOPERATIVE!
18. You will receive several messages letting you know what is happening. After a few minutes, you will receive a message "Firmware Downloaded Successfully".
19. Repeat this process for all other arrays on the system.
20. When finished downloading firmware to all arrays, at ARDIAG>, type "EXIT ALL".
21. At ISL>, type "RESET".

Download D) Downloading Disk Array Firmware from a File on a V-Class system using dfdutil Utility

Assumptions: Use this procedure when the desired version of controller firmware is available as a DFDUTIL.LIF file for the V-Class system.

CAUTION! Controller firmware HP4x and any later versions have a different data map format in NVRAM memory. Once you have HP4x or later, you can not "downgrade" to any firmware version prior to HP4x without first completely backing up all data on the array, including any meta-data, e.g., LUN and LVM configuration. After you have "downgraded" the firmware and formatted the array, all meta-data and real data will need to be restored from backup.

Note! For information on dfdutil, refer to the man page dfdutil.

1. Obtain the desired version of DFDUTIL_VHPxx.LIF (xx = the controller firmware revision) and copy it the file /spp/data/DFDUTIL.LIF on the teststation. You can get the LIF file from the web:

On the World Wide Web:

- http://www.hp.com/go/support
  - click next on "Enterprise Storage"
  - click next on "HP Enterprise Disk Arrays"
  - click next on "SureStore E Disk Arrays"
  - click next on "Disk Array 12H"
  - click GO on "Software/Firmware" beneath "Software & Drivers"

or, inside the HP firewall (HP-qualified personnel only):

- http://essd.boi.hp.com
- click on “Products”
- click on “Disk Arrays”
- click on “Disk Array 12H”
- click on “AutoRAID firmware”
- left click on “DFDUTIL_VHPxx.LIF” (xx = the controller firmware revision you want to download)
- save the file using “save as” to your system

2. Once you have the DFDUTIL_VHPxx.LIF, copy it to a tape using the following command:

   dd if= the DFDUTIL_VHPxx.LIF of=/dev/rmt/{tapedrive} bs=2k

3. Run dfdutil and download HPxx firmware.

Replace A) Replacing an Array Controller (Version of Firmware on the Replacement Array Controller Matches Version of Firmware on the Installed Array Controllers)

Assumptions: Use this procedure if an existing array controller has failed (if disk array is either a boot or non-boot device), and the replacement array controller has the same version of firmware as the installed array controllers.

1. If replacement controller is new, install the controller batteries (supplied).
2. If replacement controller is NOT new, reset (disconnect and then re-connect) both batteries on the replacement controller at the same time to erase NVRAM.
3. Verify which controller has failed by examining the logs using the `logprint` command. This is to make sure you do not remove the functioning (good) controller.
4. Remove the “failed” controller. After Initialization, display panel shows “Ready.”
5. Install the replacement controller in the disk array. After initialization, display panel shows “Ready.”
6. The disk array will display the “Ready” state when both versions of firmware match.

Replace B) Replacing an Array Controller In an Array that IS NOT used as a boot device and the Version of Firmware on the Replacement Array Controller DOES NOT Match Version of Firmware on the Installed Array Controllers.

CAUTION! Controller firmware HP4x and any later versions have a different data map format in NVRAM memory. Once you have HP4x or later, you can not "downgrade" to any firmware version prior to HP4x without first completely backing up all data on the array, including any meta-data, e.g., LUN and LVM configuration. After you have "downgraded" the firmware and formatted the array, all meta-data and real data will need to be restored from backup.

NOTE! This is an offline procedure. All I/O to the array will need to be suspended for duration of this procedure.

Assumptions: Use this procedure if an existing array controller has failed, if the disk array a non-boot device, and the replacement array controller DOES NOT have the same version of firmware as the installed array controllers.

1. If replacement controller is new, install the controller batteries (supplied).
2. If replacement controller is NOT new, reset (disconnect and then re-connect) both batteries on the replacement controller at the same time to erase NVRAM.
3. Verify which controller has failed by examining the logs using the `logprint` command. This is to make sure you do not remove the functioning (good) controller.
4. Quiet (quiesce) or stop all I/Os, deactivate volume set, unmount file systems, stop traffic to the array.
5. Remove the "failed" controller. After Initialization, display panel shows "Ready."

CAUTION! It is very important that the array be in a "Ready" state. The array should not present any warning (other than a single controller warning) statements at this point.

6. Shutdown the array using the front panel.

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
–	"View Settings"
–	"Shutdown"
ENTER	"Confirm"
ENTER	"Shutdown Complete"

After shutdown has completed, push the on/off button to the off position completing the shutdown. This will turn off power to all modules.

7. Disconnect all disk drive modules from the back plane. You do not need to remove them completely. Just pull them out so that the cam handle is fully extended.
8. Pull the existing good controller and reset (disconnect and then re-connect) both batteries at the same time. This will mean that the only copy of valid maps reside on the disk drive modules.
9. Install both controllers. Put the controller with the desired firmware into controller slot X.
10. Push the on/off button to the on position and allow the array to complete its initialization process. After the initialization has completed, the front panel should say "Not Enough Disks". Check the system state using the key strokes below. The System state should be "Not Enough Disks" with a "Firmware Needed" warning.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Warning: Firmware Needed"

11. Verify if the primary controller currently installed has the desired firmware using the front panel display. The following table shows the proper front panel commands to view which controller is the primary array controller, and what version of firmware is on the primary array controller.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Warning: Firmware Needed"
+	"Primary Cntrl: X"
+	"SCSI ID x: __"
+	"SCSI ID y: __"
+	"Firmware: HP__"

12. Copy the firmware from the primary controller to the secondary controller using the front panel:

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
+	"Cntrl Changes"
ENTER	"SCSI ID"
–	"Copy Firmware"
ENTER	"Confirm"
ENTER	"Copying Firmware", then "Firmware Loading", then array will initialize then "Not Enough Disks"

13. The front panel display should say "Not Enough Disks". Check the "System State" on the front panel display. It should say "Not Enough Disks" with no other warnings.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Primary Cntrl: X"

14. Verify that both controllers have the desired firmware using the front panel. The following table shows the proper front panel commands to view the firmware revision installed:

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Primary Cntrl: X"
+	"SCSI ID x: __"
+	"SCSI ID y __"
+	"Firmware: HP__"

15. Push on/off button to off position and wait for the power to turn off
16. Remove both controllers from slot X and Y and reset (disconnect and then re-connect) both batteries on each controller at the same time.
17. Re-install both controllers. It doesn't matter which controller goes into which slot at this time.
18. Plug in all drive modules
19. Push on/off button to the on position and wait for the initialization to complete
20. The disk array should display the "Ready" state. Check the system state. There should be no other warnings.

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Ready"
+	"Primary Cntrl: X"

21. If the array does not show up using ARMServer (`arraydsp -i`), you may have to re-connect to "see" the array using the ARMServer (`arraydsp -R`) command, which scans the bus for all arrays. This command can take a few seconds to execute. Once re-connected, you will "see" the array again.

Replace C) Replacing an Array Controller in an Array that is Used as a Boot Device (Version of Firmware on the Replacement Array Controller DOES NOT Match Version of Firmware on the Installed Array Controllers)

CAUTION! Controller firmware HP4x and any later versions have a different data map format in NVRAM memory. Once you have HP4x or later, you can not "downgrade" to any firmware version prior to HP4x without first completely backing up all data on the array, including any meta-data, e.g., LUN and LVM configuration. After you have "downgraded" the firmware and formatted the array, all meta-data and real data will need to be restored from backup.

NOTE! This is an **offline** procedure. Because the array is a boot device, the operating system needs to be shut down

Assumptions: Use this procedure if an existing array controller has failed on a boot device, and the replacement array controller DOES NOT have the same version of firmware as the installed array controllers.

NOTE! The offline diagnostic is another way to install firmware when the array is a boot device. Offline diagnostics are not covered in this paper.

1. If replacement controller is new, install the controller batteries (supplied).
2. If replacement controller is NOT new, reset (disconnect and then re-connect) both batteries on the replacement controller at the same time to erase NVRAM.
3. Verify which controller has failed by examining the logs using the `logprint` command. This is to make sure you do not remove the functioning (good) controller.
4. Perform a shutdown of the operating system. Insure that there is no I/O traffic presented to the array.
5. Remove the "failed" controller. After Initialization, the display panel should say "Ready".

CAUTION! It is very important that the array be in a "Ready" state. The array should not present any warning (other than a single controller warning) statements at this point.

6. Shutdown the array using the front panel.

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
–	"View Settings"
–	"Shutdown"
ENTER	"Confirm"
ENTER	"Shutdown Complete"

After shutdown has completed, push the on/off button to the off position completing the shutdown. This will turn off power to all modules.

7. Disconnect all disk drive modules from the back plane. You do not need to remove them completely. Just pull them out so that the cam handle is fully extended.
8. Pull the existing good controller and reset (disconnect and then re-connect) both batteries at the same time. This will mean that the only copy of valid maps reside on the disk drive modules.
9. Install both controllers. Put the controller with the desired firmware into controller slot X.
10. Push the on/off button to the on position and allow the array to complete its initialization process. After the initialization has completed, the front panel should say "Not Enough Disks". Check the system state using the key strokes below. The System state should be "Not Enough Disks" with a "Firmware Needed" warning.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Warning: Firmware Needed"

11. Verify if the primary controller currently installed has the desired firmware using the front panel display. The following table shows the proper front panel commands to view which controller is the primary array controller, and what version of firmware is on the primary array controller.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Warning: Firmware Needed"
+	"Primary Cntrl: X"
+	"SCSI ID x: __"
+	"SCSI ID y: __"
+	"Firmware: HP__"

12. Copy the firmware from the primary controller to the secondary controller using the front panel:

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
+	"Cntrl Changes"
ENTER	"SCSI ID"
–	"Copy Firmware"
ENTER	"Confirm"
ENTER	"Copying Firmware", then "Firmware Loading", then array will initialize then "Not Enough Disks"

13. The front panel display should say "Not Enough Disks". Check the "System State" on the front panel display. It should say "Not Enough Disks" with no other warnings.

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Primary Cntrl: X"

14. Verify that both controllers have the desired firmware using the front panel. The following table shows the proper front panel commands to view the firmware revision installed:

KEY	DISPLAY
CANCEL CANCEL	"Not Enough Disks"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Not Enough Disks"
+	"Primary Cntrl: X"
+	"SCSI ID x: __"
+	"SCSI ID y __"
+	"Firmware: HP__"

15. Push on/off button to off position and wait for the power to turn off
16. Remove both controllers from slot X and Y and reset (disconnect and then re-connect) both batteries on each controller at the same time.
17. Re-install both controllers. It doesn't matter which controller goes into which slot at this time.
18. Plug in all drive modules
19. Push on/off button to the on position and wait for the initialization to complete
20. The disk array should display the "Ready" state. Check the system state. There should be no other warnings.

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Ready"
+	"Primary Cntrl: X"

21. If the array does not show up using ARMServer (`arraydsp -i`), you may have to re-connect to "see" the array using the ARMServer (`arraydsp -R`) command, which scans the bus for all arrays. This command can take a few seconds to execute. Once re-connected, you will "see" the array again.

Replace D) Replacing an Array Controller in an Array with one controller installed.

Assumption #1: If a successful shutdown has occurred in which the NVRAM memory maps were copied to the disk drive modules, then you can replace the controller and restore the maps using the following procedure:

1. If replacement controller is new, install the controller batteries (supplied).
2. If replacement controller is NOT new, reset (disconnect and then re-connect) both batteries on the replacement controller at the same time to erase NVRAM.
3. Replace the failed controller with the new one in controller slot X.
4. Push the on/off button to the on position and wait for the initialization to complete.
5. The disk array should display the "Ready" state. Check the system state. There should be no other warnings.

KEY	DISPLAY
CANCEL CANCEL	"Ready"
MENU	"Language"
–	"View Settings"
ENTER	"System State: Ready"
+	"Primary Cntrl: X"

Assumption #2: Since there is only one controller in the array, it is very likely that when the controller failed the NVRAM memory maps were destroyed as well. If the maps were destroyed or the procedure failed above, there are only two other options:

1. Try to restore maps using *arrayrecover* command. See the man page for details on command usage.

NOTE! The *arrayrecover* utility is only available on ARMServer patch released IPR 9810 or newer (PHCO_15699 for 10.x and PHCO_15700 for 11.0 or newer).

Also, the array controller firmware must be running version HP4x or newer.

2. Restore array configuration (LUN and or LVM) plus data from backup storage medium.

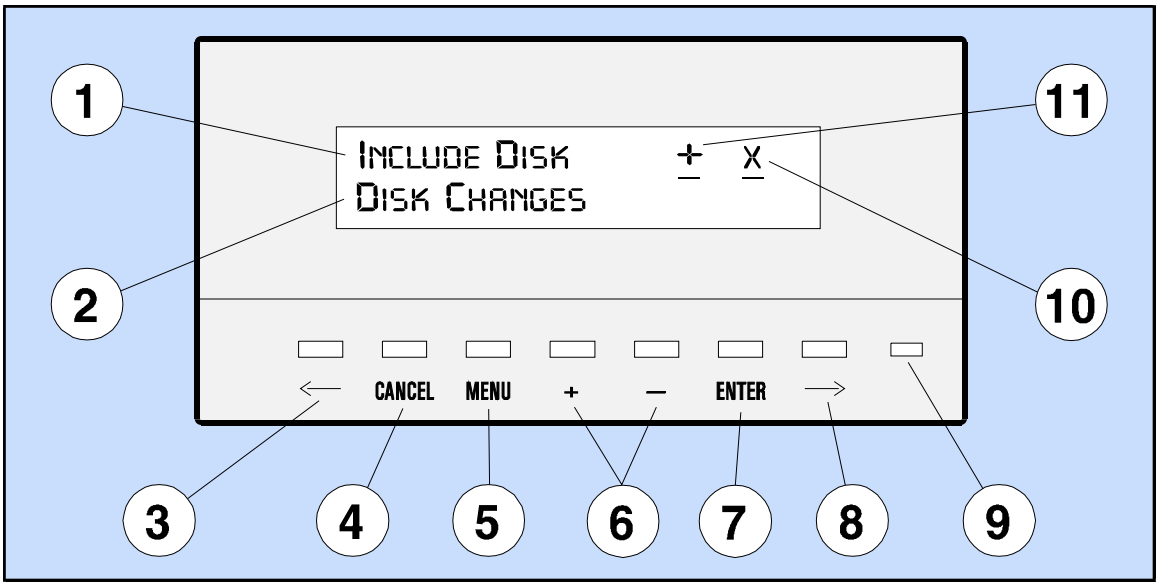
Chapter 3. Operating the Control Panel

This chapter explains how to operate the control panel on the front of your disk array. The control panel enables you to perform many array configuration and maintenance tasks. The control panel display can be seen through the front door, but the door must be open in order to access the control panel function keys.

Using the Control Panel

Figure 17 shows the control panel display and function keys.

Figure 17. Control Panel Display and Function Keys



1 – Available Choice
2 – Selection History
3 – Scroll Text Left
4 – Cancel Selection
5 – Display Main Menu
6 – Scroll Menus/Items
7 – Select Menu/Items
8 – Scroll Text Right
9 – Control Panel Status Light
10 – Controller Indicator (x or y)
11 – Menu/Item Scroll Indicator

Control Panel Status Light Operation

When first powered on, the disk array controller performs an extensive self-test. At first, a memory test is performed. During the memory test, the control panel status light will remain off for about one minute. Then a build process occurs. During the build process, the control panel status light is amber for about twenty seconds. At this time, the power-on self-test is finished, and now the control panel status light flashes green with input/output (I/O) activity.

If the power-on self-test passed successfully, the indicator will flash green with I/O activity. If any part of the disk array does not pass self-test, or if a problem occurs, the control panel status light will be amber (solid or flashing).

Table 1. Control Panel Status Light Indications

Color	Indication
Off	No power, disk array not available, or initializing.
Solid Green	Disk array Ready.
Solid Amber	Disk array self-test or disk array Fault.
Random Flashing Green	Disk array I/O (input/output) activity.
Random Flashing Amber	Disk array I/O (input/output) activity. Warning Mode.

Selecting a Menu Item

When using the control panel, follow these steps:

1. Press MENU to select the main menu.
2. Press + or – to scroll through to a menu.
3. Press ENTER to select a menu.
4. Press + or – to scroll through to a menu item.
5. Press ENTER to select a menu item.
6. Press + or – then press ENTER to select values for a task, enable/disable, and confirm/cancel.

Returning to the Main Menu

To return to the main menu, press Cancel.

Using the Control Panel Buttons

Viewing Array Settings

1. Select the View Settings from the main menu.
2. Use + or – to view the current settings.
3. Select the SCSI values menu to view settings for Unit Attn, Term Power, Parity, WDTR, SDTR, DRR, and VEB.
4. Select the Disk State menu to view the state of disks A1 to A6 and B1 to B6.
5. Select the L-Drv State menu to view the capacity of logical drives in the array.

Creating a Logical Drive

1. Select the Logical Drv Changes from the main menu.
2. Select Create Logical Drv.
3. Select a drive number 0 to 7.
4. Select a capacity size 100 Megabytes to Maximum.
5. Select Confirm.

Renumbering a Logical Drive

NOTE! Before renumbering a logical drive, you should know the impact this will have on the operating system. After you renumber a logical drive, make sure you perform the necessary steps to configure the renumbered logical drive into the operating system.

1. Select the Logical Drv Changes from the main menu.
2. Select Renumber L-Drv.
3. Select From drive number 0 to 7.
4. Select To drive number 0 to 7.
5. Select Confirm.

Deleting a Logical Drive

CAUTION! Deleting a logical drive (LUN) destroys all data on the logical drive. Before deleting a logical drive, make backup copies of the files you want to save or move the files to another logical drive.

1. Select the Logical Drv Changes from the main menu.
2. Select Delete L-Drv.
3. Select a drive number 0 to 7.
4. Select Confirm.

Including a Disk

1. Select the Disk Changes from the main menu.
2. Select Include Disk.
3. Select a disk number A1 to A6 or B1 to B6.
4. Select Confirm.

Enabling/Disabling Auto Include

1. Select the Disk Changes from the main menu.
2. Select Auto Include.
3. Select Enable or Disable.
4. Select Confirm.

Enabling/Disabling Auto Rebuild

1. Select the Disk Changes from the main menu.
2. Select Auto Rebuild.
3. Select Enable or Disable.
4. Select Confirm.

Starting/Stopping a Rebuild

1. Select the Disk Changes from the main menu.
2. Select Start Rebuild or Stop Rebuild.

3. Select Confirm.
4. Use the View Settings menu to check the rebuild progress.

Setting the Controller SCSI ID

1. Select the Cntrl Changes from the main menu.
2. Select SCSI ID.
3. Select a controller Cntrl X or Cntrl Y.
4. Select SCSI ID 0 to 15. (Offline takes disk array offline.)
5. Select Reset.
6. Select Confirm.

Changing Other Controller SCSI Settings

1. Select the Cntrl Changes from the main menu.
2. Select Unit Attn, Term Power, Parity, WDTR, SDTR, DRR, or VEB.
3. Select Enable or Disable.
4. Select Confirm.

Switching Controllers

1. Select the Cntrl Changes from the main menu.
2. Select Switch Cntrl.
3. Select Reset.
4. Select Confirm.

Testing a Controller

1. Select the Cntrl Changes from the main menu.
2. Select Reset Cntrl.
3. Select a controller Cntrl X or Cntrl Y.
4. Select Reset.
5. Select Confirm.

Formatting the Array

CAUTION! Once Logical Drives (LUNs) have been created on your disk array, you will not be permitted to Format the disk array again. You must delete all of the existing Logical Drives before a disk array can be formatted. Deleting Logical Drives (LUNs) and formatting the disk array destroys all data on the disk array. Before formatting a disk array, make backup copies of the entire disk array, or you will lose all data.

1. Follow the earlier procedure called “Deleting a Logical Drive” to delete all LUNs.
2. Select the Cntrl Changes from the main menu.
3. Select Format Array.
4. Select Confirm.

Shutting Down the Array

NOTE! Shutting down the array will take it offline.

1. Select the Shutdown from the main menu.
2. Select Confirm.

Setting the Language

1. Select the Language from the main menu.
2. Select a language.
3. Select Confirm.

Using Control Panel Menus

Table 2 shows all of the control panel main menus, except the Shutdown menu, which has no menu items. Note that some words have been abbreviated to fit the display window, such as the word “Cntrl” for “Controller,” “L-Drv” for “Logical Drive,” and “ActivSpare” for “Active Hot Spare.”

When the display panel shows that the disk array is “Ready,” it may also display an alias name for the disk array (if one has been defined). An alias must be defined with the Array Management (ARM) Utility as described in the *System Administrator’s Guide*, which is shipped with each disk array.

Table 2. Control Panel Main Menus

[1] Language	Cntrl Changes	Disk Changes	L-Drv Changes	View Settings
Deutsch	SCSI ID	Include Disk	Create L-Drv	Svstem State
English	[2] Switch Cntrl	Auto Include	Delete L-Drv	Warnings
Espanol	Reset Cntrl	Auto Rebuild	Renumber L-Drv	Primary Cntrl
Francais	Format Array	ActivSpare		SCSI ID x
Italiano	Parity	Start Rebuild		SCSI ID y
	SDTR	Stop Rebuild		Firmware
	WDTR			Array S/N
	Term Power			SCSI Values
	Unit Attn			Auto Include
	DRR			Auto Rebuild
	VEB			ActivSpare
	[3] Mark Log Disk			Number of Disks
	[3] Post Log Disk			Disk States
	Copy Firmware			Rebuild
	Recover			SIMMs Installed
				MBytes of RAM
				L-Drv States

Note 1: English Language menu shown
Note 2: Only if two controllers installed
Note 3: Only if Manufacturer Log Disk is installed

Language

The Language menu enables you to set the control panel language to one of five languages. After the language is set, the control panel will display all messages in the selected language.

Deutsch Sets the control panel language to German.
English Sets the control panel language to English.
Espanol Sets the control panel language to Spanish.
Francais Sets the control panel language to French.
Italiano Sets the control panel language to Italian.

Cntrl Changes

The Cntrl Changes menu enables you to change SCSI controller parameters for the array.

SCSI ID

NOTE! If two controllers are installed and are connected to the same SCSI bus, they must each have unique SCSI IDs.

Changes the SCSI ID (SCSI address) of controller x or controller y to any address from 0 to 15 (or offline) and resets the controller.

Switch Cntrl

For arrays with two controllers, Switch Cntrl manually makes the secondary array controller become "primary." If the primary array controller fails during operation of the array, the array automatically enables the secondary array controller to become "primary."

Reset Cntrl

NOTE! During a controller reset, all disk module lights turn amber for three to fifty seconds, and then go off.

Reset Cntrl resets controller x or controller y and runs internal diagnostics on the controller.

Format Array

CAUTION! Once Logical Drives (LUNs) have been created on your disk array, you will not be permitted to Format the disk array again. You must delete all of the existing Logical Drives before a disk array can be formatted. Deleting Logical Drives (LUNs) and formatting the disk array destroys all data on the disk array. Before formatting a disk array, make backup copies of the entire disk array, or you will lose all data.

Format Array clears all disk sets in the array. All data is lost, all disk sets are lost, and all NVRAM information is reset. You must delete all existing Logical Drives before formatting the disk array.

Parity

NOTE! This command requires a SCSI Reset or power cycle to take effect.

Parity switches SCSI Parity on (default) or off for the primary array controller. When parity is on, it enables error detection in the primary array controller.

SDTR

NOTE! This command requires a SCSI Reset or power cycle to take effect.

Synchronous Data Transfer Request. SDTR enables (default) or disables SCSI SDTR (Synchronous Data Transfer Request). SDTR controls the data rate on the SCSI bus used by the host and the array. SDTR also determines the negotiation protocol of the host. If SDTR is enabled, the array will initiate negotiation protocol; if disabled, the host will initiate negotiation protocol. In either case, the disk array will always respond to any requests made by the host.

WDTR

NOTE! This command requires a SCSI Reset or power cycle to take effect.

Wide Data Transfer Request. WDTR controls whether or not the additional eight bits on a wide bus will be utilized in most data phases of a SCSI command. WDTR also determines the negotiation protocol of the host. If WDTR is enabled, (default) the disk array will initiate for negotiation for wide transfer. If WDTR is disabled, the host will initiate negotiation protocol. In either case, the disk will always respond to any requests made by the host.

Term Power

NOTE! This command requires a SCSI Reset or power cycle to take effect.

Termination Power. Enables (default) or disables SCSI Term Power (SCSI Terminator Power). If Term Power is enabled, the disk array will supply power to the SCSI terminator connected to the array and to the SCSI termination on the HBA.

Unit Attn

NOTE! This command requires a SCSI Reset or power cycle to take effect.

Unit Attention. Enables (default) or disables SCSI Unit Attn (Unit Attention) for the primary array controller. If Unit Attn is enabled and a command failed with Unit Attention status, the controller reports to the host that a Reset has occurred since the last command was executed.

DRR

NOTE! This command requires a SCSI Reset or power cycle to take effect.

Disable Remote Reset. When DRR is ON or enabled (default), it prevents a host SCSI reset from resetting both disk array SCSI buses. With DRR set to ON, disk array controllers are not allowed to reset their own SCSI bus, even if the host resets that controller. If DRR is set to OFF, a host SCSI reset will also allow that controller to reset both disk array SCSI buses.

This parameter controls the SCSI bus reset behavior or the remote (other) disk array controller when a SCSI reset results in both disk array controllers processing a reset request. These include an ordinary reset signal, a bus device reset, or a reset subsystem command. When DRR is set to ON, the remote controller will not assert the SCSI reset signal to indicate that the commands were cleared. Hosts that cannot tolerate target bus resets should have DRR set to ON. When DRR is OFF, the remote controller will assert the bus reset signal to indicate that all outstanding requests were cleared in response to the reset.

VEB

NOTE! This command requires a SCSI Reset or power cycle to take effect.

Very Early Busy. VEB instructs the disk array to return a BUSY response during its power-on sequence. If VEB is enabled, the disk array will return a BUSY status to the host rather than simply ignore any commands during the power-on sequence. This will alert the host system to the presence of the disk array and thus avoid the possibility of the host system “timing out” before the disk array is ready.

Mark Log Disk

Mark Log Disk. Marks the log disk with information to record the starting time and stopping time of a benchmark test. The log disk is a specially formatted disk that records disk activity (IOs) with the host; it cannot store user data.

Copy Firmware

Copy Firmware will copy controller firmware from the primary array controller to the secondary array controller. This command will take the disk array offline. Copy Firmware requires that the SCSI bus be quiescent (quieted). Be sure to unmount all LUNs, deactivate any Volume Groups, and make certain that any data based activity that uses LUNs on the disk array has achieved quiescence before using this command.

Recover

If the disk array is not shutdown properly, it is possible that the data maps in NVRAM memory will be lost. For this reason, the disk array allows the data maps to be periodically written to the disk drives. If the maps are lost, an error code such as “No Address Table” will appear on the display. If your disk array is a boot device, you may have to recover the maps by using the front panel command called “Recover” under the “Cntrl Changes” menu. The Recover command is only supported in controller firmware versions later than HP40, and any patch delivered after IPR9808 release.

Disk Changes

The Disk Changes menu enables you to change disk parameters for the array.

Include Disk

Include Disk. Includes a new disk in the array. The array cannot use a newly installed disk until it has been included. Once included, you can use the disk to (1) increase capacity by creating a logical drive using part of or all of the disk capacity, or (2) protect against disk failure by enabling Active Hot Spare if not already enabled. Before a logical drive is created, the disk array can, however have increased performance capability once the new disk has been included.

Auto Include

NOTE! A disk used by another array will be marked “Previously Used” and will not be automatically included. Use Include Disk to include a “Previously Used” disk. Auto Include should be disabled if you want to run a diagnostic on a new disk before the array begins to use it.

Auto Include enables (default) or disables Auto Include when a new disk is installed in the array.

Auto Rebuild

CAUTION! Until a rebuild is complete, data may be lost if a second disk fails or is removed. If you stop a rebuild process before it completes, the array is operating in an unprotected mode. Use Start Rebuild to complete the rebuild process.

Auto Rebuild enables (default) or disables automatically rebuilding the array with the redundant data in the event of a disk failure. If Auto Rebuild is disabled, you must use Start Rebuild to manually rebuild data (see *Start Rebuild*). Auto Rebuild will start after a disk failure if Active Hot Spare is enabled or if you install a new disk of equal or greater capacity to replace the failed disk.

Active Hot Spare

Active Hot Spare enables (default) or disables the allocation of an Active Hot Spare space. If Active Hot Spare is enabled and Auto Rebuild is enabled, and if there is enough unallocated capacity, Active Hot Spare will rebuild data if a disk fails.

If you enable Active Hot Spare before creating any logical drives (LUNs), Active Hot Spare will guarantee that there is sufficient unallocated space to perform an Auto Rebuild. If there is not enough unallocated capacity available, you must add a disk to the array or delete a logical drive to create sufficient unallocated space.

When Active Hot Spare is disabled, the array may not be able to rebuild the data until another disk is added to the array.

Start Rebuild

Start Rebuild begins the rebuild process to recover redundant information that was on a failed disk. The array reconstructs the data from the failed disk using redundant data from the remaining disks.

Stop Rebuild

CAUTION! Until a rebuild is complete, data may be lost if a second disk fails or is removed. If you stop a rebuild process before it completes, the array is operating in an unprotected mode. Use Start Rebuild to complete the rebuild process.

Stop Rebuild ends the rebuild process before it completes.

Logical Drv Changes

The Logical Drv Changes menu enables you to change logical drive parameters for the array. A logical drive is a portion of the array capacity that appears to the operating system as a physical disk. Each logical drive corresponds to a SCSI Logical Unit (LUN) zero through seven. However, the data contained in each logical drive is distributed across all disks in the array, so there is no correlation between a logical drive and a single disk in the array.

The entire array capacity can be divided into up to eight logical drives. Only capacity that has been assigned to a logical drive is available to the operating system. Unassigned capacity is used to increase the array performance or may be used during a rebuild operation.

Create L-Drv — Creates a logical drive (SCSI LUN) number 0 to 7 with a capacity size of 100 Megabytes to a maximum of the total remaining capacity available in the array. Logical drives may be created any time disk space is available (or becomes available). Creating a logical drive makes the specified disk capacity available to the operating system. After creating a logical drive, you must configure the logical drive into your operating system to use the capacity.

CAUTION! Deleting a logical drive (LUN) destroys all data on the logical drive. Before deleting a logical drive, make backup copies of the files you want to save or move the files to another logical drive.

Delete L-Drv — Deletes a logical drive (SCSI LUN) number 0 to 7. When you delete a logical drive, its capacity is added to the unallocated capacity of the array.

CAUTION! Before renumbering a logical drive, you should know the impact this will have on the operating system. After you renumber a logical drive, make sure you perform the necessary steps to configure the renumbered logical drive into the operating system.

Renumber L-Drv — Renumbers any logical drive (SCSI LUN) number 0 to 7 to any logical drive (SCSI LUN) number 0 to 7. One reason for renumbering a logical drive is if you want to swap logical drive 0 with another logical drive you want to serve as the system boot drive.

Shutdown

NOTE! This command requires a SCSI Reset or power cycle for the controller to become ready. (Shutdown is a single command and has no menu items.)

Shutdown makes the array unavailable to the host. When a Shutdown is initiated, the array completes any I/Os in progress, posts array information stored in controller NVRAM to disks in the array, then goes offline. A Shutdown should be performed prior to the following procedures:

- Powering off the disk array for more than a week;
- Replacing the batteries in a controller module;
- Moving all of the disk modules to a new array and retaining all data.

View Settings

System State	Displays the system state.
Warnings	Displays the warnings.
Primary Cntrl	Displays the primary array controller (x/y).
SCSI ID x	Displays the SCSI ID for controller x.
SCSI ID y	Displays the SCSI ID for controller y.
Firmware	Displays the current version of firmware for the primary array controller.
SCSI Values	Displays the SCSI values for Unit Attn, Term Power, Parity, WDTR, SDTR, DRR, and VEB.
Auto Include	Displays the status of the Auto Include (Enabled/Disabled).
Auto Rebuild	Displays the status of the Auto Rebuild (Enabled/Disabled).
ActivSpare	Displays the status of Active Hot Spare (Enabled/Disabled).
Number of Disks	Displays the current number of disks configured in the array.
Disk States	Displays the current states of all disks A1–A6 and B1–B6 in the array.
Rebuild	Displays the current status of the rebuild operation.
SIMMs Installed	Displays the number of SIMMs currently installed in the controller indicated.
MBytes of RAM	Displays the Megabytes of RAM currently installed in the controller indicated.
L-Drv States	Displays the size in Megabytes of all logical drives 0 to 7 in the array.

Chapter 4. Concepts and Management

This chapter describes in greater detail the concepts and management of the disk array, including features and hardware design of the disk array. This information will give you a better understanding of how the disk array operates, which should help you make some of the decisions involved in managing the disk array.

Included is a very brief description of some of the basic concepts of disk array technology for those unfamiliar with disk arrays. If you would like to know more about disk arrays, many good articles have been published on the subject.

Disk Arrays in Brief

A disk array uses a group (or array) of disk drives connected to an array controller, which distributes (or stripes) data across the disks in the array. Disk array technology offers the potential to provide three important benefits: high availability, high performance, and cost-efficient data storage.

Perhaps the most important feature of disk arrays is their ability to provide high availability, or protection against disk failure. This protection is achieved through the use of redundant information, which is used to reconstruct data that is lost when a disk fails.

Disk arrays typically offer a variety of techniques for managing redundant information. These techniques are referred to as RAID levels. The RAID level used has a direct impact on the remaining two factors: performance and cost-efficient data storage.

Although there are a number of different RAID levels, the only two we are concerned with here are RAID 0/1 and RAID 5.

- **RAID 0/1** – gives you data redundancy and good performance, but the performance is achieved by using a less efficient technique of storing redundant data called “mirroring.” Mirroring maintains a backup copy of all data, so half of the disk space is consumed by redundant data. This results in a higher cost to store your data.
- **RAID 5** – provides data redundancy and improves cost-efficiency by using a more efficient method of storing redundant data. However, the storage method extracts a performance penalty for each write operation. This can impact system performance if your applications frequently update large amounts of data.

Disk Array Features

This section describes some of the key features of the disk array. Understanding how these features work will allow you to use them to best advantage when managing your disk array.

Dynamic Data Migration

Unlike most conventional disk arrays, the disk array automatically manages its disks for the optimum balance of performance and storage efficiency. It achieves this through the use of an innovative technique called Dynamic Data Migration**,** which uses the best RAID level for storing data.

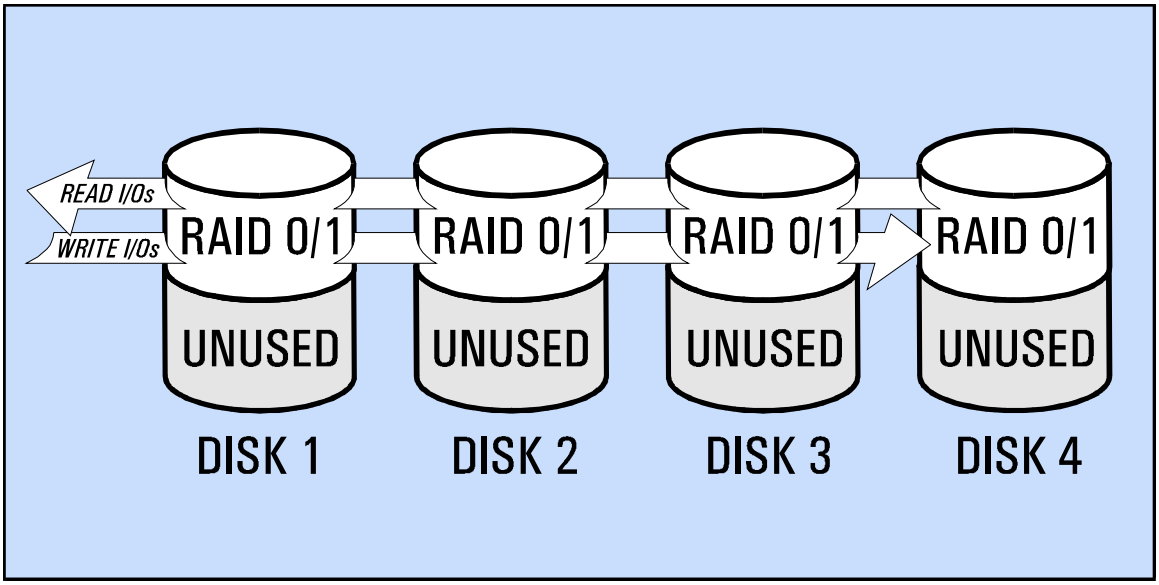
Most disk arrays operate using a single RAID level. However, Dynamic Data Migration uses two levels: RAID 0/1, which optimizes performance, and RAID 5, which optimizes storage efficiency. Dynamic Data Migration combines the benefits of RAID 0/1 and RAID 5 while reducing the disadvantages of each. Dynamic Data Migration uses RAID 0/1 and RAID 5 exclusively, therefore all data is fully protected (redundant).

Dynamic Data Migration optimizes performance and storage efficiency by changing the storage techniques used as the amount of data stored on the disk array increases. The following examples illustrate how Dynamic Data Migration manages the distribution of data during three different stages of capacity.

Stage 1: Low Data Storage

A newly installed disk array will typically have only a small amount of data stored on it. In this case, the disk array has room to keep all data in RAID 0/1. All I/Os can be serviced from RAID 0/1, so disk array performance is optimized.

Figure 18. Low Data Storage

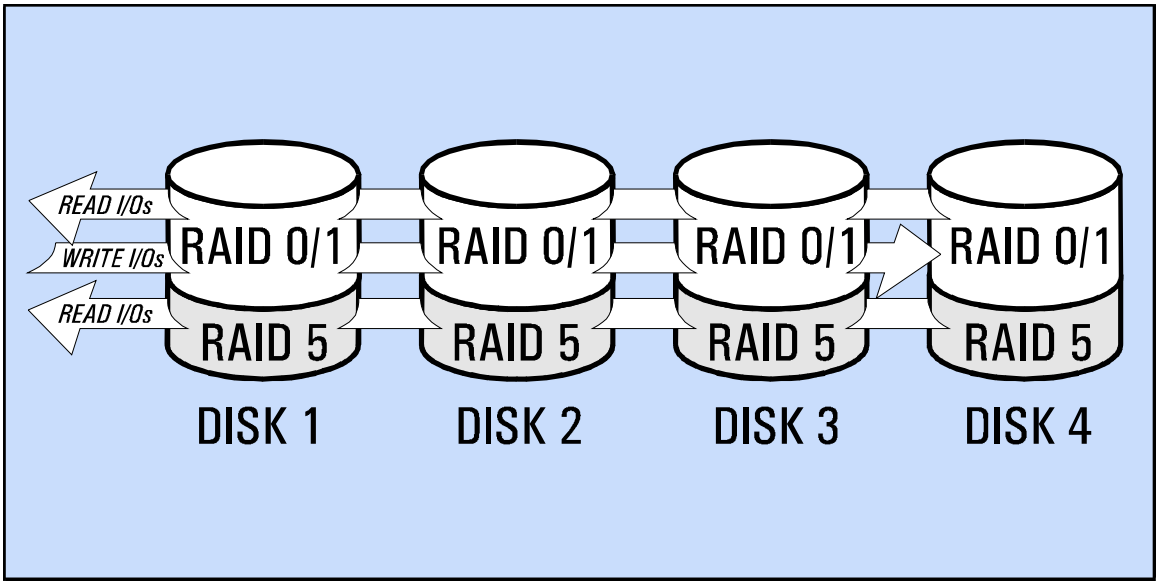


Stage 2: Moderate Data Storage

As more data is stored, a point is reached where it becomes necessary for the disk array to begin moving or migrating data from RAID 0/1 to RAID 5. Because RAID 5 is more storage efficient, this migration frees up capacity for more data. The more full the array gets, the larger the percentage of data stored in RAID 5 becomes.

The disk array examines all data and moves it to RAID 5 only if it has not been updated recently. Write I/Os are serviced faster from RAID 0/1, so this technique helps maintain disk array performance by keeping data that has the highest probability of changing in RAID 0/1. Read I/Os are serviced just as quickly from RAID 5 as from RAID 0/1, so moving data that may only be read to RAID 5 has little impact on performance.

Figure 19. Moderate Data Storage

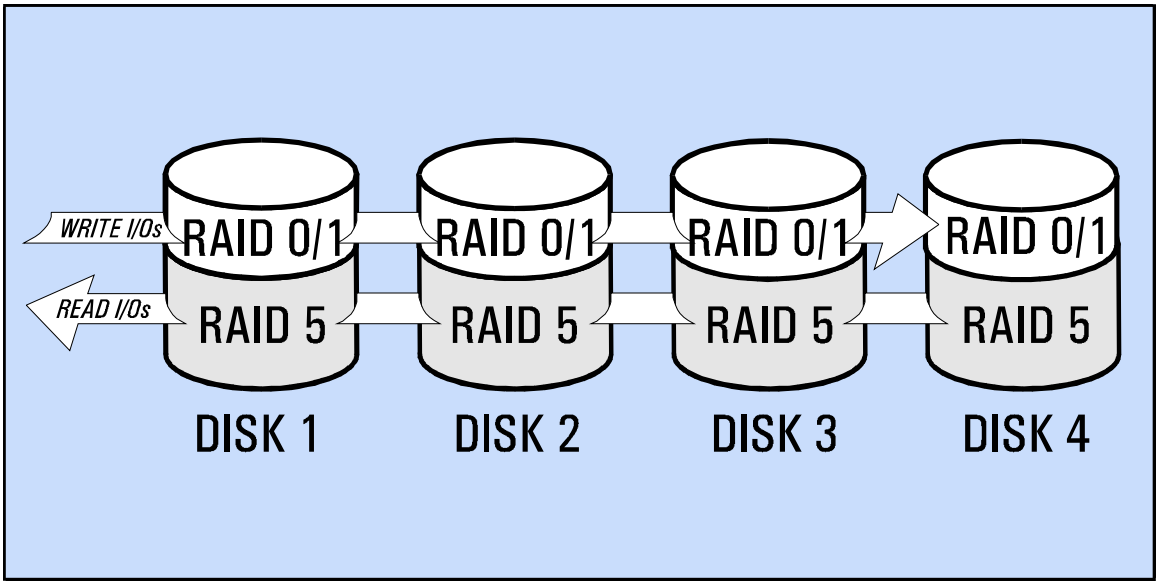


Stage 3: High Data Storage

As the disk array nears its maximum storage capacity, most data is stored in RAID 5. The array always reserves a certain amount of capacity for RAID 0/1 to maintain an adequate level of performance. The disk array continues to try to keep the most recently updated data in RAID 0/1, but if the array is near maximum capacity this becomes more difficult.

As long as the disk array can continue to service most writes from RAID 0/1, performance is maintained. But if the number of writes exceeds the current available RAID 0/1 space, the disk array must begin servicing writes from RAID 5 and performance begins to suffer. When data residing in RAID 5 must be updated, it is usually necessary to move the data to RAID 0/1 before performing the write.

Figure 20. High Data Storage

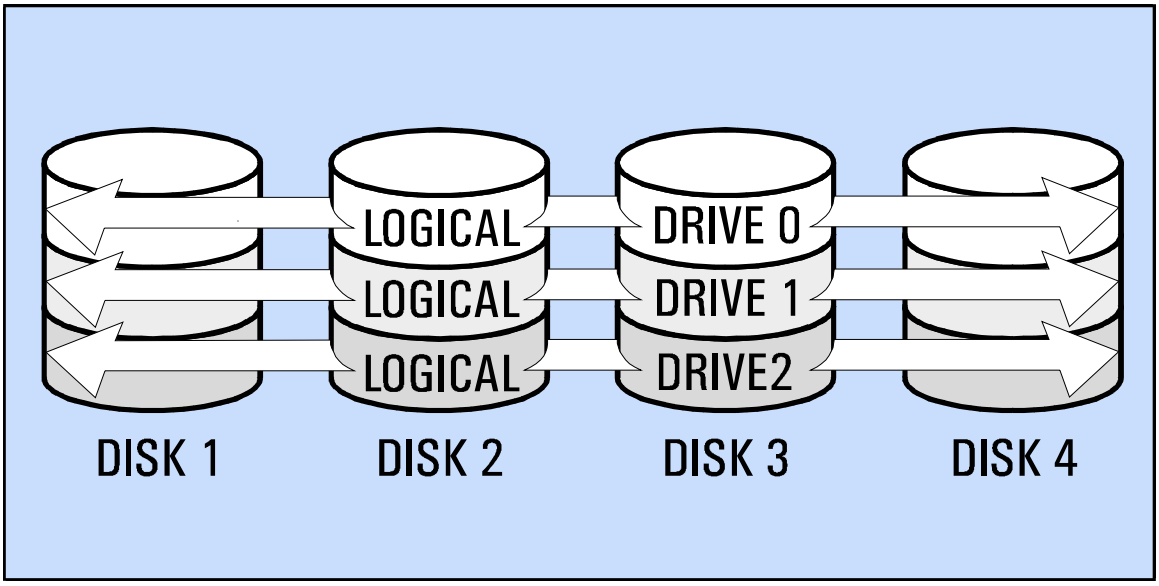


Logical Drives (LUNs)

The entire capacity of the array is divided into entities called logical drives or LUNs. The host operating system treats each disk array logical drive as an individual disk, subdividing it again if necessary into partitions. The disk array can be divided into up to eight logical drives.

To maintain data redundancy and improve performance, the data in each logical drive is distributed across all disks in the array. Consequently, there is no correlation between a logical drive and a specific physical disk—each logical drive encompasses all disks. This is particularly important to remember when adding a disk and creating a logical drive to use the new capacity. The new logical drive you create is not confined to the new disk; like all the other logical drives, it is distributed across all the disks in the array.

Figure 21. Logical Drives



Auto Include

The Auto Include feature of the disk array simplifies the process of adding new disks to your array. New disk capacity can be added to the disk array while it is running, eliminating the need to bring the host computer system down. You avoid the time consuming backup/restore process required by some disk arrays when adding new capacity.

Auto Include automatically adds new disks to the disk array configuration as soon as they are installed in the array enclosure. Once included, the array immediately begins using the new disk to increase performance by adding its capacity to the RAID 0/1 space. You can continue to use the new disk to increase performance, or you can make the capacity of the new disk available to the operating system by creating a new logical drive, which is also done online without disrupting array operation.

Auto Include is performed only for new disks which are operating normally and are ready to be used. Such disks typically are assigned a state of Normal when they are installed. If the disk array determines that the new disk has one of the following states, the disk will not be included automatically:

- **Previously Used** – to protect any data that may be on the disk, you must manually add a disk with this state.
- **Unsupported** – the disk has not been tested and certified for operation in the disk array. Only supported disks are guaranteed to work properly in the disk array. You can include an unsupported disk manually, but there is no assurance that it will operate properly in the disk array.
- **Failed** – the disk is not functional and cannot be included, even manually.
- **Initialization Failed** – the disk failed the initialization test performed by the controller and cannot be included, even manually.

Active Hot Spare

The Active Hot Spare feature of the disk array offers increased protection against disk failure. Active Hot Spare, used in conjunction with Auto Rebuild, ensures that the disk array can restore data redundancy and performance as quickly as possible following a disk failure.

Active Hot Spare reserves capacity to perform a rebuild in the event of a disk failure. If you are using disks of different capacities in your array, Active Hot Spare reserves enough space to rebuild the largest disk drive. Like logical drives, the capacity reserved for the Active Hot Spare is distributed across all the disks in the array—no one physical disk contains the Active Hot Spare.

Active Hot Spare is similar to the dedicated “hot spare” disks used in some conventional disk arrays. However, unlike conventional disk arrays that let the hot spare remain idle until it is needed, the disk array uses the Active Hot Spare for RAID 0/1 storage until the spare is needed. This provides the added benefit of enhancing performance while also protecting against disk failure.

Auto Rebuild

Auto Rebuild works in conjunction with Active Hot Spare to provide maximum protection against disk failure. Auto Rebuild allows the disk array to automatically begin rebuilding a failed disk drive, thus restoring data redundancy as quickly as possible. A rebuild priority setting allows you to balance array performance with rebuild speed.

If a disk fails with Auto Rebuild enabled, the disk array immediately begins rebuilding the contents of the failed disk on the Active Hot Spare (or other available unallocated capacity). The disk array uses redundant information stored on the remaining disks to reconstruct the data that was on the failed disk. Until the rebuild is complete, the array is vulnerable to another disk failure and performance will be impacted.

If you want more control over the rebuild process, you can disable Auto Rebuild and start a rebuild manually. This allows you to control when the rebuild is performed, but it can leave your data vulnerable to a second disk failure until the rebuild is complete.

To perform a rebuild (automatic or manual), the disk array must have adequate available capacity. The best way to make this capacity available is by enabling the Active Hot Spare. This ensures that the disk array always has enough capacity to rebuild even the largest disk in the array.

Rebuild Priority

During a rebuild, the disk array is trying to do two things at once: perform the rebuild and service I/O requests from the host. A rebuild priority allows you to define which of these operations is more important.

High rebuild priority allows the disk array to complete the rebuild as quickly as possible, but system performance may suffer because host I/Os are delayed. Low rebuild priority instructs the array to give precedence to server I/Os, thus maintaining system performance, but delaying the completion of the rebuild.

Interrupted Rebuild

Removing a disk from the array with Auto Rebuild enabled will cause the array controller to immediately begin a rebuild (assuming there is an Active Hot Spare or enough unallocated capacity available). If the disk is reinstalled before the rebuild is complete, the array controller will recognize the missing disk and stop the rebuild. It is not necessary for the rebuild to continue because any data on the disk that has not changed in its absence is still valid. However, data that gets written while the disk is missing must be rebuilt, so the rebuild operation might not stop. The rebuild must continue if there were any write I/Os while the disk was missing from the array.

Auto Failover

To provide maximum hardware redundancy, a second array controller protects the disk array against a single array controller failure. If the first array controller fails, data continues to be available by the use of the second array controller. This capability is called Auto Failover.

NOTE! To have uninterrupted access to data during Auto Failover, your host disk array driver must support failover capability (multiple paths to the same device).

The contents of the controller NVRAM is updated on both controllers simultaneously. By maintaining a mirror image of all vital operating parameters, the secondary array controller can take over immediately in the event of a failure, with no disruption to the host should the primary array controller fail.

Failure of the first array controller can be detected by the host operating system or by the second array controller, which continually monitors the operation of its partner. Regardless of how the failure is detected, it is ensured that operation is automatically handled by the second array controller if the first array controller ever fails.

Following are the firmware behavior scenarios if a controller fails. If a controller fails in a dual controller configuration, the redundant controller may be offline performing necessary initialization routines that check for data integrity. The following scenarios depict the offline activities that will occur:

1) Hot plug event of either controller.
    - This will cause the redundant controller to invoke a full initialization test cycle. This test cycle is required in order to insure data integrity of the NVRAM contents as well as back end disk drives that were affected by removing a SCSI device (the controller) from the bus.
    - The controller that is hot plugged will also issue a SCSI reset on the host side. This will invoke host initialization routines as well.
    - Time offline is approximately 2 minutes.
2) A failure in the “secondary controller” other than a hot plug event.
    - The primary controller will not need to issue an initialization test cycle.
    - There should be NO offline time
3) A failure if the “primary controller” other than a hot plug event.
    - This will cause the redundant controller to invoke a full initialization test cycle. This test cycle is required in order to insure data integrity of the NVRAM contents and to set up the controller as primary.
    - Time offline is approximately 2 minutes.

Shutdown

The disk array uses a coordinated process called Shutdown to take the disk array offline. The primary function of Shutdown is to copy the contents of the controller NVRAM to the disks. This protects critical data stored in the NVRAM against loss should battery backup for the NVRAM fail in the absence of ac power.

In the Shutdown state, the disk array can still execute some SCSI commands from the host, but the host cannot access any of the data on the disk array.

Shutdown is performed automatically when the disk array is turned off using the power switch on the enclosure. The action of the power switch delays shutting off power long enough for the array controller to copy the NVRAM contents to each disk.

NOTE! If power to the disk array is lost by means other than turning off the switch, the array will not have time to perform a successful Shutdown. In this case, the battery can sustain the NVRAM contents for a minimum of one week.

Shutdown can be initiated manually using the disk array control panel or using a host software utility. However, a Shutdown makes all data on the disk array unavailable to the host.

Disk Array Hardware

This section describes the operation and design of the disk array hardware. This information is provided for those users who desire to gain a better understanding of how the disk array hardware operates.

Disk Array Controller Module

The disk array controller contains the intelligence and functionality required to manage the operation of the entire disk array. The major responsibilities of the disk array controller include:

- Implementing Hewlett-Packard *AutoRAID*™ to ensure optimum performance and cost-efficient data storage.
- Managing all data transfers between the host and the disks.
- Maintaining data integrity by automatically correcting any data errors that occur.
- Rebuilding the array in the event of a disk failure.
- Monitoring the operation of all hardware components, including itself.
- Alerting the host in the event of a problem with the disk array.

The disk array is operated with both a primary array controller and a secondary array controller for controller hardware redundancy. The use of two controllers allows the disk array to have controller redundancy, which protects against a single controller failure.

In dual controller configurations, both controllers may be active, thus allowing a possible increase in disk array performance while simultaneously providing redundancy.

The contents of controller NVRAM is updated on both controllers simultaneously. By maintaining a mirror image of all vital operating information, the secondary array controller can take over immediately should a controller fail.

NVRAM

Each controller contains NVRAM (non-volatile RAM) used to store vital operating parameters and mapping information used in managing the array.

Because data is spread across the disks, the array controller must have some means of determining where each block of data is located. It accomplishes this using a logical-to-physical data map stored in controller NVRAM. This map is vital to managing data—without it, all data on the array is unrecoverable.

The contents of the NVRAM is maintained by dual battery backup if power to the disk array is off. Each controller module has its own dual set of batteries. If the batteries fail or lose their charge while power is off, the NVRAM contents will be lost. To protect against this, the Shutdown operation copies the contents of the NVRAM to each disk when power to the array is turned off by the power switch. This allows reconstruction of the data in NVRAM memory if the original map in NVRAM is lost or corrupted.

The process of copying the contents of NVRAM to the disks makes the disk set independent of its controller. Because all the necessary mapping information is on the disks, it is possible to install a new controller or move the entire disk set to another controller. The new controller will determine that it has a new disk set, and the controller will attach itself to those disks.

Data Maps and Array Recovery

Two of the disks in the disk array are used to store data recovery map information. If the data maps in NVRAM memory are lost, you may be able to recover them with the *arrayrecover* utility. The *arrayrecover* utility and the data recovery map settings and parameters are described in more detail in the *System Administrator's Guide*, which is shipped with each disk array.

The data resiliency feature for HP AutoRAID provides a means of recovering data after loss of NVRAM when the disk array is not shut down properly. Such a loss can only occur due to: dead battery, battery mishandling, a single failure in single controller configuration, or a multiple failure in dual controller configuration. The data maps in NVRAM memory are reconstructed using the latest copy of mapping information stored on the disk drives. This reconstruction includes a combination of the maps which were written during Shutdown, and the data recovery maps which are written at regular intervals. Part of the recovery operation includes performing a parity scan on the contents of the entire disk array to validate the accuracy of the maps and to correct any parity inconsistencies. This process can take up to several hours depending on the amount of data on the disk array.

Controller firmware places a limit on the amount of time either data or map information can reside in battery-backed RAM before the process of writing that information to disk is begun. The firmware can optionally eliminate this limited exposure, which it automatically does during single controller operation.

If the data maps in NVRAM memory are lost, all data except that retained only in NVRAM can be recovered using the Recover command via the front panel or the *arrayrecover* utility. In single-controller operation, the write cache is disabled, resulting in no data exposure to NVRAM loss. Disabling of the write cache is accompanied by a very serious degradation in performance under some workloads. This feature is supported on controller firmware versions later than HP40.

Disk Cache

The array controller implements caching during both reads and writes. Separate read and write caches are maintained in DRAM. The amount of cache DRAM and NVRAM can be expanded to improve performance.

Controller Batteries

CAUTION! Controller batteries are a vital and integral part of maintaining the memory maps during a power loss, or any time your disk array has not successfully completed a Shutdown before power off. If power is lost, and you are not using an Uninterruptable Power Supply (UPS), the batteries in the controller store the current memory maps of your data in NVRAM.

Each controller module contains dual backup batteries, which provide power to the controller NVRAM when ac power to the disk array enclosure is off.

Many factors affect battery life, including not only time of battery use, but also time of battery storage. Controller batteries should be replaced every three years, or sooner if the display module indicates a constant “Battery Discharged” message.

Typically, a Shutdown is performed when the disk array is turned off, which copies the contents of the NVRAM to each of the physical disks in the array. If power to the array is lost before a proper Shutdown can be performed, the contents of the NVRAM must be maintained by the battery backup system until power is restored. When fully charged, the batteries are capable of sustaining the contents of the NVRAM for a minimum of one week.

Disk Modules

The disk modules (also referred to as “disks”) provide the storage medium for the disk array. A minimum of four disk modules is required to operate the disk array. Different capacity disk modules can be installed in the same array.

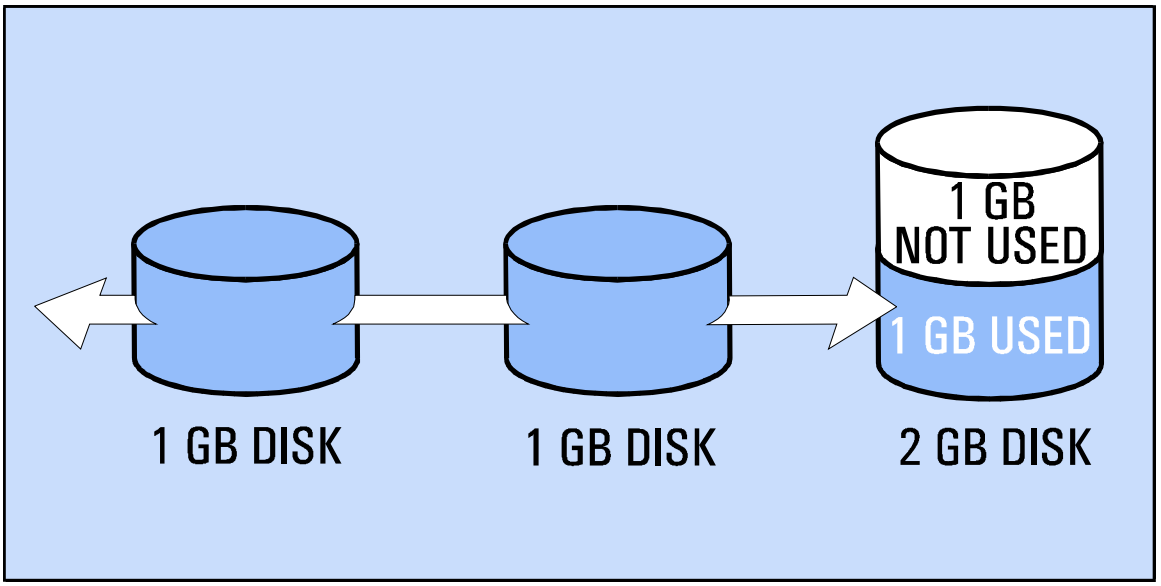
A new disk can be added at any time—even while the disk array is operating. The array controller will recognize that a new disk has been added, and will include the disk in the array configuration automatically if the Auto Include feature is enabled. To make the additional capacity available to the host, a new logical drive must be created, and the resulting drive must be configured into the operating system.

Using Disks of Different Capacities

Disks of different capacities can be installed in the same array, providing maximum flexibility and expandability for your disk array. This makes it easy to increase your array's data capacity as new, higher-capacity disks become available.

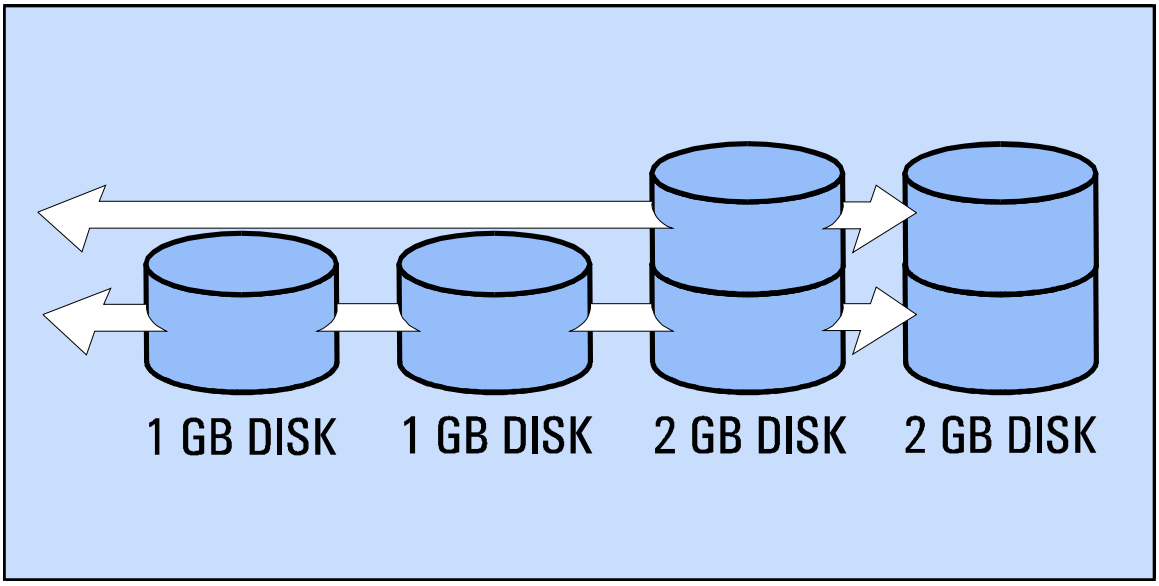
There is an important point to remember when using disks of different capacities in the same array: You should add at least two high-capacity disks to the array to use their entire capacity. If you add a single high-capacity disk, the array will not be able to use its full capacity. In this situation, the array can only use capacity equal to that of the largest disk already installed in the array. For example, if your disk array has only 4.3-Gigabyte disks and you add a single 9.1-Gigabyte disk, the array can only use 4.3 Gigabytes of the high-capacity disk (at least until another 9.1-Gigabyte disk is added).

Figure 22. Using Disks of Different Capacities



This is a result of the way in which redundant data is stored using RAID technology. Because there is no corresponding space on another disk for redundant data, the array cannot use the upper portion of the high-capacity disk. Thus, adding a single high-capacity disk will not yield all the additional capacity you had expected. To avoid this situation, always install at least two high capacity disks in the array.

Figure 23. Installing a Second High-Capacity Disk



Disk Stamps

Because data is distributed across all disks, the array controller must keep track of which disks are installed in the array. To do this, the array controller writes a unique stamp on each disk. The disk stamp includes a unique number assigned to the disk (typically its serial number), and the numbers of the other disks in the disk set. This information allows the array controller to determine if any disk is missing from the disk set.

The disk stamp identifies each disk's "logical" position in the array configuration relative to the other disks. When managing data, the array controller deals in terms of logical position, rather than physical location in the array enclosure. Thus, disks can be moved to different enclosure slots without any impact on array operation. As long as the correct disks are installed, the array controller is satisfied.

When another disk is installed in the array enclosure, the array controller checks the disk stamp to determine if the disk is new or if it was previously installed in another array. In the latter case, the array controller assumes there may be some valuable data on the disk and does not include it (even automatically) until you tell it explicitly to do so. Once included, the disk is given a new stamp indicating it now belongs to the array's disk set.

Power Modules

The fully redundant disk array includes three power modules, which provide power to all components in the enclosure. The power modules share the power load equally. If one power module fails, the other two power modules are capable of powering the disk array. If two power modules fail, the controller will shutdown the disk array.

Fan Modules

Three cooling fan modules are included in the standard disk array enclosure. The fan modules provide the air flow necessary to maintain the proper operating temperature for the disk array.

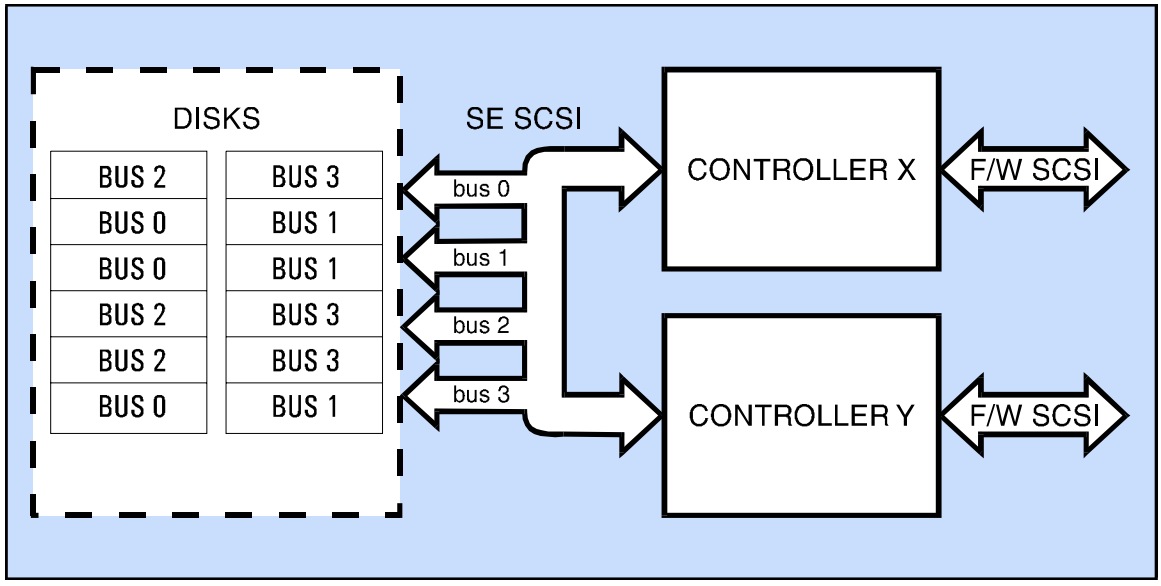
SCSI Bus Topology

The array controller communicates externally with the host over a fast-wide, differential SCSI bus. Each array controller is addressed by the host as a separate SCSI target; therefore, they must each have different addresses if they are connected to the same SCSI bus. The array controller SCSI address and all other SCSI operating parameters are set programmatically from the control panel on the disk array enclosure, or using the host software utility. There are no hardware jumpers on the array controller.

Internally, the array controller communicates with the disks over four separate single-ended (SE) SCSI buses. Disk SCSI addresses and all other operating parameters are set internally by the disk array controller. There are no hardware jumpers on the disk modules.

To ensure optimum performance, the disk modules should be distributed equally across the internal SCSI busses. This is accomplished by simply making sure the disk modules are installed in the enclosure in the correct order—left-to-right, top-to-bottom. Overloading one or two of the internal SCSI busses can impact throughput and decrease performance.

Figure 24. SCSI Bus Details



Managing the Disk Array Capacity

This section explains how to manage your disk array efficiently. It concentrates on two primary management tasks: managing capacity and optimizing performance.

The overall capacity of the disk array can be configured in a variety of ways. Depending on your system needs, you can configure the disk array capacity to provide maximum available capacity, improved performance, or optimum protection from disk failure.

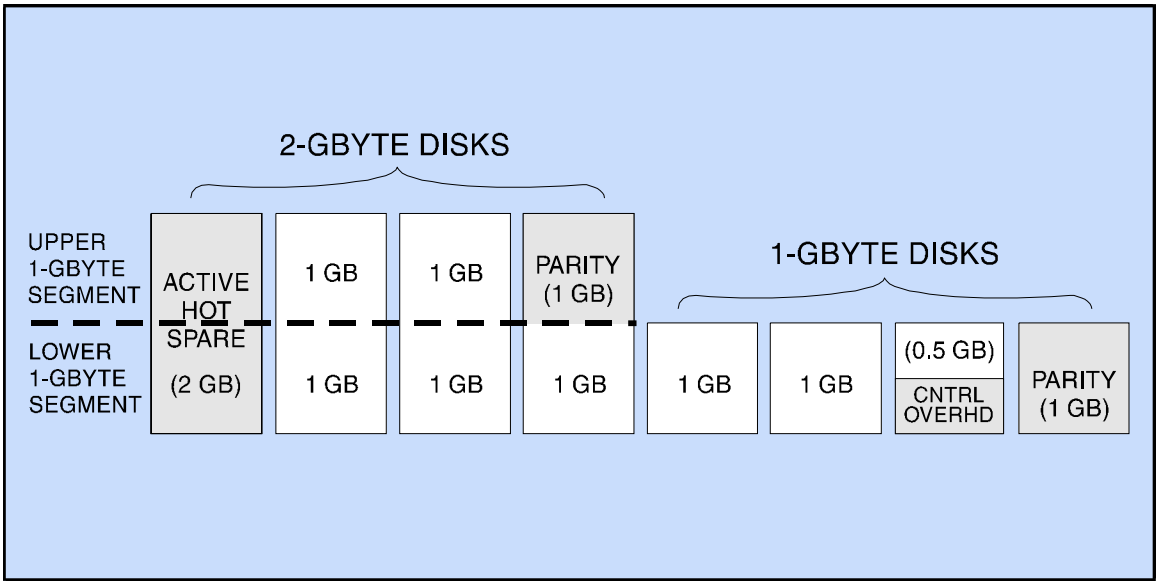
The entire capacity of the disk array is divided into several categories, each playing a different role in the operation of the array. To manage array capacity efficiently, you should understand what each of these categories do.

- **Logical Drive (LUN)** – capacity assigned to the logical drives (LUNs) created on the array. This is the capacity visible to the operating system. You must create the desired logical drive configuration on your disk array, observing any specific limitations and requirements imposed by your operating system. Each logical drive appears to the operating system as a separate disk drive. The capacity for each logical drive is distributed across all the disks in the array.
- **Data Redundancy** – capacity required to support the RAID 0/1 and RAID 5 storage techniques used by the disk array for data redundancy. This capacity is managed by the array controller and cannot be altered or reduced. This is the only portion of the array capacity that you cannot control.
- **Active Hot Spare** – capacity reserved to perform a rebuild if a disk fails. The disk array creates an Active Hot Spare large enough to rebuild the largest disk in the array. Until needed, the array uses the Active Hot Spare capacity as RAID 0/1 space to improve performance. The capacity for the Active Hot Spare is distributed across all the disks in the array.
- **Unallocated –** capacity that has not been allocated to a logical drive or the Active Hot Spare. The array uses unallocated capacity as RAID 0/1 storage to improve system performance. Should you need to increase capacity, you can use the unallocated capacity to create a new logical drive.
- **Disks Not In Use –** capacity contained on any disk that is installed in the array enclosure but is not included in the array configuration. Such disks are not being currently used by the disk array to store any user data.

Sample Capacity Allocation

The following example illustrates how the disk array uses capacity in a typical configuration. In this example there are eight disks installed in the array: four 2-Gigabyte disks and four 1-Gigabyte disks. Active Hot Spare is enabled for maximum data protection. This explanation describes how information is logically distributed. Physically, the information is spread evenly throughout all the disks.

Figure 25. Capacity Allocation



Starting with 12 Gigabytes of disk storage, the capacity is distributed as follows:

- **Gigabytes for Active Hot Spare** – When using Active Hot Spare, the disk array always reserves enough capacity to rebuild the largest disk, which in this example is 2 Gigabytes.
- **Gigabytes for parity** – This is the capacity used to support the data protection provided by RAID 5. When using disks of different sizes, the disk array divides the capacity into segments. To ensure adequate protection for all the data, parity must be maintained for each segment. In this example, 1 Gigabyte of parity is required for the upper segment, and 1 Gigabyte for the lower segment.
- **Gigabytes for RAID 0/1 and controller overhead** – This is the capacity used by the disk array to support dynamic data migration and maintain performance. This calculation is approximate and will vary as more disks are added or removed.
- **Gigabytes available capacity** – This is the capacity used for creating logical drives (LUNs). It represents the total amount of capacity available to the host.

Some General Rules Regarding Capacity Allocation

Building on the information provided in the preceding example, there are some general rules you can follow to achieve the most efficient use of your disks capacity.

- Using disks of all the same size in the array produces the most efficient use of capacity. In this case, there is only one segment and only one parity block.
- When adding a new disk, the array will be able to make almost the entire capacity of the disk available to the host (assuming the disk is not larger than the other disks). This is because the Active Hot Spare and parity requirements are already satisfied. For example, adding another 4.3-Gigabyte disk to the array would yield almost 4.3 Gigabytes of additional capacity. A small amount would be required for RAID 0/1 and controller overhead.
- Adding one or two large disks to an array of smaller disks will not yield the capacity you might expect. The upper segment created by the new larger disks will be used for Active Hot Spare and parity, and not for available capacity. For this reason, it is much better to have twelve 4.3-Gigabyte disks than six 9.1-Gigabyte disks.
- When installing a 36-Gigabyte disk drive module into an HP SureStore E Disk Array 12H, the controller firmware of the disk array **must be** at revision HP54 or higher. The use of 36-Gigabyte disk drives on controller firmware revision previous to HP54 is **not supported**. If a 36-Gigabyte disk drive is manually included under older controller firmware, it will be treated as if its physical capacity is about 24 Gigabytes.

AutoRAID Capacity Planning Tool

For planning the maximum usable capacity that can be achieved, refer to the AutoRAID Capacity Planning Tool on the World Wide Web as follows:

On the World Wide Web:

- http://www.hp.com/go/autoraid_tool
- http://www.hp.com/essd/model12H_autoraid_tool.html
- http://www.hp.com/essd/capacity.html

Inside the HP firewall (HP-qualified personnel only):

- http://essd.boi.hp.com/products/DiskArrays/autoraid/capacityplanningtool/index.htm
- http://essd.boi.hp.com/products/DiskArrays/autoraid/capacityplanningtool/capacity.html

Capacity Management Strategies

The way you decide to configure your disk array capacity will be determined by your system needs and your disk array management strategy. Are you willing to sacrifice maximum protection against disk failure for increased capacity? Is performance an issue?

Table 3 describes the steps you can take to achieve your primary goal in managing the disk array. The trade-offs associated with each strategy are also described.

Table 3. Disk Array Management Strategy

To optimize...	*You should...*	*But be aware that...*
Capacity	• Make sure all capacity is allocated to logical drives. Do not leave any capacity unallocated. • Avoid using Active Hot Spare, thus freeing up more capacity for logical drives.	• Disabling Active Hot Spare to increase the available capacity has the disadvantage of reducing protection from multiple disk failures.
Disk Array Performance	• Leave some capacity unallocated for use as RAID 0/1 space. This maintains performance as your disk array begins to reach its maximum storage capacity. • Keep Active Hot Spare Enabled to maintain performance following a disk failure. Because performance suffers when the disk array is operating in critical or non-redundant mode, rebuilding quickly will maintain disk array performance. The array also uses the Active Hot Spare as RAID 0/1 space until needed.	• Leaving capacity unallocated and enabling Active Hot Spare both reduce the amount of capacity available to the operating system.
Data Redundancy	• Leave Active Hot Spare and Auto Rebuild enabled. This offers the best protection from a disk failure.	• Enabling Active Hot Spare decreases the amount of capacity available to the host.

Upgrading the Capacity of a Fully-Loaded Disk Array

It is easy to increase the capacity of your disk array, even if it is fully loaded with disk modules. By simply replacing the original disk modules with higher-capacity modules, you can add more logical drives or you can improve disk array performance by creating more unallocated capacity. Replacing the disk modules is done while the disk array is operating, thus avoiding any downtime.

There are some important points to remember when replacing disk modules in a fully-loaded disk array.

NOTE! Anytime a rebuild is in progress, the disk array is vulnerable to a disk failure. If another disk fails before the rebuild is complete, data loss will occur. Although this is unlikely to occur, it is something to consider before making the decision to increase the capacity of the disk array by replacing the disk modules. If another disk fails, you can minimize data loss by replacing the failed disk with the original disk removed to perform the upgrade.

As added protection, it is a good idea to backup all your data before upgrading the capacity of the disk array.

- The disk modules must be replaced one at a time, and the disk array must be allowed to rebuild the data from the disk module before a another disk module is removed. This ensures that no data is lost as a result of two disk modules being removed from the disk array simultaneously. Once the Rebuild is complete, the capacity of the new disk module is added to the disk array configuration and another disk module can then be replaced.
- To make the additional capacity of the new disk modules available to the disk array, you must install at least two of the higher-capacity disk modules. The disk array cannot make full use of the added capacity if only one higher-capacity disk module is installed.
- Because the Rebuild process can impact disk array performance, you may want to perform this operation during periods of low activity. This will minimize the impact on users who may be accessing the disk array.

Optimizing Performance

Disk array performance is influenced by many factors, some host-related, some related to the configuration of the disk array itself. Host-related disk array performance issues can typically be identified and corrected using operating system utilities or third-party applications designed for this purpose.

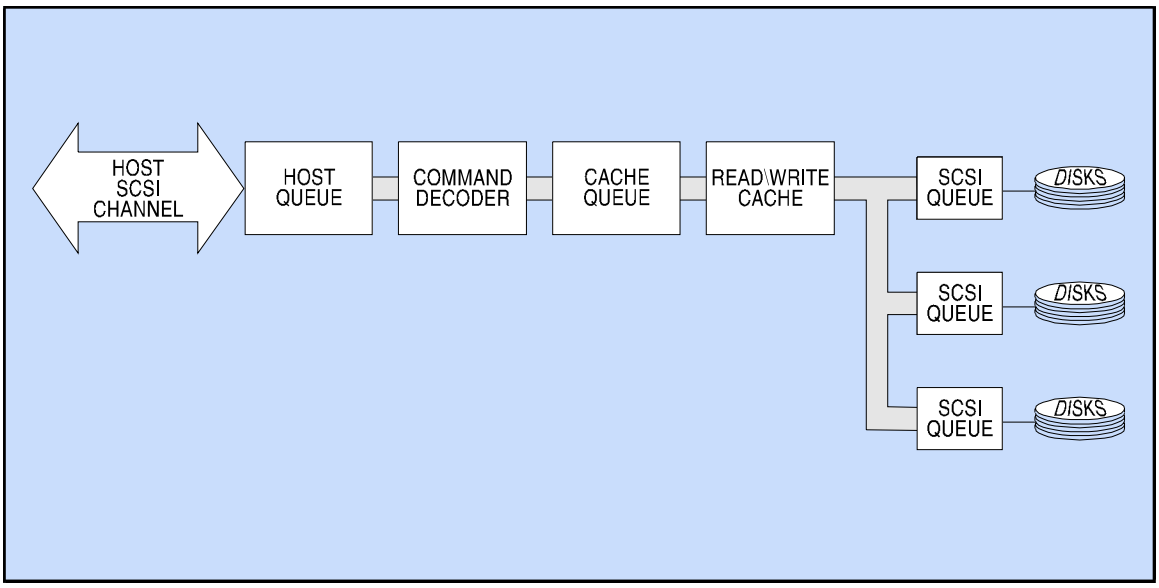
The following list identifies some of the factors that directly influence disk array performance. Other factors, such as a rebuild, can temporarily affect array performance.

- **Amount of available RAID 0/1** – In most cases, the more RAID 0/1 space available, the better the disk array performance. With enough RAID 0/1 space, the disk array can service all write I/Os from RAID 0/1, thus allowing an optimum write working set. RAID 0/1 space can be increased by increasing the amount of unallocated capacity on the disk array.
- **Enabling Active Hot Spare** – With Active Hot Spare enabled, the disk array can recover quickly from a disk failure without the need for any action on your part. This maintains performance because while the disk array is operating in non-redundant or critical mode, performance decreases. Active Hot Spare provides an additional performance benefit because it is used as RAID 0/1 space until a disk fails.
- **Amount of cache DRAM** – Increasing the amount of cache DRAM can alleviate bottlenecks that may form in the controller data path. This increases the rate at which the disk array can service host I/Os.
- **Proper disk module installation** – Installing the disk modules in the correct slots in the enclosure distributes the disks across the internal SCSI busses and balances the I/O load properly. Disk modules should be installed from left-to-right, top-to-bottom.
- **Keep the disk capacity small** – Having twelve disks with smaller capacities will improve the performance as compared to having twelve disks with larger capacities.

Controller Data Path

The data path through the controller is designed to transfer data between the disks and the host as efficiently as possible. However, under heavy I/O loads, bottlenecks may form in the data path. These bottlenecks can frequently be reduced by adding more hardware resources, such as cache RAM or disks.

Figure 26. Data Path



The controller continually monitors various points along the data path to determine how efficiently data is moving. These measurements form the metrics used to identify performance problems and make recommendations for their solution.

Performance Metrics

As shown in Table 4, the disk array uses an internal set of metrics to monitor its own performance. These metrics reflect internal events and conditions that are continually measured and stored by the disk array. A host disk array management utility can access the metrics and use them to evaluate performance, and even make recommendations on how to improve performance. For more information on accessing the performance metrics, refer to your operating system documentation.

Table 4. Disk Array Performance Metrics

Disk Array Performance Metric	Values: Typical/Limit	Definition
Disk Diff	0–1/>1	Indicates if the disks are properly distributed across the internal SCSI channels. If the disks are not installed properly, one of the SCSI channels may be handling more than its share of activity, reducing performance. Redistributing the disks will solve this problem. For more information, see *SCSI Bus Topology*.
Relocate Blocks	0.008/>0.07	Indicates how much data is being moved between RAID 0/1 and RAID 5. If too much data is being transferred between RAID 0/1 and RAID 5, performance declines.
Working Set	1/>1.1	Indicates the ratio of the write working set to the amount of RAID 0/1 space available. To maintain performance, the amount of RAID 0/1 space should equal or exceed the write working set (a value of 1 or less). A value greater than 1 indicates that the working set is larger than the available RAID 0/1 space. In this case, the disk array must service writes from RAID 5 space, which degrades performance. For more information, see *Write Working Set*.
Cache Utilization	0.1/0.2	Indicates how efficiently the write cache on the disk array controller is being utilized. If the write cache is consistently full, too many commands begin stacking up in the cache queue, resulting in decreased performance.

Disk Array Performance Metric	Values: Typical/Limit	Definition
Disk Queue	2-4/>=10 (per disk)	Indicates the average number of transactions on all disk drives waiting in the internal disk SCSI queues. Too many commands in the queues decrease performance.
Concurrency	>= drive count/ < drive count	Indicates the number of internal simultaneous disk accesses the disk array is making. The disk array achieves optimum performance when it is accessing multiple disks at the same time, so some concurrency is desirable. Too low a value indicates that the host is not requesting enough concurrent I/Os to keep the disk array busy.
Cache Queue	0.05/>=0.32	Indicates the number of commands in the cache queue. An excessive number may reflect address conflicts in host I/Os, caused by repeated access to the same block(s) of data.
Host Queue	0/>32	Indicates the number of host commands waiting in the host queue. A problem here typically reflects another bottleneck further along in the controller data path. For example, if the cache queue is full, commands will stack up in the host queue waiting for the cache queue to empty. The counter does not show until 32 commands are in the queue.
Throughput	Not Used	Indicates the average number of bytes per second being transferred over the SCSI channel. This metric reflects channel activity, and does not indicate any problems with the disk array.
I/O Rate	Not Used	Indicates the average number of I/Os per second being serviced by the disk array. This metric reflects channel activity; it does not indicate problems with the disk array.

Rebuild Impact on Performance

Because the rebuild process uses internal array resources, it may decrease array performance while a rebuild is in progress. This is particularly true if the host is issuing many I/Os to the disk array.

The disk array uses a rebuild priority that allows you to determine which is more important: system performance or data redundancy. A high rebuild priority ensures the rebuild will be completed as quickly as possible, but at the expense of disk array performance. A low rebuild priority maintains disk array performance but delays completion of the rebuild, leaving your data vulnerable for a longer period of time.

Write Working Set

A key factor in maintaining disk array performance is the balance between the RAID 0/1 space and the write working set. The write working set is the number of unique data blocks written to the disk array over a period of time. The disk array monitors the number of write I/Os to create the write working set size parameter. As long as the amount of RAID 0/1 space available is equal to or greater than the write working set size, maximum performance is maintained.

On newly installed disk arrays there is enough RAID 0/1 space for the write working set and performance is not a problem. However, as more data is stored on the disk array and the amount of RAID 5 space increases, the RAID 0/1 space available for the write working set decreases. If a point is reached where the write working set exceeds the size of the available RAID 0/1 space, some writes will have to be serviced from RAID 5, and then there may be a performance degradation.

To maintain performance, the disk array reserves at least 10% of the array capacity as RAID 0/1 for the write working set. This value was chosen after careful analysis of many diverse operating environments and application loads. It makes the assumption that in most situations 90% of the data on the disk remains essentially unchanged. That is, it is only read or not accessed at all and can therefore be stored in RAID 5 without impacting performance. Thus 10% of the capacity should be large enough to service the remaining data that is frequently updated, and performance can be maintained.

However, if your applications make heavy write demands on the disk array, the write working set may exceed the 10% RAID 0/1 minimum. In this case, the array must begin servicing write I/Os from RAID 5, and the performance of the array begins to degrade. Large data base applications that frequently update many records may have a write working set large enough to exceed the 10% RAID 0/1 space.

Increasing the Amount of RAID 0/1 Space Available

CAUTION! Deleting a logical drive (LUN) destroys all data on the logical drive. Before deleting a logical drive, make backup copies of the files you want to save or move the files to another logical drive.

If the write working set is exceeding the amount of available RAID 0/1 space, you can restore performance by increasing the amount of RAID 0/1 space. You can do this in one of the following ways:

- Add a disk and leave its capacity unallocated. This is an effective way of permanently increasing the amount of RAID 0/1 space available for the write working set.
- Delete an unneeded existing logical drive and leave its capacity unallocated. This too will permanently increase the amount of RAID 0/1 space available for the write working set. Move the data to another device.
- Add a disk and create a new logical drive with its capacity. This is a temporary way of increasing the amount of available RAID 0/1 space. As the new logical drive begins to fill up with data, it will be converted to RAID 5 space and you may again find that the available 10% RAID 0/1 minimum is too small to accommodate the write working set.
- Delete a logical drive and recreate it. This has the same temporary effect as adding a new disk and creating a logical drive.

Why Deleting Files Won't Increase RAID 0/1 Space

It might appear that simply deleting some unneeded or archived files from the disk array would increase the amount of RAID 0/1 space available for the write working set. However, this is not the case due to the way the disk array (and most other disk systems) handles deleted files.

When you delete files from the disk array, the operating system updates its file system to record the deletion. From the operating system's perspective there is now more disk capacity available. However, the disk array itself is unaware of the deletion and keeps the data files intact. From the disk array's perspective, the amount of stored data has not changed. Consequently, a disk array that has reached the 10% RAID 0/1 minimum cannot increase the RAID 0/1 space when files are deleted because none of the data stored in RAID 5 has been deleted.

This situation represents a trade-off between disk array performance and operating system file management. Most operating systems have the ability to recover ("undelete," or "salvage") files that have been deleted. They can do this because the data remains on the disk media. If the disk array really "deleted" files to regain RAID 0/1 space, you would no longer be able to use these operating system recovery features.

Deleting a Logical Drive to Increase RAID 0/1 Space

Unlike deleting files from the operating system level, deleting a logical drive does free up capacity for use as RAID 0/1 space. To understand how file space is allocated, you must differentiate between file system free space and free space (or unallocated capacity) within the disk array. The following example should help make this distinction clear.

If you create a three-Gigabyte logical drive on the disk array and then write three Gigabytes of data to that logical drive, you have used three Gigabytes of space on the disk array. If you then “erase” the data by deleting all the files you have written, you now have no user data on the disk array, but the logical drive is still occupying three Gigabytes of space.

Therefore, even if you delete files from the file system, updating the structures within the file system to indicate deletion is not the same as actually freeing space within the disk array. The file system data still occupies the same amount of space on the disk array, so deleting files from the file system will not release capacity back to the disk array for use as RAID 0/1 space.

The key point is this: Once data has been written to the disk array, you cannot reclaim the space consumed by that data simply by deleting files from the operating system. To truly erase the data and reclaim the capacity for use as RAID 0/1 space, you must delete the logical drive on which the data resides. Of course this will erase all the data on that particular logical drive, so you must make sure you backup any critical data on a logical drive before you delete it.

Chapter 5. Troubleshooting

This chapter describes how to troubleshoot the disk array if a failure is indicated by module status lights or control panel messages.

Module Slot Numbers

Each module has a slot number which can be displayed in control panel messages (see Figure 5). The index number is embossed near each module slot. The indexes for the disk modules have two parts: column letter A or B and row numbers 1 through 6.

Module Status Lights

Each module has a status light located on its front panel (see Figure 4). Table 5 through Table 8 list the status light indications and actions for each of the modules.

NOTE! The control panel status light changes from amber (testing) to green (ready) during power-on self-test, and then blinks with bus activity. The primary array controller (x or y) appears on the control panel display when the array is ready to service a read/write request and is ready for all normal I/O activity. Depending on the number of disk modules in the array and the spin-up times for the disks, there can be a delay of 2 to 90 seconds between the time the status light goes on and the time the controller is online.

Table 5. Fan Module Status Light Indications

Color	Indication
Off	No power or fan module not operating.
Green	Normal operation.
Amber	Fan speed too low. Replace the fan module.

Table 6. Power Module Status Light Indications

Color	Indication
Off	No power or power module not operating
Green	Normal operation.
Amber	Power supply fault or excessive current draw from power supply. Replace power module.

Table 7. Disk Module Status Light Indications

Color	Indication
Off	No power, no data activity, or self-test completed.
Random Flashing Green	Read/write data activity.
Solid Green	Heavy data activity or waiting in an I/O state.
Solid Amber	Power-on self-test or disk module fault.

Table 8. Controller Module Status Light Indications

Color	Indication
Solid Green	Ready State with no data activity.
Random Flashing Green	Read/write data activity. Normal operation.
Off	No power, self-test, or unterminated SCSI bus.
Solid Amber	Controller fault. Replace controller module.

Replacing Modules

If any module has a fault, you should acquire a replacement module before removing the failed module and install a replacement module. Since the modules are hot pluggable, they can be replaced even when the array is online with the host.

When replacing a fan module, do not leave a fan slot empty for more than ten minutes or a “power off pending” error will occur. When a fan slot is empty, the disk array will not be cooled properly. Without adequate cooling, disk module failures may occur.

The control panel display module or backplane assembly should be replaced only by a qualified Field Service Engineer.

To maintain availability while replacing a power module, always make sure that there are three power modules installed (to provide redundancy), then remove the failed power module. Never remove a power module from a disk array with only two power modules while the disk array is functioning.

All modules are replaced in the same way (see Figure 27 through Figure 30):

1. Pull out the module lever.
2. Remove the module from the enclosure.
3. Install the new module.

Figure 27. Removing and Replacing a Power Module

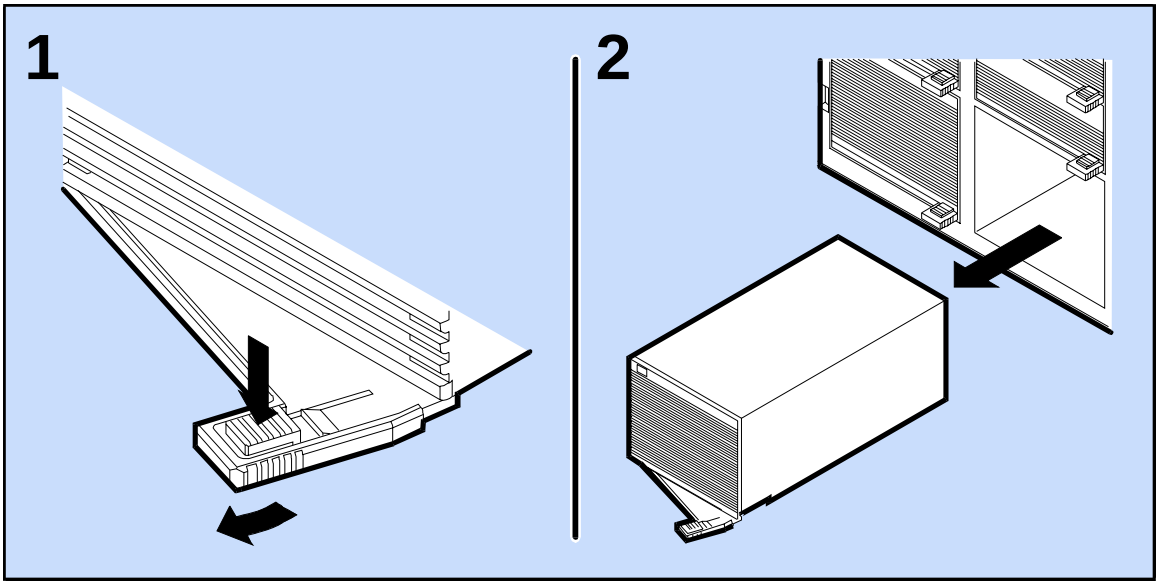
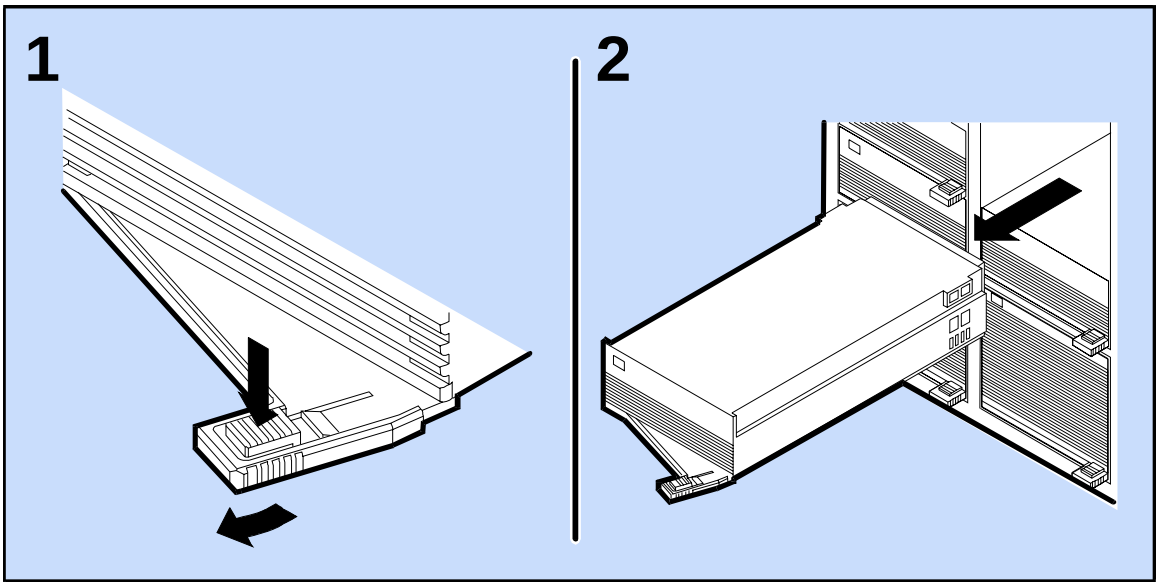
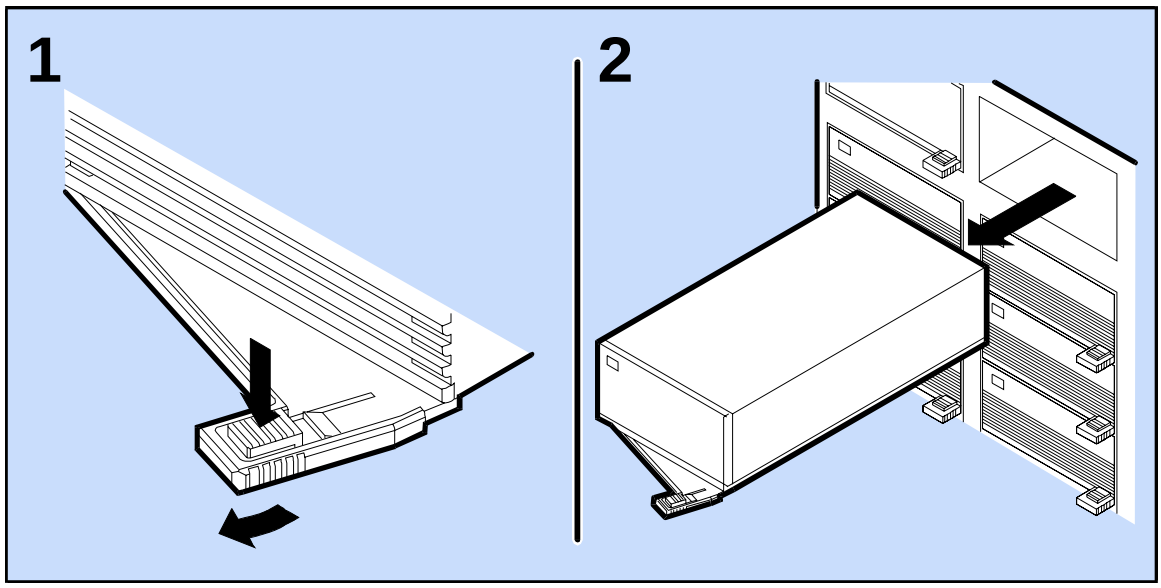


Figure 28. Removing and Replacing a Disk Module



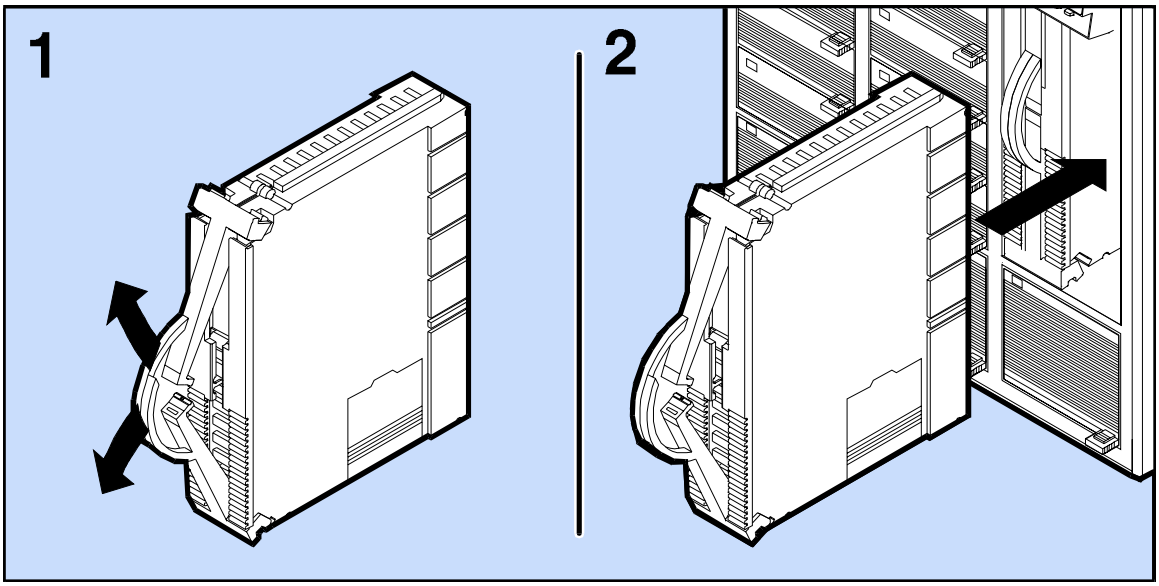
CAUTION! To maintain proper cooling within the disk array, a failed fan module *must* remain in the fan slot until a replacement fan module can be installed. A missing fan module will cause a "power off pending" error, since eventually the loss of cooling air could cause the disk modules to overheat. The "power off pending" means that the disk array will power off automatically within ten minutes.

Figure 29. Removing and Replacing a Fan Module



CAUTION! Before replacing a controller module, you should always perform a successful Shutdown on the array using the control panel to avoid loss of data.

Figure 30. Removing and Replacing a Controller Module



Troubleshooting Procedures

This section provides troubleshooting procedures that can be used to identify components within the disk array that have failed.

Fan Module

The disk array enclosure is designed to ensure proper airflow with two fan modules operational, regardless of the number of disk modules installed. No filler panels are required for empty disk module slots. All three fans must be installed for proper airflow.

If a fan module fails, an amber fan status light indicates that the fan speed is too slow or that the fan has stopped blowing air. A failed fan module has no airflow. If two fans fail, power will automatically shut down to avoid overheating.

Power Module

Each power module contains a power supply with an internal fan for cooling. Three power modules (redundant configuration) use active current sharing to distribute the power load. If one power module fails or is removed, or if one of the ac power cords is accidentally removed, the other two power modules take over the entire power load for the enclosure without interruption.

CAUTION! The following conditions will cause a power module to shut down automatically:

- **two failed fan modules;**
- **a power module internal fan failure or other internal failure;**
- **an over-current condition caused by a faulty disk module or by using an unsupported disk type with an excessive current rating.**

Power Module General Troubleshooting Procedure

Follow these steps for any power module failure, except if the disk array contains three power modules (see "Three Power Modules Troubleshooting Procedure" in this chapter):

1. Remove all disk modules.
2. Install the disk modules one at a time until a power module fault occurs.
3. Remove all disk modules except the last one installed.
4. If a power module fault occurs again, replace the disk module.
5. If a power module fault occurs after replacing the disk module, replace the power module.

Three Power Modules Troubleshooting Procedure

If the disk array contains three power modules and the status lights on all three power modules are amber, follow this procedure:

1. Cycle the disk array power.
2. After power-on, the power module status lights will be amber. If all fan module status lights do not turn green before the array turns off, replace the fan modules. If at least one fan status light turns green after power-on, either a power module has failed or an over-current condition exists. Follow the steps under "Power Module General Troubleshooting Procedure" in this chapter.

Disk Module

If a disk module failure occurs, check the following:

1. A solid amber status light at any time other than during a self-test indicates a disk module fault. A flashing or pulsing green status light indicates read/write activity.
2. Replace the disk module.

Host SCSI Bus

Check for SCSI bus problems as follows:

1. Check the SCSI cable connections and also look for bent pins.
2. Check the SCSI terminator connections. A single-ended terminator on a differential bus will cause the bus to hang.
3. Check SCSI IDs for conflicting ID numbers.
4. Check to see if the Host Bus Adapter includes on-board termination and termination power, or if these must be supplied externally.

Power On Sequence Test

When the disk array is powered on, it goes through a power on sequence test, during which time various numbers are displayed on the front panel. The numbers step higher as each initialization step is completed. The changing sequence numbers assure you that the disk array is performing the various power-on tests.

When the tests have all completed, the front panel will display the word “ready.” If the word “ready” is not eventually displayed, the sequence number at which the power on stops will help diagnose what might have went wrong.

Table 9. Power On Sequence Test

Sequence Code	Description of Power On Sequence Test Performed
1	host SRAM test; parity SRAM test
4	chip register test; data path tests
6	ROM test; copy perf code to SRAM
10	delay for mirror to come up; start mirrored communications
12	check backplane
16	start early spinup
20	local NVRAM pretest
22	remote NVRAM pretest
24	local NVRAM decode test
26	setup remote NVRAM decode test
28	remote NVRAM decode test
30	SIMM 1, 1st half test
32	SIMM 1, 2nd half test (32 MB SIMMs only)
34	SIMM 2, 1st half test
36	SIMM 2, 2nd half test (32 MB SIMMs only)
38	remote SIMM 1, 1st half test
40	remote SIMM 1, 2nd half test (32 MB SIMMs only)
42	remote SIMM 2, 1st half test

Sequence Code	Description of Power On Sequence Test Performed
44	remote SIMM 2, 2nd half test (32 MB SIMMs only)
46	SIMM 0, 1st half test
48	SIMM 0, 2nd half test (32 MB SIMMs only)
50	remote SIMM 0, 1st half test
52	remote SIMM 0, 2nd half test (32 MB SIMMs only)
54	remote SIMM 0, 2nd half test retry (32 MB SIMMs only)
60	initialize remote board NVRAM
62	test local NVRAM checksum
64	test remote NVRAM checksum, part 1
66	test remote NVRAM checksum, part 2
68	NVRAM consistency check
70	sync communication areas
72	determine if download is required
74	test for nocode on primary or secondary
76	no download required; check for personality mismatch
78	chip initialization
80	initialize NVRAM for clients
82	jump to OS
90	drive spinup and configuration
95	map and cache upload
99	final initialization

Control Panel Error Messages

The control panel is capable of displaying error messages, which indicate possible disk array failures. Different types of errors may be displayed, such as System States, Disk States, and other errors.

Table 10 shows all possible errors regarding System States. Table 11 shows all possible errors regarding Disk States. Table 12 shows the remaining control panel error messages listed alphabetically. Each table shows the control panel error message, an explanation of the error, and the action that should be taken to resolve the problem.

NOTE! The letter “x” or “y” that is displayed on the right side of the display panel usually indicates which array controller is set as the primary array controller. If there is a controller fault, it does not indicate the faulty controller.

Table 10. Control Panel Error Messages (System States)

Error Message	Explanation	Action
System States: ActivSpare Warning	An Active Hot Spare request cannot be honored; the array no longer has the physical capacity necessary to enable an Active Hot Spare.	Either add more data capacity (disks) or disable Active Hot Spare.
System States: Battery Charging	The battery in a controller module is not fully charged, but has enough power to allow normal operation. Also, the battery may not be connected properly.	If the array stays in this mode for more than one hour, check the battery connection. If the battery is properly connected, replace the battery or replace the controller module. **Caution: Always perform a successful Shutdown prior to replacing the batteries.**
System States: Capacity Warning	The capacity threshold alarm has occurred; the threshold set for capacity consumption has been exceeded.	Add more capacity (disk modules) and reset the capacity to a higher threshold or disable the capacity warning.
System States: Cntrl Failed	The X or Y controller has failed.	Replace the X or Y controller.
System States: Cntrl Y Disabled	Dual controllers are not able to communicate and controller X has become primary and controller Y is silent.	Replace faulty controller (could be either primary or secondary array controller at fault). Also, could be a backplane failure. Replace backplane.
System States: Data Warning	Data may have become inaccessible.	Replace the faulty disk module(s).
System States: Degraded Warning	Data redundancy has been lost.	If Auto Rebuild is disabled, perform a manual rebuild. If Auto Rebuild is enabled, wait for the array to restore data redundancy; data rebuild is in progress. You may need to add more disk modules to complete the Rebuild.
System States: DRAM Failed	DRAM errors have occurred.	Replace the controller module or the DRAM.
System States: DRAM Unused Warning	A SIMM was added without first performing a Shutdown.	Shutdown the array and then power it on.

Error Message	Explanation	Action
System States: Disk Warning	An invalid configuration has been detected, caused by one of the following cases: Case 1) a failed disk module in the array Case 2) a Previously-Used disk module has been added Case 3) a "down" disk drive in system	The following action should be performed for each of the cases listed: Case 1) Replace the disk module and perform a Rebuild. Case 2) Use Include Disk on the Previously-Used disk module or remove the Previously-Used disk module. Case 3) Fix or replace the disk drive.
System States: Fan Failed (or) Fan Missing	A fan in slot F1, F2, or F3 failed.	Check the fan status lights to determine which fan module failed, then replace the fan module. **CAUTION: Do not remove a fan module until a replacement fan is available. Also, replace only one fan at a time. Removing two fans at one time shuts down the power module!**
System States: Log Full	The controller event/fault logs are full.	Use a SCSI command to clear the logs. (You may want to read the logs first.)
System States: Missing Disk	A disk that is required is no longer present.	Find the missing disk to recover data.
System States: NVRAM Failed	NVRAM errors have occurred.	Check the control panel display for more information regarding what to replace.
System States: Power Supply Failed	A power module has failed.	Replace the indicated power module.
System States: RAM Unmirrored	The RAM is not being reflected in both controllers due to some other error condition.	Determine what the other error condition is by the front panel.
System States: Rebuild Failed	The rebuild process terminated abnormally.	Restart the rebuild or add more capacity.
System States: Verifying Disks	A Hot Pluggable operation has occurred.	None. Information only.
System States: Warning	A warning condition exists on the disk array.	Check the front panel for appropriate action to identify and correct the problem.

Table 11. Control Panel Error Messages (Disk States)

Error Message	Explanation	Action
Disk States: Current Log Disk	Log information is being logged on the specified log disk.	None. Information only.
Disk States: Downed	The disk module is in a Not Included state.	The user requested the array to enter this state. Use the Include Disk command if you want to include the disk module.
Disk States: Failed	The disk module is in a failed state.	Replace the disk module.
Disk States: Failed Setup	The disk module failed during initialization.	Replace the disk module.
Disk States: Log Disk Failed	The log disk has failed.	Return the log disk to the factory for a replacement.
Disk States: Log Disk Full	The log disk is full and ready to be evaluated.	Return the log disk to the factory for an evaluation of the log.
Disk States: Not Included	The disk module is not part of a logical drive. Auto Include is OFF.	You must manually include the disk module to make it become part of the logical drive set.
Disk States: Previously Used	The disk module has been used in a different array.	None. Information only. **CAUTION: The disk module may be used in the present array, but the original data will be lost when Include Disk is executed.**
Disk States: Ready	The disk module is in a ready state.	None. Information only.
Disk States: Unknown	The disk module is in an unknown or unexpected state.	Call the support line and remove the disk module.
Disk States: Unsupported	This type of disk module is unsupported and has not been tested.	CAUTION: Replace the disk module with one that is supported. Inclusion of this disk module may cause unpredictable results or loss of data.
Disk States: Unused Log Disk	More than one log disk is installed. This log disk will not be used.	None. Information only.

Table 12. Control Panel Error Messages

Error Message	Explanation	Action
Abterm	Abnormal process termination has occurred.	Record the error code and call the support line.
Balancing	The array is redistributing data among the disk modules for better performance.	None. Information only.
Battery Charging	The battery in a controller module is not fully charged, but has enough power to allow normal operation. Also, the battery may not be connected properly.	If the array stays in this mode for more than one hour, check the battery connection. If the battery is properly connected, replace the battery or replace the controller module. **Caution: Always perform a successful Shutdown prior to replacing the batteries.**
Battery Discharged	The controller module batteries are discharged or low. Each set of batteries provides one week of backup time. The controller can operate on only one of the two batteries installed within each controller; the second battery is for redundancy.	Wait 15 minutes for the battery to recharge. Controller batteries should be replaced every three years, or sooner if the display module indicates a constant “Battery Discharged” message. If the message persists after replacing the batteries, call the support line.
Cntrl Failed	The primary array controller failed.	Replace the primary array controller.
Cntrl x/y Failed	The controller module in slot X or Y failed.	Replace controller module X or Y. If the array has a single controller, install a replacement controller and power on the array before removing the failed controller.
Disk Not Included	The SCSI command to Include Disk failed.	The disk module may be malfunctioning or unsupported. View settings menu of front panel. If the state shows a disk module failure, replace the disk module. Otherwise, call the support line.
Disk Xn Failed	The disk module in slot Xn failed, where (X =A/B; n=1–6).	Replace the disk module.
Display Failed	The control panel display was temporarily unable to fully display a character.	Call the support line. Replace the display module.

Error Message	Explanation	Action
Fan Failed	A fan in slot F1, F2, or F3 failed.	Check the fan status lights to determine which fan module failed, then replace the fan module. **Caution: Do not remove a fan module until a replacement fan is available. Also, replace only one fan at a time. Removing two fans at one time shuts down the power module!**
Firmware Loading	EPROMs are being reprogrammed.	None. Information only.
Firmware Needed	The controllers installed in the disk array have different firmware revisions. A new controller may have been installed that has a later version of firmware. The firmware revisions must be the same on both array controllers.	Perform ONE of the following procedures: 1) Copy firmware from the primary to the secondary array controller, or; 2) Update firmware on both controllers. For both of these procedures, refer to the "Downloading Firmware" section in this document, and also to the ARM Download utility procedure in the Array Utility Manual.
Format Failed	The SCSI command to format failed.	The array is malfunctioning. Call the support line.
Incompatible CNTLR	The two controllers installed have different personality profiles. Unique controller personalities are created for different vendors. These personalities are incompatible with one another.	Do not use controllers from different vendors in the same disk array enclosure. Remove the incompatible controller and replace it with a controller from the correct vendor. Call the support line.
Incompatible Format	The controller(s) installed in the disk array are the wrong type. Different HP disk array products use different controllers. Although the controller may fit mechanically into the enclosure, the disk formats used by different product families are incompatible.	Remove the incompatible controller(s) and install the correct controller(s) in the disk array. Controller family can be determined by a small label on the controller handle. Call the support line.
Incompatible Image	The firmware on the primary array controller is not compatible with the NVRAM image.	Copy the image number displayed on the control panel display and contact the support line for assistance in determining if the image is compatible with your firmware.
Initializing	The array is running the initialization process.	None. Information only.

Error Message	Explanation	Action
Log Disk Not Marked	A requested mark on the log disk has failed.	Retry. If error continues, return log disk for a replacement.
L-Drv Not Deleted	The SCSI command to Delete Volume failed.	Call the support line.
L-Drv Not Renumbered	The SCSI command to Renumber Logical Drive failed.	Call the support line.
Mismatched CNTLR	The two controllers installed have different personality profiles. Unique controller personalities are created for different vendors. These personalities are incompatible with one another.	Do not use controllers from different vendors in the same disk array enclosure. Remove the incompatible controller and replace it with a controller from the correct vendor. Call the support line.
Mismatched CNTLR	The two controllers installed are from different product families.	Do not use controllers from different product families (different vendors) in the same disk array enclosure. Call the support line.
No Address Table	No data maps are available for the controller module; data was lost due to missing disk modules or no NVRAM image to match disk modules.	If your disk array is a boot device, you may have to recover the maps by using the front panel command called “Recover” under the “Cntrl Changes” menu. The *arrayrecover* utility is described in detail in the *System Administrator’s Guide*, which is shipped with each disk array.
No Code	The firmware download was unsuccessful; there is insufficient processor firmware to operate the controller.	Attempt downloading firmware upgrade again. Call the support line.
No L-Drv Created	The SCSI command to Create Logical Drive failed.	The array diagnostics may have been running when someone accessed the control panel, or the array is malfunctioning. Call the support line.
No Quorum	Less than half of the disk modules in the disk set are present.	Install missing disk modules or format the array. **Caution: Formatting the array requires deleting logical drives (LUNs), and deleting LUNs erases all data!**
No Resources	A front panel request is in contention with user I/O.	Retry the front panel operation until you are successful.

Error Message	Explanation	Action
Not Enough Disks	There are not enough (fewer than three) disk modules in a logical drive set for redundancy.	Install more disk modules.
NVRAM Mismatch	The NVRAM images miscompared; array doesn't know which image to use. This error can occur if you remove two controllers from two separate arrays, neither of which were Shutdown, and install them into a new array. **Caution: The data memory maps stored in NVRAM are necessary to read the user data.**	If possible: 1) remove both controllers, 2) reinstall them in their original arrays, 3) run Shutdown, 4) return them to the array where the error occurred, or; 1) remove one controller, 2) power on the array and wait for it to become "Ready," 3) Shutdown the array, 4) reinstall the controller you removed, 5) power on the disk array.
NVRAM x/y Failed	The NVRAM in the controller module in slot X or Y failed.	Replace the controller.
Offline SCSI ID	One or more controller in this disk array has not been assigned a SCSI ID.	Set the desired SCSI ID for the controller(s).
Optimizing	The array is migrating data to RAID 0/1 to optimize the array performance.	None. Information only.
Power Off Failure	The primary array controller attempted to switch off the power to the power module but it was unsuccessful.	Either the secondary array controller or the primary array controller failed and did not allow the power off to occur, or the power module itself may be malfunctioning.
Power Off Pending	The disk array will continue to function if one fan module fails; however, when a fan module is physically removed from the disk array enclosure, this disrupts the flow of cooling air to the other modules in the enclosure.	If you remove a fan module (whether it is working or has failed) from the disk array enclosure, it must be replaced in ten minutes or less, or a power-off will occur.
Power 1 Failed	The power module in slot P1 failed.	Replace power module P1.
Power 2 Failed	The power module in slot P2 failed.	Replace power module P2.
Power 3 Failed	The power module in slot P3 failed.	Replace power module P3.

Error Message	Explanation	Action
Ready	No errors or warnings to report; the array is ready to transfer data.	None. Information only.
Rebuild Not Started	The command to Rebuild did not start.	The array is malfunctioning. Call the support line.
Rebuild Not Stopped	The SCSI command to Rebuild did not stop.	The array is malfunctioning. Call the support line.
Recover Failed	Data was not fully recovered during the recover utility.	The array is malfunctioning. Call the support line.
Recover Warning	Problem occurred while using the recover utility.	The array is malfunctioning. Call the support line.
Rebuild Requested	A front panel request to begin a rebuild occurred.	None. Information only.
Shutdown Complete	The controller has posted the NVRAM to the disks and the array is ready to be turned off.	None. Information only.
Shutting Down	The controller is preparing to enter the Shutdown state.	None. Information only.
SIMM 1/2 x/y Failed	SIMM 1 or 2 on controller module X or Y failed.	Replace the controller.
SIMM Count Error	The controller modules each have a different number of SIMMs installed. You must have the same amount of memory on both controller modules.	Add or remove SIMMs from the NEW controller module so that each controller has the same amount of memory. DO NOT remove any SIMMs from the original single controller module; you must always have the same amount of memory (or more) on each controller module as you had on the original single controller module.
SIMM Error	The primary controller does not have enough SIMMs to upload the present disk volume set.	Add more SIMMs to the controller module(s). Each controller must have the same amount of memory.
Single Controller	Resiliency parameters are not set to single controller mode but the array has a single controller installed.	Either put the disk array in single controller mode or install a second array controller.

Error Message	Explanation	Action
System Warning	An array warning condition exists; warning designators follow. This error can occur if you are using a single controller.	Use the control panel View Settings Warnings menu to see what error occurred. If you are using a single controller, you may have to run the *arraymgr* utility to suppress these errors. The *arraymgr* utility is described in detail in the *System Administrator's Guide*, which is shipped with each disk array.
Unused Log Disk	The specified log disk is not being used.	None. Information only.

FRU Codes

Each replaceable hardware assembly in the disk array is assigned a FRU (Field Replaceable Unit) code. These FRU codes are used to identify suspect hardware in the controller event logs. Table 13 lists the FRU codes and the hardware assembly associated with each.

Table 13 Disk Array FRU Codes

FRU Code	Hardware Assembly
0	Disk in slot A1
1	Disk in slot B1
2	Disk in slot A2
3	Disk in slot B2
4	Disk in slot A3
5	Disk in slot B3
6	Disk in slot A4
7	Disk in slot B4
8	Disk in slot A5
9	Disk in slot B5
10	Disk in slot A6
11	Disk in slot B6
129	Reporting Controller[1], or No FRU.
130	First installable SIMM on X controller
131	Second installable SIMM on X controller
132	First installable SIMM on Y controller
133	Second installable SIMM on Y controller
134	Other (non-reporting[2]) controller
135	Battery
136	Fan 1
137	Fan 2
138	Fan 3
139	Power Supply 1
140	Power Supply 2
141	Controller X
142	Controller Y
143	Power Supply 3
192	Internal SCSI Bus 0
193	Internal SCSI Bus 1
194	Internal SCSI Bus 2
195	Internal SCSI Bus 3

[1] The reporting controller is the controller identified in the Component Specific ID field of the Controller Error Event specific data.

Event Code Descriptions

Table 14 lists all event codes that can appear in the HP XLR1200/1255 Advanced Disk Array controller log event pages. The table also includes events that are not logged, but can still generate SCSI sense data.

Appropriate corrective action is included for all events that require it. Many events are informational and require no action on the part of the user.

The Suspected Component column lists the hardware components potentially implicated by the event code. In general, the most likely failing component is indicated in the FRU field of the event descriptor. The components are listed in decreasing order of likelihood.

Term Definitions

The following terms used in the table may require some clarification:

- **Disk Drive ID Number** - this is the unique number assigned by the controller to each disk drive installed in the array. This number is used by the controller for its internal management of the disks, and is in no way related to the slot position of the disk drive or to the disk mechanism's serial number. The disk drive ID number is frequently used in the component identifier field of disk system change events to indicate the disk drive involved.
- **Internal SCSI Bus** - This refers to all of the components that comprise the SCSI channel between the disk array controller and the disk drive. This includes the disk array controller, the enclosure backplane, and the disk module. In general, the term "back end" refers to the communication path between the disk array controller and the disk drives.
- **Host SCSI Bus** - This refers to all of the components that comprise the SCSI channel between the disk array and the host computer. This includes the disk array controller, the enclosure backplane, external SCSI bus cabling, and components internal to the host computer (for example, the host SCSI adapter). In general, the term "front end" refers to the communication path between the disk array controller and the host.
- **SIMM** - A controller NVRAM memory module.

Predictive Data Terms

This column indicates if the event code is useful to predictive diagnostics. If it is, then this column contains the occurrence rate which should trigger predictive maintenance.

The following terms used in this column.

- **NA** - This event code is not applicable because it is never logged.
- **Ignore** - This event code is not relevant to predictive diagnostics
- **Single Occurrence** - A single occurrence of this error is sufficient to warrant maintenance
- **See accompanying errors** - This refers to other log entries which occur in conjunction with the event. This indicates that a given event should always be accompanied by other events which lend it the appropriate significance.
- **Host reported error** - Indicates that there should be additional information in host logs describing the occurrence of an event if it is significant
- **Ignore unless...** - Indicates that this event normally accompanies other events or operator activity. If the event appears in the log without accompanying events or activity, then a single occurrence is sufficient to warrant maintenance. Note that exceptions may exist based on drive type.
- **Recurs After Recovery** - This indicates that the error is expected under certain circumstances and a recovery procedure should be invoked. The recovery procedure should be described in the description of the event. If recovery is unsuccessful, then maintenance is warranted.

Table 14. Controller Log Event Code Descriptions

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
0/0x00	No Sense	N	NA	None	No sense data available. See the SCSI Command Specification for more information.
1/0x01	Event Log Full	N	NA	None	The controller event log is full. The log can be cleared using the SCSI Access Log command.
2/0x02	Controller Log Full	N	NA	None	The controller log is full. The log can be cleared using the SCSI Access Log command.
3/0x03	Parameter List Length Error	N	NA	None	A SCSI parameter list length error occurred. See the SCSI Command Specification for more information.
4/0x04	Invalid Field In Parameter List	N	NA	None	A SCSI invalid field in parameter list error occurred. See the SCSI Command Specification for more information.
5/0x05	No Physical Device Present	N	NA	None	A command tried to address a disk drive that doesn't exist. Check the physical configuration of the disk array to see what disk drives are installed.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
6/0x06	Invalid Opcode	N	NA	None	A SCSI invalid opcode error occurred. See the SCSI Command Specification for more information. NOTE. In certain disk array states, this event may occur even if the opcode is valid. These are typically states that indicate a larger problem with the disk array.
7/0x07	Invalid Bit In CDB	N	NA	None	Invalid bit in CDB. See the SCSI Command Specification for more information.
8/0x08	Logical Block Address Out Of Range	N	NA	None	The specified logical block address was out of range. See the SCSI Command Specification for more information.
9/0x09	Not Ready	N	NA	None	Not Ready, Init command required.
10/0x0a	Invalid Identify Received	N	NA	None	Invalid Identify Received. See the SCSI Command Specification for more information.
11/0x0b	Power On Unit Attention	N	NA	None	Power on unit attention. See the SCSI Command Specification for more information.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
12/0x0c	Hardware Error Unit Attention	N	NA	None	Power on or self-test failure. Check system state and warning states for more information.
13/0x0d	Commands Cleared Unit Attention	N	NA	None	Commands cleared by another initiator. See the SCSI Command Specification for more information.
14/0x0e	Mode Parameters Changed Unit Attention	N	NA	None	Mode parameters changed by other initiator. See the SCSI Command Specification for more information.
15/0x0f	Unconfigured LUN	N	NA	None	A command tried to address a LUN that hasn't been created.
16/0x10	Invalid Target LUN	N	NA	None	A command tried to perform an illegal operation on the specified LUN. For example, trying to create a LUN that already exists.
17/0x11	Invalid Source LUN	N	NA	None	A command tried to renumber a LUN that doesn't exist.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
18/0x12	Not Enough Space	Y	Ignore	None	A write command had to move data in order to find enough space to complete. Errors were encountered during this process which prevented the controller from providing enough space for the write. This would typically result from multiple failing or missing drives. If disk drives have been removed, reinstall them in the array.
19/0x13	Command Illegal In Current State	N	NA	None	The requested operation is not allowed due to the current state of the disk array. Certain operations require the disk array to be in a specific state for execution. For example, the disk array must be shutdown to perform a download.
20/0x14	Becoming Ready	N	NA	None	The disk array has not finished its initialization.
21/0x15	Recovered With Low Level Retries	Y	Ignore	Disk Drive Controller Internal SCSI Bus	After failing the initial I/O, data was recovered using retries. It was necessary to use redundancy to recover the data.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
22/0x16	Recovered By Disk Drive	Y	See information provided by drive vendor	Disk Drive	Data was recovered be the disk drive using its own internal recovery process. The sense information provided by the disk drive should provide more information on the nature of the failure.
23/0x17	Disk Drive Media Error	Y	See information provided by disk drive vendor	Disk Drive	The disk drive returned a status indicating a media error condition. Retries have been exhausted. This event will only occur in degraded mode.
24/0x18	Disk Drive Hardware Error	Y	See information provided by drive vendor	Disk Drive	The disk drive returned a status indicating a hardware error condition. The controller retries are exhausted, or the I/O is not retryable. This event will only occur in degraded mode.
25/0x19	Disk Drive Reset By Related Hot Plug	N	NA	None	A disk drive sharing the same internal bus as the target drive was either installed or removed causing a bus reset. The controller could not retry the I/O either because it is not retryable (RAID 5), or retries are exhausted.
26/0x1a	Disk Drive Reset Itself	N	NA	None	The disk drive returned a status indicating it had been reset. The controller could not retry this I/O. The host should retry the I/O.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
27/0x1b	Disk Drive Reset by Pass Through	Y	Ignore	None	A Pass Through Reset command has reset the disk drive, causing I/Os to fail. The controller could not retry I/Os. This typically occurs when performing diagnostic testing on the disk drive.
28/0x1c	Disk IO Failed Due To Drive Removal	N	NA	None	A disk drive was removed, causing I/Os to fail. Any I/Os in the controller queue are flushed with this status.
29/0x1d	Disk Drive Failed Initialization	Y	NA	None	Following a device reset, the controller could not successfully initialize the disk drive. This is typically caused by a disk drive's failure to spin up. The controller flushes all non-pass through I/Os from the queue when this event occurs.
30/0x1e	Disk I/O Failed Due To Related Hot Plug	Y	NA	None	A disk drive was in unknown state during command execution. The I/O was not retryable, or the all retries have been exhausted. The host should retry the I/O. This event will occur only if the disk array is operating in degraded mode.
31/0x1f	Unexpected Disk Drive Error	Y	Single Occurrence Unless Excluded For Drive Type	Disk Drive	The disk drive returned a status that could not be handled by the controller's error recovery algorithms. All retries are exhausted, or the I/O is not retryable.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
32/0x20	Disk Drive Data Transfer Failed	N	NA	None	The I/O completed with status indicating the data transfer failed. All retries are exhausted or the I/O is not retryable.
33/0x21	Disk Drive Miscompare on Write And Verify	Y	Single Occurrence	Disk Drive Controller Internal SCSI Bus	The read verify following a write indicated a Miscompare error status. All retries are exhausted or the I/O is not retryable.
34/0x22	Disk Drive State Conflict	Y	Ignore	None	A disk drive was in the wrong state for read, write or pass through. For a read or write, the wrong states are “down”, “missing”, or “initialization failed”. For pass through, the wrong state is “missing”. Check the state of the disk drive and try to return it to “ready” by adding it if it was downed, or reinstalled it if it is missing.
35/0x23	Disk Drive Data Out Of Sync After Access	Y	Ignore - See accompanying errors	None	Data being read or written to a disk drive was out of sync after the access was complete. The redundant copy of the data stored on the disk drive is no longer valid. A rebuild will ensure the data is valid.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
36/0x24	Illegal Drive State For Down Command	N	NA	None	An attempt to down a disk failed. Downing the disk would have resulted in loss of redundancy or data unavailability. Make sure the correct down type is specified when performing the command.
37/0x25	Recovered With RAID 5 Retries	Y	Ignore - See accompanying errors	None	Retries were used successful completion of a read or write to RAID 5 space.
38/0x26	Recovered With RAID 5 Redundancy	Y	Ignore - See accompanying errors	None	Redundancy was used in the successful completion of a read or write to RAID 5 space.
39/0x27	Unavailable Data Detected By RAID 5	Y	See Accompanying Errors	None	An attempt to read or write failed because the array is in a data unavailable state. This may be a result of removing disk drives. Reinstall any disks that may have been removed.
40/0x28	Send Diagnostic Self Test Failure	N	Single Occurrence	Controller	The current system state and warnings indicate that the self test should return bad status. Check system state and warning states for more information.
41/0x29	Invalid Pass Through	N	NA	None	The host attempted an execute pass through command without a valid Set Pass Through Mode command preceding.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
42/0x2a	Pass Through Reset Failed	Y	Ignore	None	A command to the disk drive failed. Drive status should be returned and can be examined to determine the condition of the disk drive.
43/0x2b	Recovered With RAID 1 Redundancy	Y	Ignore - See Accompanying Errors	None	Redundancy was used by the controller in the successful completion of a read or write.
44/0x2c	Unavailable Data Detected By RAID 1	Y	Ignore - See accompanying errors	None	The controller detected that the disk drives necessary for a read or write were not available for access before the access was attempted. This can apply to an initial attempt to read or write, or to a retry.
45/0x2d	Shutdown Failed	N	NA	None	The controller could not shutdown the disk array because all the disk drives were missing. Reinstall the missing disks to shutdown the array.
47/0x2f	Disk Drive Removed During Add Physical Drive	N	NA	None	A disk drive was removed from the disk array while an Add Physical Drive command was in progress against the drive.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
48/0x30	Cancel Rebuild With Auto-Rebuild Enabled	N	NA	None	An attempt was made to cancel a rebuild operation while Auto-Rebuild was enabled. Because Auto-Rebuild is enabled, the rebuild would only start up again after the cancel, rendering it ineffective. Therefore the controller always rejects a cancel rebuild command while Auto-Rebuild is enabled.
49/0x31	Disk Drive Stamp Write Failed	Y	Single Occurrence - See accompanying errors	Disk Drive Controller Internal SCSI Bus	In order to make a disk drive a member of a disk set it must have a stamp written onto it by the controller. This error indicates that the writing or updating of the stamp failed during an Add Physical Drive command, causing the command to fail. This is typically caused by disk drive errors.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
50/0x32	Disk Drive State Changed During Add Physical Drive	N	NA	None	During an Add Physical Drive command the disk drive is reconfigured for proper operation with the controller. If the reconfiguration fails the first attempt but succeeds the second, the controller simulates a hot plug event on the disk drive to determine the true status of the disk drive. The add physical drive command fails if this condition is encountered. The disk drive state should be reviewed by the host and the add command reattempted if appropriate.
51/0x33	Host SCSI Controller Parity Error	Y	Single Occurrence	Controller	A SCSI DATA-IN phase received a parity error which indicates a problem on the controller, not the SCSI bus. All retries have been exhausted.
52/0x34	Host SCSI Parity Error	Y	Single Occurrence	Controller, Host SCSI Bus	A parity error was detected on the Host SCSI bus. All retries have been exhausted. This may be caused by an improperly configures SCSI bus. Make sure all cables and terminators are installed correctly.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
53/0x35	Host Overlapped Commands Attempted	Y	Ignore- Host Protocol Incompatibility	None	Commands were attempted to be overlapped from the host. This is usually an incorrect initiator connection error, and usually reflects a SCSI protocol violation on the part of the host.
54/0x36	Unsupported Host SCSI Message	Y	Ignore - Host Protocol Incompatibility	None	An illegal/unsupported SCSI message was received. This usually reflects a SCSI protocol violation on the part of the host.
55/0x37	Host SCSI Initiator Detected Error	Y	Ignore - See host error report	None	The initiator detected an error condition (usually parity). All retries have been exhausted. Check host error reports for more information.
56/0x38	Host Invalid Message	Y	Ignore - Host compatibility problem	None	An invalid SCSI message was received. This usually reflects a SCSI protocol violation on the part of the host.
57/0x39	Host Reselection Failure	Y	Single Occurrence. Ignore if occurs with timeouts	Host SCSI Bus Host Controller	The initiator did not respond to reselection attempts. All retries have been exhausted.
58/0x3a	Host Data Phase Error	Y	Single Occurrence	Host SCSI Bus Host Controller	The initiator timed-out in a data phase.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
59/0x3b	Internal SCSI Error	N	More than two per hot plug event	Disk Drive Controller Internal SCSI Bus	A disk drive responded incorrectly. The result was an internal SCSI bus reset, and a hot-plug recovery sequence to regenerate the bus state.
60/0x3c	Internal Data Transfer Error	Y	Single Occurrence	Controller Disk Drive Internal SCSI Bus	A data transfer failed due to a parity error. This typically indicates a hardware problem.
61/0x3d	Host SCSI Bus Timeout	Y	Ignore - Host Reported Error or Compatibility	Host SCSI Bus Host Controller	The target timed-out on a SCSI transaction.
62/0x3e	Reassign Failed	Y	Single Occurrence	Disk Drive	The controller's attempts to reassign a bad block failed due to a disk drive error.
63/0x3f	Reassign Out Of Resources	Y	Single Occurrence	Disk Drive	The controller was unable to complete a Reassign Blocks command because the sparing buffer is too small. There are too many bad blocks in the sparing buffer, indicating a problem with the disk drive.
64/0x40	Optimal Space Error In RAID 5	Y	Ignore	None	The controller detected that space allocated for an "optimal only" migrating write (i.e. rebuild policy) was no longer optimal after the write had completed. This event is logged for debugging purposes only and requires no action.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
65/0x41	Optimal Space Error In RAID 1	Y	Ignore	None	The controller detected that space allocated for an "optimal only" migrating write (i.e. rebuild policy) was no longer optimal after the write had completed. This event is logged for debugging purposes only and requires no action.
66/0x42	No Shutdown Image Posted	N	NA	None	The controller could not shutdown the disk array because all the disk drives were missing. Reinstall the missing disks to shutdown the array.
67/0x43	Bad Disk Drive State During Add Physical Drive	N	NA	None	An Add Physical Drive command failed with the disk returning a status of Initialization Failed. The drive is failing initialization, so information on the nature of the failure should appear in the event log in a separate entry.
68/0x44	Internal SCSI Underrun	N	NA	None	A disk drive sent/received less data than expected.
69/0x45	Internal SCSI Overrun	N	NA	None	A disk drive sent/received more data than expected.
70/0x46	Internal SCSI Timeout	N	More than 2 occurrences per hot plug event	Disk Drive Controller Internal SCSI bus	A disk drive didn't respond within a specified time limit. The disk drive may be failing, or it may be busy performing data retries.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
71/0x47	Internal SCSI Hot Plug	N	NA	None	A command failed due to a hotplug event, or possibly due to an error that caused error recovery.
72/0x48	Host Write Collision With Failed Cache Post	Y	Ignore - see accompanying errors	None	An earlier host write was flushed from cache but was not written successfully to the disk. This caused cache to mark the write cache entry as RETRY, which means it is stuck in cache. A subsequent host write involved the same address as the write stuck in cache, and the controller failed the new write.
73/0x49	Disk Drive Defect List Error	Y	Single Occurrence	Disk Drive	The disk drive returned a status indicating a disk drive defect list error. The controller's retries are exhausted or the I/O is not retryable. A low level format of the disk drive may correct this problem.
74/0x4a	Disk Drive Format Error	Y	Single Occurrence	Disk Drive	The disk drive returned a status indicating a format error problem. The controller did not attempt to send a Reassign Blocks command. This may be cause for immediate failure. A low level format of the disk drive may correct this problem. This event may occur following the download of new firmware to the disk drive.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
75/0x4b	Internal Data Transfer Aborted By Hot Plug	N	NA	None	A data transfer with the disk drive failed due to a hot-plug event on the channel. When performing RAID 1 mirrored transfers, a hot plug event may disrupt the transfers on both SCSI channels in use.
76/0x4c	Internal SCSI Bus State Error	N	Single Occurrence	Controller Internal SCSI Bus Disk Drive	A disk drive responded incorrectly. The result was an internal SCSI bus reset, and a hot-plug recovery sequence to regenerate the bus state. The control panel display may indicate "verifying drives" as a result of the internal bus reset.
77/0x4d	Write Sequence In Cache Broken By Host Abort	N	Ignore	None	A part of a write cache stream was aborted by the host. The failed write was forced because the operation could not be completed. This is a normal part of an abort operation. The host should retry the operation.
78/0x4e	Silent Disk Drive Error Recovery	N	NA	None	On a previous attempt(s), the disk drive failed the I/O. The controller retried the I/O and the drive returned good status.
79/0x4f	Check Condition From Disk Drive With No Sense	Y	Single Occurrence	Disk Drive	The disk drive returned a check condition with no sense data. The controller's retries are exhausted or the I/O is not retryable.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
80/0x50	Disk Drive Failed Start Unit Command	Y	Single Occurrence	Disk Drive	The disk drive returned bad status for a start unit command. The controller's retries are exhausted.
81/0x51	Unexpected Disk Drive Status	Y	Single Occurrence, possible compatibility problem	Disk Drive Controller Internal SCSI Bus	The disk drive returned a status inconsistent with the current operation The controller's retries are exhausted or the I/O is not retryable.
82/0x52	Target Storage Unchanged By Compare And Swap	Y	Ignore	None	The requested compare and swap command was valid but did not change the contents of target storage.
83/0x53	Internal Data Transfer Timeout	Y	Single Occurrence, unless with other errors	Controller Disk Drive Internal SCSI Bus	A transfer failed due to a timeout. Typically results because the disk drive took too long to complete the command.
84/0x54	Internal SCSI Bus Data Transfer Error	N	Single Occurrence unless with other errors	Controller Disk Drive Internal SCSI Bus	A data transfer failed. This error is typically accompanied by other errors that overwrite it.
85/0x55	Recovered By Disk Drive On Retry	Y	See drive vendor recommendation	Disk Drive	On a previous attempt(s), the disk drive failed the I/O. The controller retried the I/O and the disk drive returned a status indicating the I/O was successful.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
86/0x56	Not Ready Manual Intervention Required	N	Ignore	None	The disk array is not ready and the action required to solve the problem will require user intervention. Check system state information for more details.
87/0x57	Data loss detected	Y	NA	None	An otherwise successful read op failed due to data loss recorded in at least 1 of the disk blocks read.
88/0x58	Format Precluded due to LUN Existence	N	NA	None	The subsystem could not be formatted because logical units were created and still in existence. Delete all LUNs prior to issuing the format subsystem command.
89/0x59	Can't download because NV is not shutdown	N	NA	None	Download is not possible even though the target controller is in NO CODE because the NVRAM image is not valid on the disks (i.e., the subsystem is not shutdown). Make the secondary controller the primary controller, have it shutdown and then do the download.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
90/0x5a	Host Read Collision With Failed Cache Post	Y	Ignore - see accompanying errors	None	A host write was flushed from cache but ended with a non-SUCCESS status; this caused cache to mark the write cache entry as RETRY which means it is stuck in cache. A new host read partially hits the same address which normally causes the write to flush but the write is stuck in cache. The response is to fail the read.
91/0x5b	Ambiguous Volume Set Reference	Y	Ignore	None	A volume set ID referenced in a recover command was ambiguous. If a null (wild card) volume set was used in a recover command then this error means that the controller found drives multiple volume sets present. If a non-null volume set was used then this error means that the controller is already attached to a volume set other than the one referenced in the recover command.
92/0x5c	Recovery From RAM Loss Failed	Y	Single Occurrence	Disk Drive, Back End SCSI Bus, Controller, Operator	This error indicates that the controller was unable to recover an NVRAM image any disk in the volume set. This could be because of the disks present have images, or the disks that have images were removed, or failed before the could be fully uploaded into the controller.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
93/0x5d	Multiple Failures Suspected During Recovery	Y	Ignore - see accompanying errors	None	Conditions detected during recovery indicate that at least one failure or hot plug occurred in addition to the loss of NVRAM that the recovery. This implies that data integrity likely to have been compromised in ways that are detectable outside of the occurrence of this log or sense data report. It is likely that the controller does not have sufficient information to determine the extent of the damage.
94/0x5e	Volume Set Missing During Recovery	Y	Ignore - operator error	None	The volume set referenced in a recover command is not present in the subsystem. If a NULL volume set was referenced then this error indicates that no members of any volume set were present. This error can also result from incompatible stamp versions.
95/0x5f	RAM Configuration Mismatch During Recovery	Y	Single Occurrence	Controller SIMM, operator error	An attempt was made to recover an image after RAM loss but the image would not fit in the non-failing memory available on the controller. Either the SIMM configuration has been modified, or one or more SIMMs have failed. Recovery may be possible using another controller as the primary controller.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
96/0x60	Read Recovered With RAID 5 Retries	Y	Ignore - See accompanying errors	None	Retries were used by the R5 module in the successful completion of a read.
97/0x61	Write Recovered With RAID 5 Retries	Y	Ignore - See accompanying errors	None	Retries were used by the R5 module in the successful completion of a write.
98/0x62	Read Recovered With RAID 5 Redundancy	Y	Ignore - See accompanying errors	None	Redundancy was used by the R5 module in the successful completion of a read.
99/0x63	Write Recovered With RAID 5 Redundancy	Y	Ignore - See accompanying errors	None	Redundancy was used by the R5 module in the successful completion of a write.
100/0x64	Read Recovered With RAID 1 Redundancy	Y	Ignore - See accompanying errors	None	Redundancy was used by the R1 module in the successful completion of a read.
101/0x65	Write Recovered With RAID 1 Redundancy	Y	Ignore - See accompanying errors	None	Redundancy was used by the R1 module in the successful completion of a write.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
102/0x66	Disk drive reported a SMART event	Y	Signals internal drive errors threshold exceeded, probable disk failure in future	Disk Drive	The disk drive reported a SMART event. The event is logged and the common sense data is updated for all regular read/write and passthru commands. The precedence for SMART event data in the common area is low, so that other errors that occur during the same I/O are reported back to the host. A SMART event does not affect the I/O except that it does count as one try of the I/O.
128/0x80	Access Time Count Error	Y	Ignore	None	The frequency distribution table used to locate recently modified blocks was found to be inconsistent. This problem is self correcting.
129/0x81	Disk Drive Placed In Failed State	Y	Single Occurrence	Disk Drive Controller Internal SCSI Bus	The controller failed a disk drive due to its accumulated error history. Replace the failed disk drive.
130/0x82	NVRAM Image Out Of Date	Y	Ignore - Operator activity	None	This event would occur if the disk drives were moved from one disk array to another, and then reinstalled in the original array. The result is that the controller will detect a different stamp on the disks.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
131/0x83	No Quorum For Disk Set Access	Y	Ignore - Operator activity or accompanying errors	None	During startup, fewer than half of the original disk drives in the disk set were present. To recover the data, reinstall the missing disk drives. The disk array can be reformatted with the remaining disk drives, but this will result in all data being lost.
132/0x84	No Quorum For Disk Set Attachment	Y	Ignore - Operator activity or accompanying errors	None	During startup, fewer than half of the original disk drives in the disk set were present. To recover the data, reinstall the missing disk drives. The disk array can be reformatted with the remaining disk drives, but this will result in all data being lost.
133/0x85	No Quorum Due To Broadcast Failure	Y	Ignore - See accompanying errors	None	During startup (with disk set related NVRAM invalid) the controller was unable to invalidate the NVRAM disk image on more than half of the members of the disk set. The disk have disappeared or are not working.
134/0x86	No Address Table	Y	Ignore - Operator activity or accompanying errors	None	During startup the controller was unable to find a disk set with a valid shutdown image on any of the members present. The data mapping information has been lost, and it will be necessary to reformat the disk array.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
135/0x87	No Disk Drives Found During Initialization	Y	Ignore - Operator activity	None	During startup no disk drives were present. A new disk set was created with no members.
136/0x88	Insufficient Space During Rebuild	Y	Ignore - See accompanying errors.	None	There is insufficient disk space for migrating data during a rebuild. This is a controller error, although the disk array may still support some I/Os without adding disks.
137/0x89	Rebuild Started	Y	Ignore - See accompanying errors.	None	A rebuild has been started either automatically or by command.
138/0x8a	Rebuild Complete	Y	Ignore	None	A rebuild has completed successfully.
139/0x8b	Insufficient Space To Start Rebuild	Y	Ignore - See accompanying errors	None	A rebuild was not started due to insufficient disk space. This event is most likely to occur when Active Hot Spare is not enabled. To create the necessary disk space, add a disk or delete a LUN.
140/0x8c	Rebuild Failed	Y	Ignore - See accompanying errors	None	Rebuild has failed to complete due to multiple disk failures or a controller failure. Previous messages in the log should indicate whether or not there have been multiple disk failures.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
141/0x8d	Cancel Rebuild Complete	Y	Ignore - Operator or Host Activity	None	The cancellation of a rebuild has completed.
142/0x8e	Disk Drive Table Overflow	Y	Ignore - Operator activity	None	The controller is capable of retaining information about 16 drives. Disk drives that are removed from the array and enter the missing drive list are included in this count. If the total number of disk installed in the array plus any missing drives ever exceeds 16, this condition is logged. The disk array always generates a data unavailable warning before this condition is reached. Once the 16 disk limit is reached, the controller will not recognize any additional drives installed in the array. Because the controller cannot add the new disks to the drive list, the status light on the newly installed disk will remain amber. To correct his problem and maintain data integrity, find and reinstall the missing disks. If the data on the disk array is not critical, the disk array can be reformatted with the new disks. .

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
143/0x8f	Duplicate Disk Drive Identifier	Y	Single Occurrence	Controller Erroneous Operator Activity	As part of its stamp, each drive indicates its logical position in the disk set to which it is attached. This event indicates that the controller has detected two disk drives with identical stamps, indicating that they occupy the same logical position of the same disk set. The most likely source of this error is the erroneous assignment of duplicate disk set ID's by the controller. This would generally originate with incorrect controller serial number assignment, and/or loss of NVRAM. This error would also occur if a user made an image copy of a drive. The solution to this difficult problem involves two steps: 1. Try to determine which of the disk drives share the conflicting stamp. This can be done by removing disk drives until the problem disappears. Concentrate on any previously used or unincluded disks first. 2. When you have isolated the two conflicting disks, determine which one contains valid data.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
144/0x90	Disk Drive Installed	Y	Ignore - Operator Activity	None	The controller has detected the installation of a new disk drive. This event occurs regardless of the disposition of the drive toward the disk set. The disk drive ID number assigned to the drive installed appears in the component identifier field of this log entry. A disk drive ID number consisting of the controller serial number followed by a 0 indicates that the disk drive ID number has not yet been assigned.
145/0x91	Disk Drive Added To Disk Set	Y	Ignore - Operator activity	None	The controller has included a new disk drive in the disk set. This event occurs only when a disk drive that was not previously a member of the disk set becomes a member. It does NOT occur when a down, failed, or missing disk is returned to ready status. The disk drive ID number assigned to the drive added appears in the component identifier field of this log entry.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
146/0x92	Disk Drive Removed	Y	Ignore unless no operator activity	Disk Drive Internal SCSI Bus Controller	The controller has detected that a disk drive has been removed. This event occurs for disk set members only. The disk drive ID number assigned to the drive removed appears in the component identifier field of this log entry. A disk drive ID number consisting of the controller serial number followed by a 0 indicates that the disk drive ID number has not yet been assigned.
147/0x93	Disk Drive Deleted From Disk Set	Y	Ignore - operator activity or associated errors	None	The controller has deleted a disk set member. This occurs only when a drive that was previously a member becomes a non-member. The drive may or may not be present in the disk array at the time. The disk drive ID number assigned to the drive deleted appears in the component identifier field of this log entry.
148/0x94	Logical Unit Created	Y	Ignore - operator or host activity	None	The controller has successfully created a new LUN. The component identifier field of this log entry contains the number of the new LUN (first 8 bytes) and its capacity (last 8 bytes).

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
149/0x95	Logical Unit Deleted	Y	Ignore - operator or host activity	None	The controller has successfully deleted a LUN. The number of the deleted LUN appears in the last 8 bytes of the component identifier field of this log entry.
150/0x96	Logical Unit Renumbered	Y	Ignore - host activity	None	The controller has successfully renumbered a LUN. The component identifier field of this log entry contains the original number of the LUN (first 8 bytes) and the new number of the LUN (last 8 bytes).
151/0x97	Disk Set Attached	Y	Ignore - operator activity	None	The controller has successfully attached to a new disk set. This occurs after every format disk array, and whenever a power on or reset occurs while the controller is not attached to a disk set. In some cases, the currently attached disk set may be empty.
152/0x98	Unable To Complete Internal Data Transfer	Y	Ignore - See accompanying errors	None	The system experienced a memory error and was unable to resolve the error because DMAs did not complete. The disk drive must be reset.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
153/0x99	Unable To Recreate Memory Error	Y	Ignore	None	The controller experienced a memory error but was unable to recreate the failed memory accesses. The disk array will reset in response to this condition. A reset will rescan all memory and attempt to locate the problem.
154/0x9a	Memory Error Not Recovered With Redundancy	Y	More than 1 in 6 mo.	SIMM Controller Backplane	The controller experienced an unrecoverable error that could not be recovered using redundant memory. This may cause data loss if the error occurs in non-redundant NVRAM memory..
155/0x9b	Memory Error Recovered With Redundancy	Y	Ignore - See accompanying errors	None	The controller experienced an unrecoverable error that was recovered using redundant memory, or a controller reset
156/0x9c	Uncorrectable Memory Error	Y	More than 1 in 6 months per controller	SIMM Controller Backplane	The controller experienced an uncorrectable memory error ECC error.
157/0x9d	Correctable Memory Error	Y	See correctable rate associated with usage page	SIMM Controller Backplane	The controller experienced a correctable error.
158/0x9e	Memory Compare Error	Y	Ignore - See accompanying errors	SIMM Controller Backplane	The system experienced a compare error between the redundant memories. The mirrored image maintained by the two controllers does not match, but the exact cause is not apparent.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
159/0x9f	Controller Data Bus Microprocessor Access Parity Error	Y	More than 1 in 6 months	Controller	The controller experienced a parity error during microprocessor access to PRAM or host SRAM. Typically occurs during self-test.
160/0xa0	Internal Data Bus Error	Y	More than 1 in 6 months	Controller SIMM	The controller experienced a parity error during a DMA operation. Typically occurs during self-test.
161/0xa1	Mirrored Memory Down	Y	Ignore - see accompanying errors	None	A communication problem has developed that prevents the two controllers from communicating properly. In this state, X will be on line and controller Y will be offline. The secondary controller will remain offline until a power cycle is performed. controller
162/0xa2	Mirrored Memory Blocked	Y	Ignore if recovered by power cycle	Controller SIMM Backplane	A communication problem has developed that prevents the two controllers from properly maintaining their memory mirror image. The secondary controller will be offline in this state.
163/0xa3	Disk Set Detached	Y	Ignore - Operator/Host activity	None	The controller has detached itself from the disk set. This occurs when a shutdown has completed successfully. Note: The component identifier in the log record is the disk set number for this system change event.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
164/0xa4	Microprocessor Software Fault	Y	More than 1 in 1 month	Controller	A problem occurred which caused the microprocessor to vector to the software fault interrupt service routine. The controller always resets following this log entry. This error is caused by illegal instruction fetches, divide by zero, or other illegal processor activity.
165/0xa5	Microprocessor Hardware Fault	Y	More than 1 in 1 month	Controller	A problem occurred which caused the microprocessor to vector to the hardware fault interrupt service routine. The controller always resets following this log entry. This error occurs when the microprocessor attempts an illegal interrupt vector.
166/0xa6	Internal SCSI Event	Y	Single Occurrence not with other entries	Disk Drive Controller Internal SCSI Bus	This is an error detected by the interface driver during a bus scan, or an error that cannot be linked to a particular command. It is normal for this event to accompany hot plug events. If it occurs independent of any hot plug events, it may indicate a hardware failure.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
167/0xa7	Insufficient RAM For Image Upload	Y	Ignore - Operator error or accompanying errors	None	This errors occurs if a disk set has been moved from a controller with more RAM to a controller with less RAM. Consequently, the current RAM configuration is not large enough to hold the NVRAM image stored on disk. More RAM can be added to the controller to correct this problem
168/0xa8	Internal SCSI Queuing Disabled	Y	Immediate Performance Problem - Unsupported Disk	Disk Drive	This event indicates that the controller couldn't set the SCSI configuration settings for the disk drive correctly. This could be caused by a failing disk drive, or the use of an unsupported disk drive.
169/0xa9	Internal SCSI Disconnects Disabled	Y	Immediate Performance Problem - Unsupported Disk	Disk Drive	The controller could not configure the disk drive to disable disconnects during data transfer phase. This will cause the interface driver to disable disconnects on the channel, thus causing degraded drive performance. This event may also indicate that the controller could not enable queuing on this drive so the interface driver will disable disconnects on the channel. This is typically caused by using an unsupported disk drive that the controller cannot configure properly.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
170/0xaa	Internal SCSI Reassign Completed	Y	See disk drive vendor's reassign rate spec.	Disk Drive	The controller successfully completed a sparing operation. The reported FRU is the slot number.
171/0xab	Internal SCSI Reassign Canceled	Y	Ignore	None	A sparing operation was canceled, typically due to a hog plug event on the bus. The sparing operation will not be retried until another the bad block is accessed again. The reported FRU is the slot number.
172/0xac	No Error On Disk Media After Medium Error	Y	Ignore unless medium error recurs	Disk Drive	The controller has determined that media for which a disk drive had reported a MEDIUM ERROR is actually OK. The data stored at the affected block may or may not have been recovered. The reported FRU is the slot number.
173/0xad	Incompatible RAM Image Revision	Y	Ignore - Operator Error	None	The NVRAM image stored on the disk set when it was shutdown is not compatible with the current version of controller firmware. This is typically caused when upgrading controller firmware. Returning to the previous firmware revision will correct this problem without data loss.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
174/0xae	Other Controller Interrupts Stuck On	Y	Single Occurrence	Controller Backplane	The reporting controller has detected that the other controller's interrupt seems to be stuck on. This error is logged only once per power on.
175/0xaf	No Interrupts From Other Controller	Y	Single Occurrence	Controller Backplane	The reporting controller has detected that the other controller's interrupt is not working properly. This error is logged only once per power on.
176/0xb0	Internal SCSI Disconnect	Y	Ignore - Drive compatibility problem	Disk Drive	A drive disconnected during a data transfer. This results in failure of the transfer because there is no method for ensuring correct generation of parity data. This is typically accompanied by other errors.
177/0xb1	Disk Drive Downed	Y	Ignore - Operator or Host activity	None	A disk drive was successfully downed in response to user request.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
178/0xb2	Data Unavailable	Y	Ignore - See accompanying errors	None	The data unavailable condition was triggered. This is caused by multiple failed, downed, or missing disk drives. The condition persists as a warning until fewer than 2 drives are down, failed, or missing. If this condition occurred as a result of removing disk drives, reinstall them to correct the problem. This event also occurs if data and redundancy have been lost for any part of the disk set. The disk array must be reformatted in this case.
179/0xb3	Insufficient Optimal Space For Rebuild	Y	Ignore - See accompanying errors	None	There is insufficient disk space for rebuild to execute. This event is most likely to occur when using disk drives of different capacities. To create the necessary disk capacity, add another disk (equal in capacity to the largest disk in the array) or delete a LUN.
180/0xb4	Rebuild Restarted	Y	Ignore	None	A rebuild has been automatically restarted due to a disk failure or a disk removal.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
183/0xb7	Cancel Rebuild Started	Y	Ignore - Operator or Host activity	None	A rebuild has been canceled either automatically or by command. The disk array automatically cancels a rebuild if it needs to restart rebuild due to a disk addition, a LUN deletion, or a LUN format.
184/0xb8	Rebuild IO Priority Changed	Y	Ignore - Host activity	None	The host has changed the rebuild priority.
185/0xb9	Non-Member Drive Removed	Y	Ignore - Operator activity	None	The controller detected that a disk drive was removed. This event occurs for drives that are not disk set members when they are removed. The device number field is not used.
186/0xba	Drive Missing At Power On	Y	Ignore unless no Operator activity	Disk Drive Controller Internal SCSI Bus	Indicates that a disk drive was discovered to be missing during a power on or reset. This event occurs for disk set members only. The disk drive ID number assigned to the missing drive appears in the component identifier field of this log entry. A disk drive ID number consisting of the controller serial number followed by a 0 indicates that the disk drive ID number has not yet been assigned.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
187/0xbb	RAM Image Upload Failed	Y	Single Occurrence	Disk Drives Controller Internal SCSI Bus	The controller was unable to upload a usable disk copy of NVRAM during startup. This may be a result of missing or failing disk drives.
188/0xbc	Old Cache Configuration Used	Y	Ignore - See errors associated with shutdown	None	Write data found in the uploaded NVRAM image blocked a requested transition to a new cache configuration. The previous configuration is being used.
189/0xbd	Incompatible RAM Image Content	Y	Ignore - Operator error	None	The current RAM configuration is not compatible with the RAM configuration of the NVRAM disk image. This is caused by a different mapping of NVRAM in the disk image that cannot be supported by the current configuration. For example, the disk image may support 8 GB disk drives but the current configuration does not. To use the existing disk image, the current controller map configuration must be changed to match the disk map configuration.
190/0xbe	Internal SCSI Underrun Event	Y	Single Occurrence not accompanied by other errors	Disk Drive Controller Internal SCSI Bus	A disk drive sent/received less data than expected.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
191/0xbf	Internal SCSI Overrun Event	Y	Single Occurrence not accompanied by other errors	Disk Drive Controller Internal SCSI Bus	A disk drive sent/received more data than expected.
192/0xc0	Internal SCSI Timeout Event	Y	More than 2 occurrences per hot plug event	Disk Drive Controller Internal SCSI Bus	A disk drive didn't respond within a specified time limit. The disk drive may be failing, or it may be busy performing data retries.
193/0xc1	Controller ECC Miscorrection	Y	Single Occurrence	SIMM Controller	The system experienced a correctable error which was most likely miscorrected.
194/0xc2	Controller Data Bus Microprocessor Access Error	Y	Single Occurrence	Controller	The controller experienced a microprocessor access error without the needed other qualifiers. Microprocessor access errors should only occur in conjunction with correctable or uncorrectable memory errors, or with parity errors. If no other condition is present, this event is reported to indicate the malfunction.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
195/0xc3	Incompatible Address Table In RAM Image	Y	Ignore - Operator error	None	The controller has detected that the amount of NVRAM available for the address table has been reduced. The disk array uses all available NVRAM to create the largest possible address table, which increases the total amount of usable capacity the controller can support. Once the size of the address table has been established, it cannot be reduced. This event is typically caused by removing a SIMM from the controller. Reinstall the SIMM to correct the problem.
196/0xc4	Non-Volatile SIMM Contents Lost	Y	Ignore unless no operator activity	SIMM Controller	This error occurs when NVRAM has failed or has been removed at a time when its contents were critical to disk array operation (not shutdown). The NVRAM on the affected controller is invalidated due to missing contents in the additional NVRAM.
197/0xc5	Battery Failed Discharge Test	Y	Single Occurrence	Batteries	A battery has failed the long discharge test. This test occurs following power on and every 30 days thereafter. The test takes about 36 hours to complete. Replace both batteries.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
198/0xc6	Fan Failed	Y	Single Occurrence	Fan Controller Backplane	A fan has failed and should be replaced.
199/0xc7	Power Supply Failed	Y	Single Occurrence	Power Supply Controller Backplane	A power supply has failed and should be replaced.
200/0xc8	Power Down Due To Fan Failure	Y	Single Occurrence	Fans Controller Backplane	The controller has detected that not enough fans are functioning to cool the disk array properly. As a result, the controller is shutting off the power supply to avoid overheating. Note: The NVRAM is not posted to disk, so it is critical to repair the system quickly.
201/0xc9	Fan Missing At Initialization	Y	Ignore - See accompanying errors.	None	During startup, the controller detected that a fan had been removed from the enclosure. The total length of time a fan has been missing will be checked periodically and when it exceeds approximately 10 minutes, the controller will shut off the power supply.
202/0xca	Power Down Due To Missing Fan	Y	Single Occurrence	Fan Controller Backplane	The controller is shutting off the power supply because a fan has been missing from the enclosure for too long (approximately 10 minutes).

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
203/0xcb	Replace Batteries	Y	Single Occurrence	Batteries Controller	The batteries have failed a discharge test or have dropped below an acceptable voltage level. Both batteries should be replaced.
204/0xcc	Cache Shrink Attempted After Shutdown Warning	Y	Ignore - see errors during shutdown	None	The amount of cache on the controller has shrunk due to SIMM failure or removal. This happened with valid writes still in cache, and all the writes no longer fit in the reduced amount of cache.
205/0xcd	Controller Failed	Y	Ignore if corrected by reset or power cycle	Controller	During power on, a bad controller was detected. This may result if the controller has difficulty establishing communication. Ignore if recovered by power cycle or reset.
206/0xce	SIMM Failed	Y	Single Occurrence	SIMM Controller	A SIMM was discovered to be bad during power on.
207/0xcf	Extended Drive Installation Event	Y	Ignore unless no operator activity	Disk Drive Controller Internal SCSI Bus	An internal SCSI channel is being held reset longer than expected. Typically caused by a partially-installed drive module, a failing drive module, a failing controller, or a bent pin on a connector.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
208/0xd0	Internal SCSI Bus State Event	Y	Single Occurrence	Controller Disk Drive Internal SCSI Bus	A disk drive responded incorrectly. The result was an internal SCSI bus reset, and a hot-plug recovery sequence to regenerate the bus state. The control panel display may indicate “verifying drives” as a result of the internal bus reset.
209/0xd1	Uncorrectable ECC Error During Initialization	Y	More than 1 in 6 months if no operator activity	SIMM Controller	The controller experienced an unrecoverable error during power on. This is expected in any of the following situations: - The batteries have been fully discharged. - The batteries were disconnected from the memory - New SIMM memory was added All other situations, this event represents a true memory error.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
210/0xd2	Correctable ECC Error During Initialization	Y	More than 1 in 6 months if no operator activity	SIMM Controller	The controller experienced an unrecoverable error during power on. This is expected in any of the following situations: - The batteries have been fully discharged. - The batteries were disconnected from the memory - New SIMM memory was added All other situations, this event represents a true memory error.
211/0xd3	Controller Failed Local Address Decode Test	Y	Ignore if corrected by reset or power cycle.	SIMM Controller	A controller was discovered to be bad during power on. Specifically, the secondary controller appears to have failed the request to perform a local memory decode test or was unable to establish communication with the other controller. This may be recovered by power cycle or reset.
212/0xd4	Controller Failed Remote Address Decode Test	Y	Ignore if corrected by reset or power cycle.	SIMM Controller Backplane	A controller was discovered to be bad during power on. Specifically, the secondary controller appears to have failed the request to perform a remote memory decode test or was unable to establish communication with the other controller. This may be recovered by power cycle or reset.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
213/0xd5	Secondary Controller Failed, Entered Isolation Mode	Y	Ignore if corrected by power cycle	Controller Backplane	A controller was discovered to be bad during power on. Specifically, the secondary controller appears to have failed due to an event which caused isolation mode to be entered. In isolation mode controller X becomes the primary controller and controller Y is offline. This may be recovered by power cycle.
214/0xd6	Secondary Controller Failed, Entered Separation Mode	Y	Ignore if corrected by reset or power cycle	Controller Backplane	A controller was discovered to be bad during power on. Specifically, the secondary controller appears to have failed due to an event which caused separation mode to be entered. In separation mode, the NVRAM contents is not mirrored between controllers. This may be recovered by reset or power cycle.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
215/0xd7	Secondary Controller Failed With Memory Error	Y	Ignore if SIMM configurations do not match	SIMM Controller Backplane	A controller was discovered to be bad during power on. Specifically, the secondary controller appears to have failed due to some memory error or violation. If the memory contents on each board does not match (in number), this error can occur. Additionally, if a memory component fails, it will cause this error. This will occur if a different number of SIMMs are used on each controller.
216/0xd8	Secondary Controller Failed, Communication ECC Errors	Y	See accompanying errors	None	A controller was discovered to be bad during power on. Specifically, the secondary controller appears to have failed due to the inability for the communication area of NVRAM to be cleared of ECC errors.
217/0xd9	Secondary Controller Failed To Enable RAM Mirroring	Y	See accompanying errors	None	A controller was discovered to be bad during power on. Specifically, the secondary controller appears to have failed due to the mirror not coming to an up state within 1 second of power on.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
218/0xda	Secondary Controller Failed With Communication Timeout	Y	See accompanying errors	Controller Backplane	A controller was discovered to be bad during power on. Specifically, the secondary controller appears to have failed due to its failure to respond within the message timeout period.
219/0xdb	Member Disk Drive Added Back Into Disk Set	Y	Ignore - Operator or host activity	None	The controller has detected that a member of the disk set that was either down, failed, or missing has been returned to the ready state. This can occur as a result of a Add Physical Drive command, or a hot plug installation of the drive. The disk drive ID number assigned to the drive added appears in the component identifier field of this log entry.
220/0xdc	Controller Initiated Host SCSI Reset	Y	Ignore	None	The controller is going to initiate a Host channel SCSI reset. This will occur if the controller detects that the channel has not already seen a reset, and DRR (Disable Remote Reset) indicates that a SCSI reset should be generated.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
221/0xdd	Cache Version Mismatch In RAM Image	Y	See errors associated with shutdown	None	A new version of controller firmware has been download with writes stuck in cache. Normally there will be no writes stuck in cache and a firmware download will complete without any problems. However, if there are writes stuck in cache, the upload will fail with this event code. To correct this it may be necessary to revert to the old version of firmware and solve whatever problem is causing writes to be stuck in cache (probably one or more disks have failed).
222/0xde	RAM Version Mismatch	Y	NA	None	The upload routine was unable to upload part of the disk NVRAM image because the current firmware does not support that use of RAM. (Most likely an older version of firmware is trying to upload a disk image posted by some other firmware version.)

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
223/0xdf	Disk Format Version Mismatch	Y	NA	None	The NVRAM format of the disks does not match the format used by the controller. This event is logged when an icicle controller attempts to use disks previously shutdown by an Ice controller or visa-versa. The controller cannot use an NVRAM image in the incorrect format.
224/0xe0	Shutdown Due To Power Supply Failure	Y	Single Occurrence	Power Supplies, Controller, Backplane	This error code indicates that the Background Manager (BGM) has discovered that there are not enough good power supplies to run the system. The BGM is shutting down the subsystem to minimize system operation with inadequate power. Note: The NVRAM is posted to disk.
225/0xe1	Recovery from battery backed RAM Loss Started	Y	Single Occurrence	Controller	This error code indicates that recovery from a battery backed RAM loss has been initiated. The contents of the NVRAM that is battery backed up has been lost and the arrayrecover command has been initiated. The contents of the NVRAM has started to be rebuilt. (This is a feature only in controller firmware revisions HP54 and later.)

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
226/0xe2	Recovery from Battery Backed RAM Loss complete	Y	Ignore	None	This error code indicates that recovery from a battery backed RAM loss completed with at least partial success. Maps were recovered. Multiple failures may or may not have occurred. Occurrence of multiple failures are reported in the log between the RECOV_STARTED and RECOV_DONE events.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
227/0xe3	Redundancy corrected	Y	Suspect data if followed by error code 93 (0x5d)	Disk Drive, Back End SCSI Bus, Controller	This error code indicates that the parity scan which executes during recovery from RAM loss found an instance of incorrect redundant data. Data which was being updated when RAM was lost may produce this error in single failure scenarios. This error can also result from multiple failure conditions. Firmware differentiates the two scenarios by placing a limit on the number of these conditions which can occur before recovery is terminated due to multiple component failures. If this error is followed by error 93 (0x5d) then the contents of data blocks reported in this error should be considered suspect. The block address of the error appears in the first 4 bytes of the controller serial number field of this log record. The LUN appears in the fifth byte of the controller serial number, and the length of the affected area in 512 byte blocks appears in the last 3 bytes. The FRU field reports the FRU of the drive corrected.

Event Number (DEC/hex)	Event Name	Event Logged	Predictive Maintenance Implication	Suspected Components	Description
228/0xe4	Local Controller Failed DRAM Address Decode Test	Y	Ignore if recovered by reset or power on	DRAM SIMM, Controller	This error code indicates that the DRAM SIMM on the local controller failed the DRAM address decode test during the power-on process. Specifically, the DRAM SIMM on the primary controller failed the decode test.
229/0xe5	Remote Controller Failed DRAM Address Decode Test	Y	Ignore if recovered by reset or power on	DRAM SIMM, Controller	This error code indicates that the DRAM SIMM on the remote controller failed the DRAM address decode test during the power-on process. Specifically, the DRAM SIMM on the secondary controller failed the decode test.
230/0xe6	Controller Failed Background ROM checksum test	Y	Ignore if recovered by reset or power on	ROM, Controller	This error code indicates that the ROM on the local controller failed the ROM checksum test done in the background during idle time. The firmware stored in the ROM is corrupted.
231/0xe7	Scrub policy detected error	Y	Ignore - should be preceded by Drive errors	Disk drive	This error code indicates that an error was returned to the Scrub policy by a device read. It is logged to provide information about the cause of the error. Additional information about the error from the device should precede this entry.

Chapter 6. Preventive Maintenance

This chapter provides instructions for preventive maintenance of the disk array.

Tools Required

No tools are required for preventive maintenance of the disk array.

Required Preventive Maintenance

Airways

Monthly, or more frequently if operating in a dusty environment, clean any dust accumulation from the front door and module grills. Clean any dust accumulation from the rear power module fan grill.

Controller Batteries

Controller batteries should be replaced every three years, or sooner if the display module indicates. See *Replacing Controller Batteries*.

Chapter 7. Removal and Replacement

This chapter provides detailed instructions for enclosure parts removal and replacement. This chapter also describes and identifies part numbers.

WARNING! The procedures in this chapter should only be performed by a qualified service representative. If you are not a qualified service representative, performing these procedures may result in personal injury or loss of data.

CAUTION! Check with system administrator before powering down the system.

Tools Required

- T-15 (TORX) driver
- T-20 (TORX) driver
- T-25 (TORX) driver
- Standard flat-bladed screwdriver
- Small flat-bladed screwdriver (less than 4 inches long and less than 0.25 inch width)
- 3/8-inch nut driver
- 19-mm deep socket
- 5-mm nut driver
- Needle-nosed pliers

Replacing a Failed Controller Module–HP-qualified personnel only

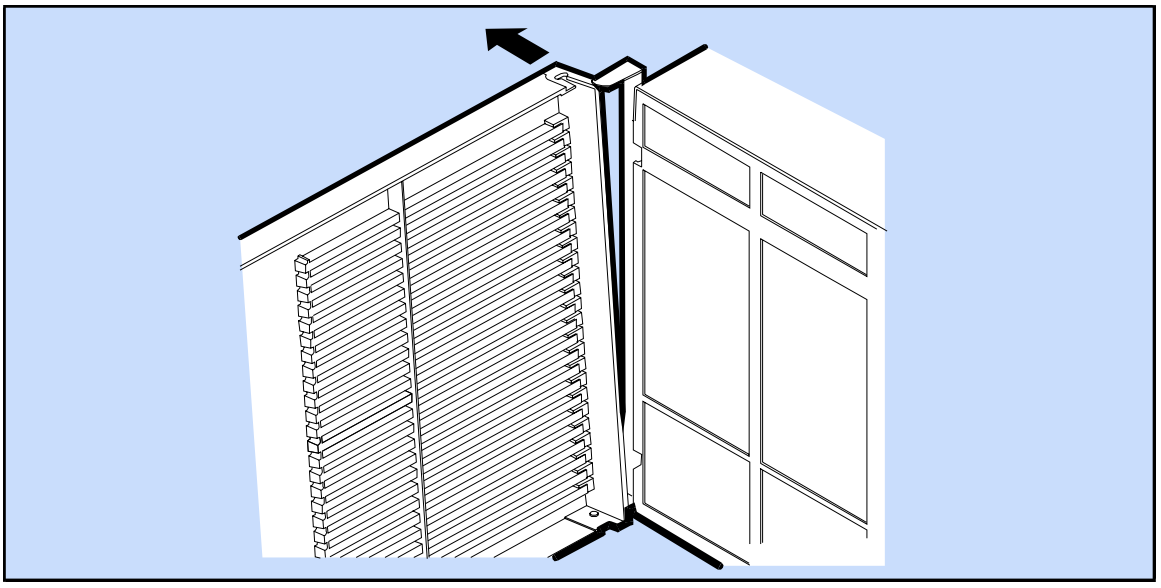
Replacement controller modules are shipped without batteries. Therefore, if you are installing a replacement controller, you should remove and use the good battery packs from the controller module being replaced.

Front Door Assembly–HP-qualified personnel only

To replace the front door (See Figure 31):

1. Open the door to a position 90 degrees from the closed position.
2. Center the top hinge pin in the top slot of the door.
3. Push the door top outward, so the hinge pin exits through the perpendicular slot.
4. Pull the door up and free it from the bottom hinge pin.
5. Replace the door by dropping the lower door mounting hole onto the lower hinge pin.
6. Swing the upper corner mounting slot into the upper hinge bracket pin until it snaps into place.

Figure 31. Replacing the Front Door



Switch Cover

To replace the switch cover:

Snap the cover in place from the front of the door.

Front Door Snap

To replace the front door snap (see Figure 36, Item 14):

1. Align the door snap with the alignment pins on the right mounting flange.
2. Secure the door snap with a T-15 screw.

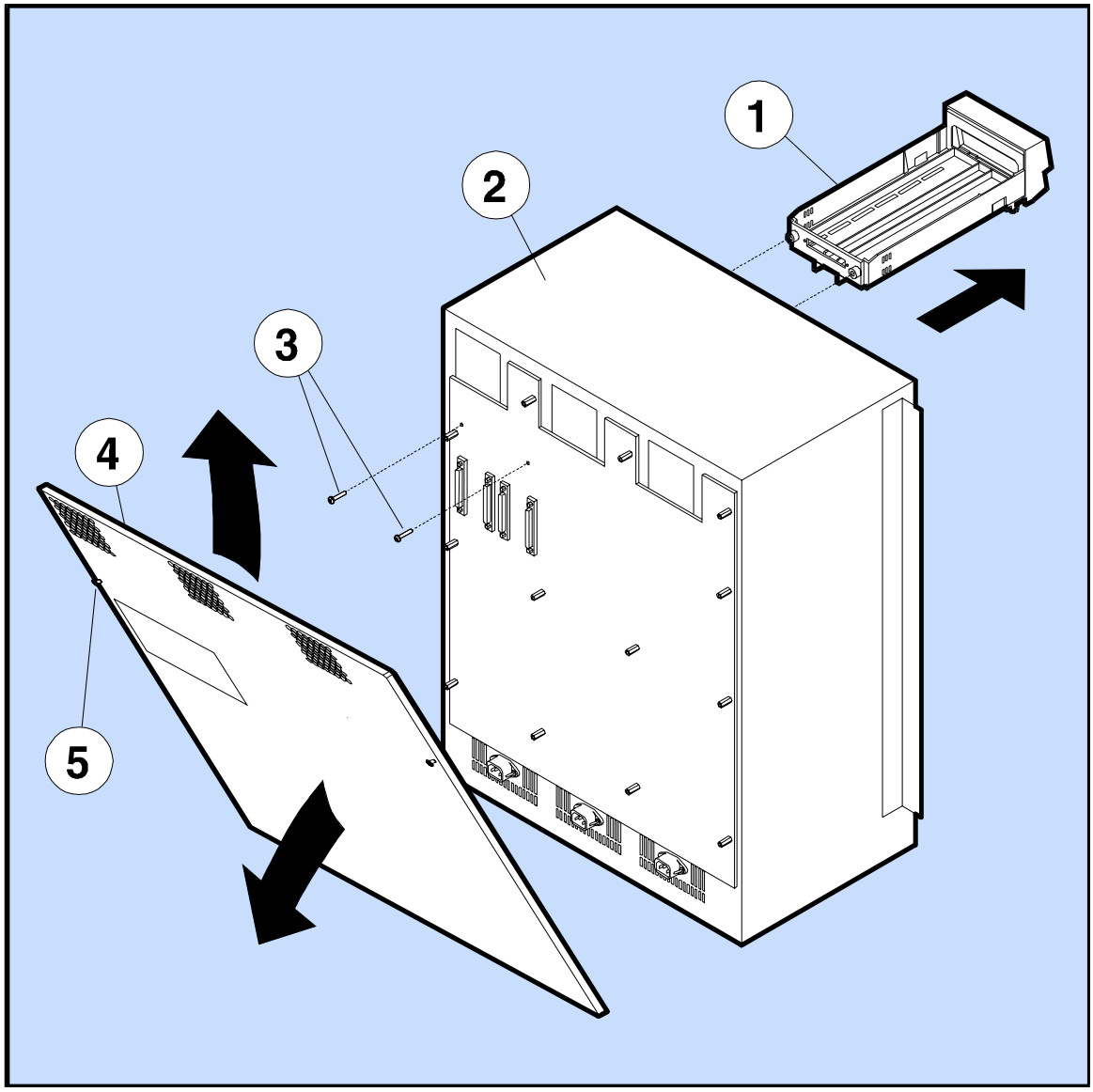
Display Module–HP-qualified personnel only

CAUTION! The following procedures require that you perform a shutdown, turn off the disk array, and make it inaccessible. Check with the system administrator before proceeding.

To replace the display module(see Figure 32):

1. Shut down the disk array, turn off the disk array, disconnect the ac power cords and SCSI interface cables.
2. Remove the two captive screws from the rear cover. Tilt back the top of the rear cover and remove it completely.
3. Remove the two T-15 M4 Screws (Figure 32, Item 3) that secure the display module to the backplane assembly.
4. Remove both controller modules from the enclosure.
5. Remove the display module from the front of the disk array.

Figure 32. Replacing the Display Module



Backplane Assembly–HP-qualified personnel only

CAUTION! The following procedures require that you perform a shutdown, turn off the disk array, and make it inaccessible. Check with the system administrator before proceeding.

To replace the backplane assembly (see Figure 33, Item 2):

1. Shut down the disk array, turn off the disk array, disconnect the ac power cords and SCSI interface cables.
2. Remove all modules (fans, disks, power supplies, and controllers) from all bays.
3. Remove the two rear cover captive screws, as shown in Figure 33, Item 6. Tilt back the top of the rear cover (5) and remove the rear cover completely from the disk array (1).
4. Remove the four standoffs (3) and their lock washers. Note carefully the position of the standoffs for later reassembly.
5. Remove the two T-15 M4 screws (4) that secure the display module to the backplane assembly.
6. Remove the display module from the front of the disk array.
7. Remove the eleven M4 nuts (8) from the backplane assembly. Note that the three nuts across the top of the backplane assembly also have flat washers (7) beneath the nuts. Do NOT remove any Pozidriv or Phillips screws from the backplane!
8. Remove the backplane assembly (2).
9. Reassemble in reverse order. Align the push rod with the switch on the backplane assembly and check for proper operation of the power button before attaching all hardware.

SCSI Bus Reset Switches–HP-qualified personnel only

CAUTION! After replacing the backplane assembly, make sure that the SCSI bus reset switches are set as shown in Figure 33. Altering the default factory settings on the SCSI bus reset switches may cause operating system conflicts for the host computer(s).

The SCSI bus reset switches (see Figure 33) are located on the top-left corner of the backplane assembly. To locate the switch, remove the rear cover to expose the switch. Figure 33 shows the switch segments on the SCSI bus reset switch and Table 15 shows the switch functions.

The SCSI bus reset switches are preset at the factory for proper operation. A SCSI bus reset is a very high priority interrupt. The SCSI bus reset option is used when the host controller or software requires a SCSI bus reset to be sent as notification of the removal of a controller or of a power shutdown.

The default setting for the SCSI bus reset switch is shown in Figure 33. There are two switches for each bus; one switch for power detect and the other is for controller detect. When enabled, the SCSI bus is reset when the following conditions occurs:

Power detect conditions:

- The power switch is cycled.
- When power is first applied (power on).
- When all power is removed (power off).

Controller detect conditions:

- A controller module is removed.
- A controller module is inserted.

The following actions will not cause a power or controller detect (reset) condition:

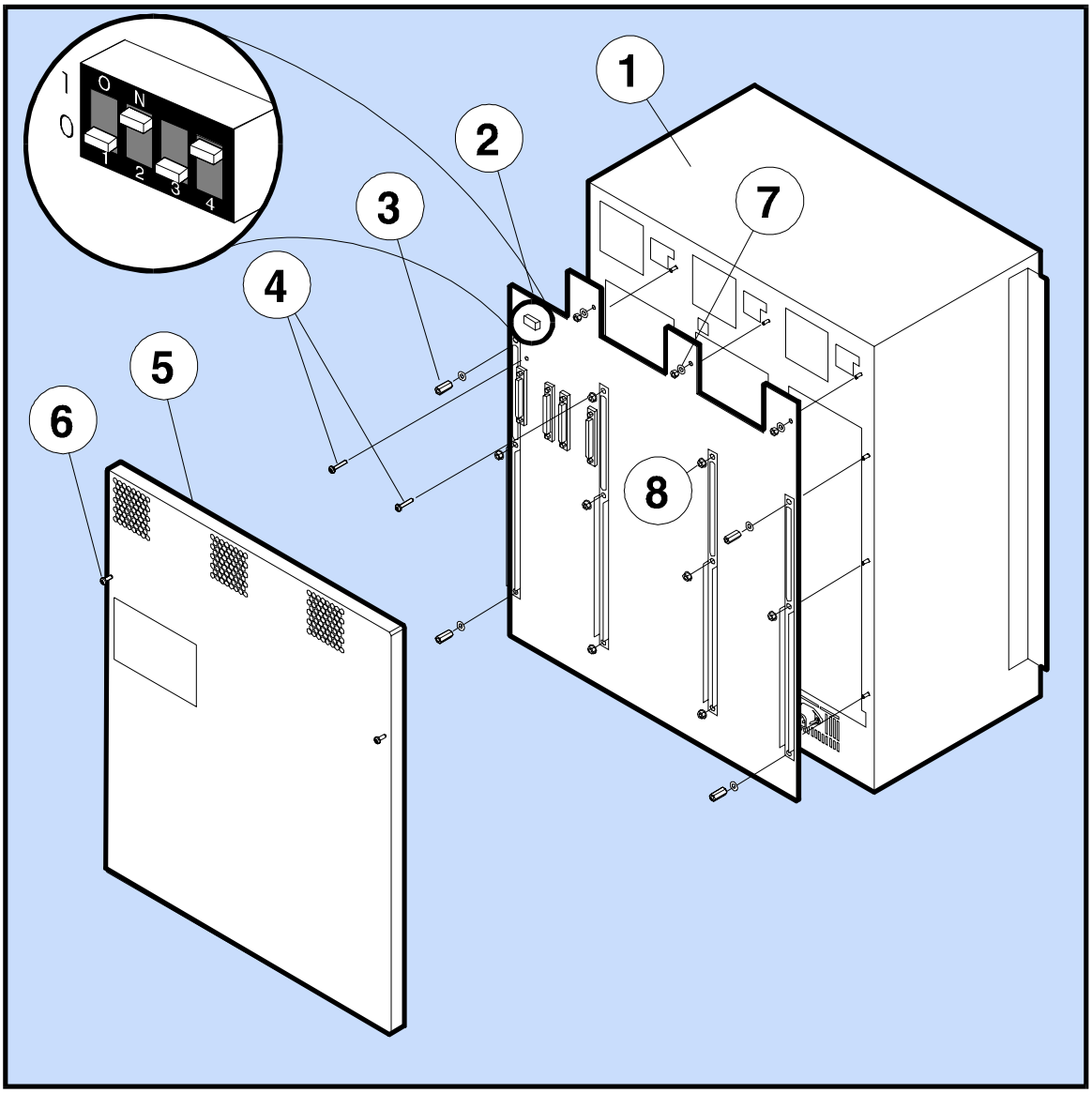
- Removing, replacing, or adding a single power module if there are two additional functioning power modules in the enclosure. A single power module is not sufficient to operate a fully loaded disk array.
- Removing a fan module.

NOTE! Removing a single fan module will power off the disk array.

Table 15. SCSI Bus Reset Switch Functions

Switch Number	1	2	3	4
SCSI Bus Switch Name	**Bus Y Power Detect**	**Bus Y Controller Detect**	**Bus X Power Detect**	**Bus X Controller Detect**
SCSI Bus Default Switch Setting	**OFF (Disabled)**	**ON (Enabled)**	**OFF (Disabled)**	**ON (Enabled)**
Switch Function When Enabled	When the Bus Y Power Detect Switch is enabled, the disk array controller generates a SCSI Bus Reset on Bus Y whenever power is applied or removed.	When the Bus Y Controller Detect Switch is enabled (default), the disk array controller generates a SCSI Bus Reset on Bus Y whenever disk array controller Y is inserted or removed.	When the Bus X Power Detect Switch is enabled, the disk array controller generates a SCSI Bus Reset on Bus X whenever power is applied or removed.	When the Bus X Controller Detect Switch is enabled (default), the disk array controller generates a SCSI Bus Reset on Bus X whenever disk array controller X is inserted or removed.
Switch Function When Disabled	When the Bus Y Power Detect Switch is disabled (default), the disk array controller will not generate a SCSI Bus Reset on Bus Y whenever power is applied or removed.	When the Bus Y Controller Detect Switch is disabled, the disk array controller will not generate a SCSI Bus Reset on Bus Y whenever disk array controller Y is inserted or removed.	When the Bus X Power Detect Switch is disabled (default), the disk array controller will not generate a SCSI Bus Reset on Bus X whenever power is applied or removed.	When the Bus X Controller Detect Switch is disabled, the disk array controller will not generate a SCSI Bus Reset on Bus X whenever disk array controller X is inserted or removed.

Figure 33. Replacing the Backplane



Power Button and Push Rod–HP-qualified personnel only

CAUTION! The following procedures require that you perform a shutdown, turn off the disk array, and make it inaccessible. Check with the system administrator before proceeding.

To replace the power button and push rod (see Figure 36):

1. Remove the Backplane Assembly.
2. Grasp the power button with pliers and pull out to remove the power button.
3. Locate and carefully remove the spring from the power button housing on the front of the enclosure.
4. Slide the push rod to the rear.
5. Reassemble in the reverse order, holding the push rod while sliding on the spring and then snapping the power button onto the push rod. Note the following:
   - The rear of the push rod is angled downward to fit the switch on the backplane assembly.
   - The spring fits between the front of the enclosure and the power button.
   - The clock hand on the power button should point upward.

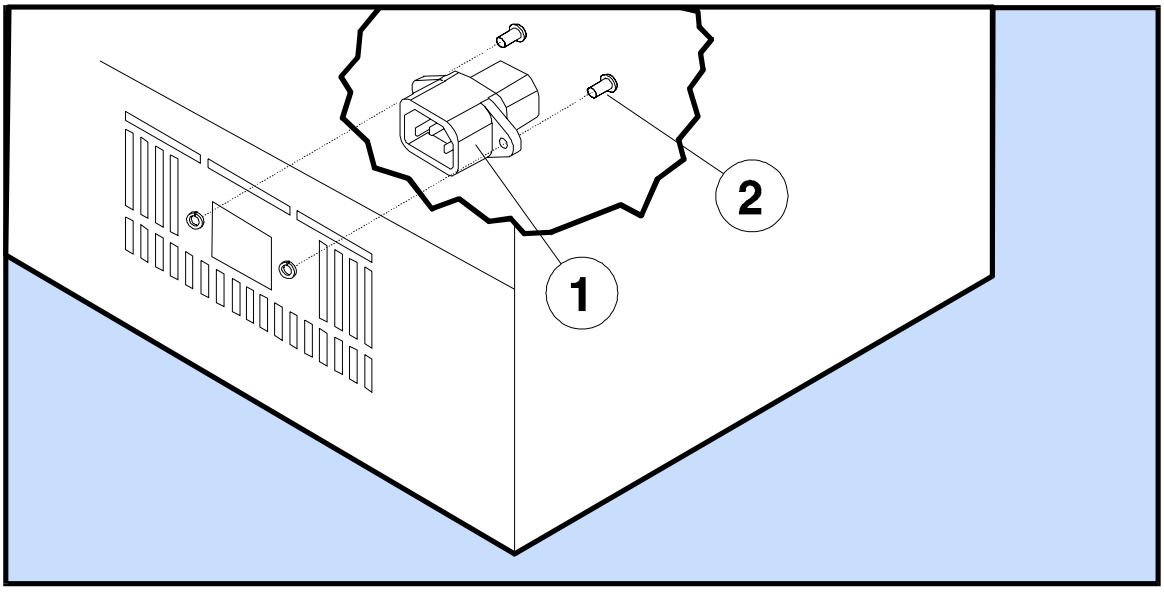
AC Power Receptacle–HP-qualified personnel only

CAUTION! The following procedures require that you perform a shutdown, turn off the disk array, and make it inaccessible. Check with the system administrator before proceeding.

To replace the ac power receptacle (Figure 34, Item 1):

1. Remove appropriate power module and its power cord.
2. Remove the two T-15 screws (2) from the ac power receptacle. Remove the ac power receptacle. Be careful not to drop the screws into the chassis, since they are difficult to locate if they fall below the chassis tray.
3. Replace in reverse order, ensuring that the metal spacer is inserted between the ac power receptacle and the back of the chassis. Also, make sure that the larger end of the ac power receptacle is installed toward the outside of the chassis, and that the ground pin on the ac power receptacle is facing upward.

Figure 34. Replacing the AC Power Receptacle



1 – AC Power Receptacle

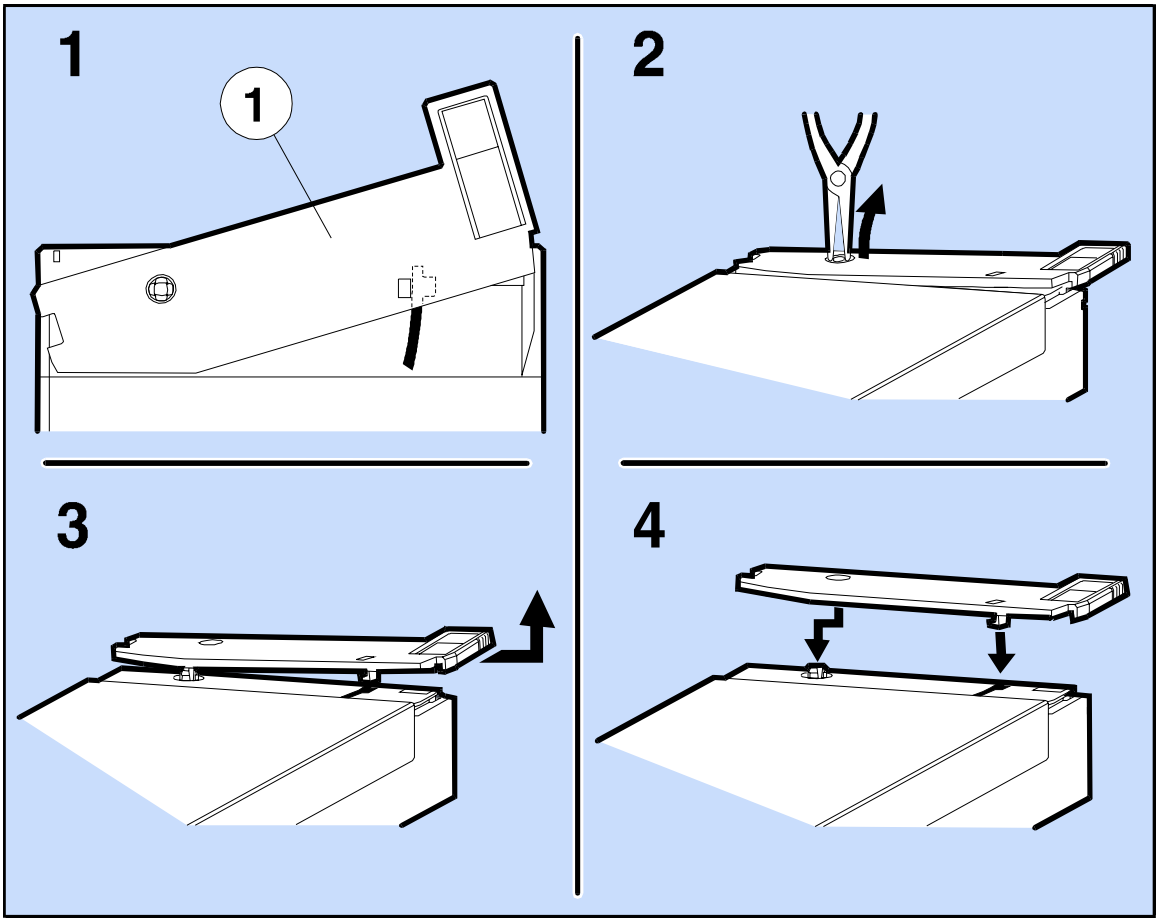
2 – Screw (with Captive Lock Washer)

Module Cam Lever–HP-qualified personnel only

To replace the module cam lever (see Figure 35):

1. Observe the module cam lever is guided by a locking bracket that fits into a track. Notice the track has a notch observable when the lever is fully out (Figure 35).
2. Remove the lever by squeezing the tabs of the pivot and lifting the lever away from the module.
3. Position the lever locking bracket over the track notch (observed in step 1), and lift it from the track.
4. To replace, insert the cam lever locking bracket into the track at the notched area, then snap the cam lever onto the pivot point.

Figure 35. Replacing the Module Cam Lever



Replaceable Part Numbers

Figure 36. Replaceable Parts

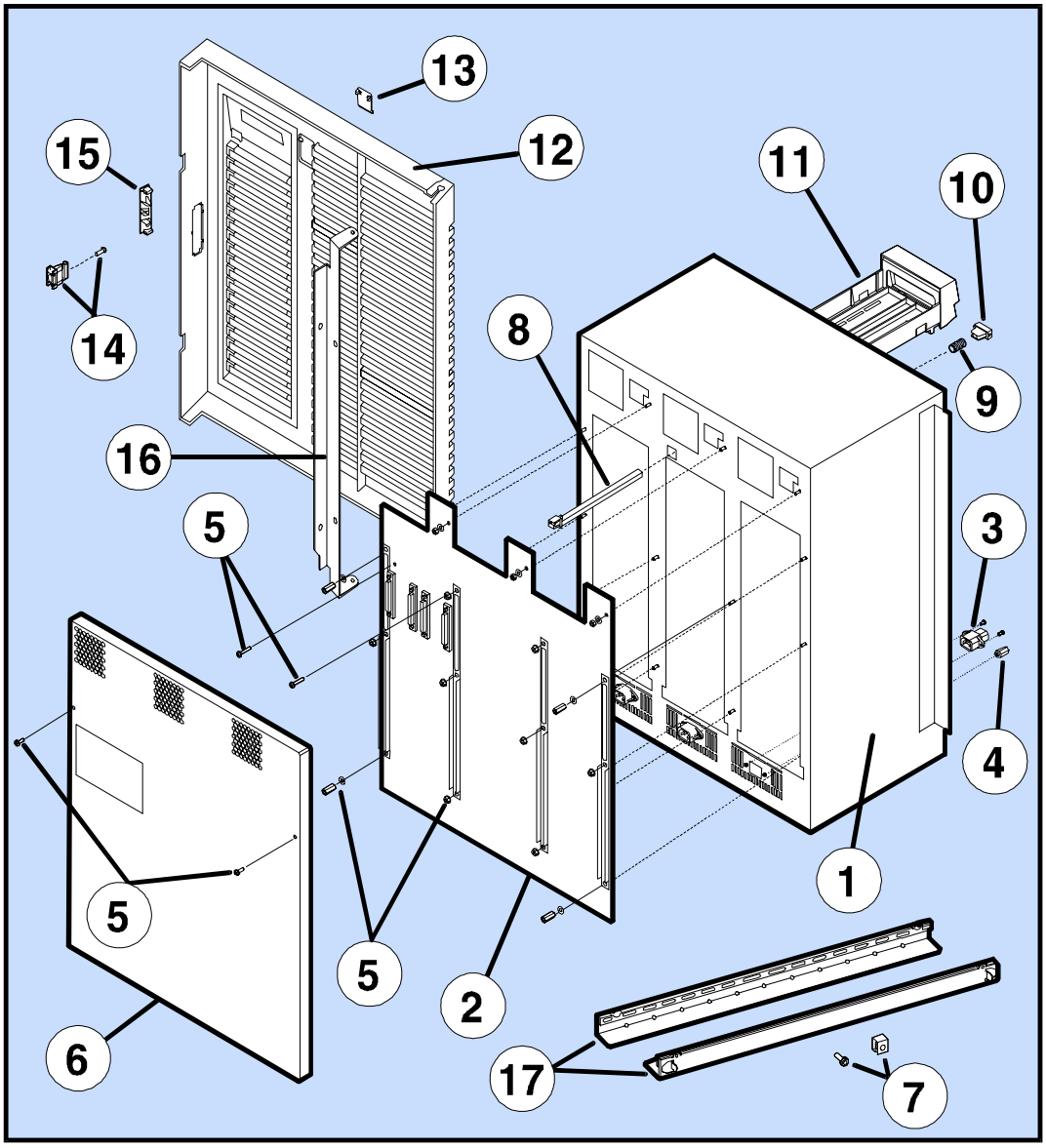


Table 16. Modular Replaceable Parts

HP Product Number	HP Replacement Part Number	HP Exchange Part Number	Description
A3702A	A3702-60003	A3702-69003	4.3 Gigabyte Disk Module (7200 rpm)
A3703A	A3703-60002	A3703-69002	9.1 Gigabyte Disk Module (7200 rpm)
A3710A	A3710-60001	A3710-69001	18.2 Gigabyte Disk Module (7200 rpm)
A5289A	A5289-60001	A5289-69001	36.4 Gigabyte Disk Module (7200 rpm)
A3713A	A3713-60001	A3713-69001	9.1 Gigabyte Disk Module (10,000 rpm)
A3714A	A3714-60001	A3714-69001	18.2 Gigabyte Disk Module (10,000 rpm)
A5292A	A5292-60001	A5292-69001	36.4 Gigabyte Disk Module (10,000 rpm)
A3706A	A3706-60004	A3706-69004	96-Megabyte Controller Module
N/A	C5445-60005	N/A	Backplane Assembly
A3708A	A3708-60002	A3708-69002	Power Module
A3709B	A3709-60002	N/A	Fan Module

Table 17. Disk Array Enclosure Replaceable Parts

Item No.	HP Replacement Part Number	Description	Qty
1	Not Available	Enclosure Chassis	1
2	C5445-60005	Backplane Assembly	1
3	5064-2404	AC Power Adapter Kit: (1) Power Receptacle, (2) T-15 Screws (with Captive Lock Washers)	3
4	C5445-60042	Power Supply Lockout Kit: (1) Standoff, (1) Screw	3
5	C5445-60043	Backplane Assembly Hardware Kit: (11) M4 Nuts, (4) Standoffs, (4) Star Washers, (3) Flat Washers, (2) T-15 Screw (Display Module), (2) M4 Captive Screws (Rear Cover Assembly), (2) #6 Star Washers (Rear Cover Assembly)	1
6	Not Available	Rear Cover Assembly	1
7	5063-6712	(4) T-25 Screws, (4) 6-32 Clip Nuts (Cabinet Install Kit)	1
8	C3595-40009	Push Rod	1
9	5181-7781	Spring	1
10	C3595-40010	Power Button	1
11	C5445-60027	Display Module	1
12	A3700-60100	Front Door Assembly (Parchment White Color, Standard)	1
	A5329-60100	Front Door Assembly (Quartz Gray Color, Optional)	REF
13	C3593-40031	Power Switch Flapper Door Cover	1
14	5064-2405	Door Snap Kit: (1) Door Snap, (1) T-15 Screw	1
15	C5445-00025	Latch Bracket	1

Item No.	HP Replacement Part Number	Description	Qty
16	C5445-00024	Hinge Bracket	1
17	C2786-00002	Rack Rail (Rackmount Only)	2
	8120-6514	Power Cord, CA-ASSY IEC 320 (Rackmount Only)	3
	5064-2407	Module Cam Tooth Kit: (1) Module Cam Tooth, (1) Nut, (1) Washer (Not Shown)	1
	1420-0532	Battery Pack (Not Shown)	2
	C3595-60141	Battery Box Cover (Not Shown)	1
	C3595-40043	Battery Cover (Not Shown)	1
	C3595-60018	Shipping Package, Enclosure (Not Shown)	1
	C3595-60055 C3595-80049	Shipping Package: Disk Module and Power Module (Not Shown)	1
	C3595-60055	Shipping Package: Fan Module (Not Shown)	1
	C3595-60053	Shipping Package: Controller Module (Not Shown)	1
	C2905-60150	Fast/Wide SCSI Terminator (Not Shown)	1
	C3595-40007	Module Cam Handle (Not Shown)	1
	C3595-40030	Module Cam Handle, Controller (Not Shown)	1
	A3701-60001	Cabinet Assembly (Deskside Cabinet Only)	1
	A3701-60100	Rear Door Assembly (Deskside Cabinet Only)	1
	5064-2413	Hook and Loop Straps (Deskside Cabinet Only)	1
	5064-2408	SCSI Cable, Right Angle (Deskside Cabinet Only)	1

Item No.	HP Replacement Part Number	Description	Qty
#851	A4801-63002	V-Class SCSI Cable, 10 m, 68-pin, HD Inline Term Cable	REF
#857	A4801-63004	V-Class SCSI Cable, 5 m, 68-pin, HD Inline Term Cable	REF
#873	A4801-63010	V-Class SCSI Cable, 2 m / 3 m Y-Cable, 68-pin Inline Term Cable	REF
#871	A4801-63012	V-Class SCSI Cable, 2 m / 5 m Y-Cable, 68-pin Inline Term Cable	REF
#900	8120-1351	Power Cord, UK BS1363	REF
#901	8120-1369	Power Cord, Australia AS-3112	REF
#902	8120-1689	Power Cord, Europe CEE7	REF
#903	8120-2371	Power Cord, CA-ASSY 16 AWG North America	REF
#904	8120-0698	Power Cord, CA-ASSY 18 AWG North America 250V	REF
#906	8120-2104	Power Cord, SEV Type 12 Power Cord Swiss	REF
#912	8120-2956	Power Cord, Denmark	REF
#917	8120-4211	Power Cord, CA-ASSY-18 AWG South Africa	REF
#918	8120-4753	Power Cord, Japan 100	REF

Appendix A. Product Specifications

This appendix contains the following information:

- Enclosure Physical Specifications
- Operating Characteristics and Requirements
- Environmental Requirements
- Module Specifications
- Enclosure Features

Enclosure Physical Specifications

Weight

Weight	Disk Array
Maximum Configuration (Net)	77.2 kg (170 lb.)
Maximum Configuration (Shipping)	92.0 kg (202.5 lb.)

Maximum configuration: 3 fans, 3 power modules, 12 disk modules, 2 controllers.

Product Dimensions

Dimensions	Disk Array
Height	578 mm (22.8 in.) (10 EIA)
Width	425 mm (16.7 in.)
Depth	310 mm (12.2 in.)

Packaging Dimensions

Packaging	Disk Array
Height	706 mm (27.8 in.)
Width	610 mm (24.0 in.)
Depth	508 mm (20.0 in.)

Operating Characteristics and Requirements

Power Requirements:

NOTE! Power requirements are specified for a unit during spin-up with a maximum configuration of three fan modules, three power modules, twelve disk modules, and two controller modules.

- 870 W (7.3 A at 120 Vac, 3.8 A at 230 Vac)

Airflow Space

- Minimum: 102 mm (4 in.) front and rear

Heat Dissipation

- Minimum Configuration: 135 watts (460 Btu/hr; 115 kcals/hr)
- Maximum Configuration: 750 watts (2560 Btu/hr; 645 kcals/hr)
- Typical Configuration (with twelve 9.1-Gigabyte 7200 rpm disk modules in the enclosure): 420 watts (1433 Btu/hr; 361 kcals/hr)

Electromagnetic Emissions

- Radiated and conducted interference:

  For USA, this 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. See instructions if interference to radio reception is suspected.

  For Europe, this equipment is designed to meet EC EN55022 (CISPR 22 Level A)

- Magnetic interference:

  Magnetic Operating: <5 Gauss peak to peak on all surfaces of product.

  Magnetic Nonoperating: <2 mGauss at 7 ft (2 m)

Acoustic Emissions

- 6.6 bels

Environmental Requirements

Temperature Ranges

- Operating: 5° to 40° C (41° to 104° F)

  [maximum rate of change: 20° C/hour (36° F/hour)]

- Recommended Operating Range 20° to 25° C (68° to 78° F)
- Nonoperating (Disk Module): –40° to 65° C (–40° to 149° F)

Humidity Ranges

- Maximum Wetbulb Temperature: 28 C (82 F)
- Operating (Disk Module): 10 to 80% RH (noncondensing)
- Nonoperating (Disk Module): 10 to 90% RH (noncondensing)

Altitude Ranges

- Operating: 0 to 3,048 m (0 to 10,000 ft)
- Nonoperating: 0 to 4,572 m (0 to 15,000 ft)

Vibration

- Operating Random Vibration: 0.21 Grms, 5 to 500 Hz
- Nonoperating Random Vibration: 2.09 Grms, 5 to 500 Hz
- Nonoperating Vibration Sine Sweep: 0.5 G (0 to peak), 5 to 500 Hz

Shock

- Operating Shock: 6.35 mm (0.25 in.) tilt drop (independent of weight)

Line Input Requirements

- Nominal Voltages: 100-127 Vac, 200-240 Vac
- Maximum Input Power: 870 VA (7.3 A @ 120 Vac, 3.8 A @ 230 Vac)
- Voltage Range: 88 – 140 Vac, 180 – 269 Vac
- Nominal Frequencies: 60 Hz (120 Vac), 50 Hz (230 Vac)
- Inclusive Frequency Range: 47 to 66 Hz
- Transparent Line Surge: 293 Vac for 0.5 seconds
- Recoverable Line Surge: 298 Vac for 0.5 seconds
- Line voltage sag: 80.5 Vac for 0.5 seconds
- Power Line Dropout: Must not exceed 20 ms

Electromagnetic Susceptibility Operating Range

- Radiated: 3V/m,14 kHz to 1000 MHz
- Conducted:

  3 Vrms, 30 kHz to 50 kHz,

  1 Vrms, 50 kHz to 400 MHz
- Magnetic: 47.5 Hz to 198 Hz at 4 Gauss external field
- Electrostatic Discharge: 1–10KV, operating; 1–25KV, Nonoperating.
- Magnetic interference (Nonoperating)

  <5.25 mGauss at 4.6 m

  <2 mGauss at 7.0 ft.
- Magnetic Field Interference (operating)

  <5 Gauss Peak to Peak at the Surface of the product

Enclosure Features

- Disk modules: 4.3-Gigabyte, 9.1-Gigabyte, 18.2-Gigabyte, or 36.4-Gigabyte SEW SCSI-2
- Controller modules: 1 or 2 (second controller provides redundancy)
- Power modules: 2 or 3 (third power module provides redundancy)
- Fan modules: 3 (one redundant, but all three must be installed for proper airflow)
- Control panel: 2 x 20 back-lit LCD display with function keys
- Protected power/standby switch
- Rackmountable enclosure mounts in EIA cabinets
- Airflow is from front bottom to top rear
- Hot pluggable modules with activity/fault LEDs
- Front access

Module Specifications

Disk Module

- Size: 1.6-inch, 3.5-inch form factor
- 1.6-inch Disk Dimensions: 54 x 120 x 240 mm (2.1 x 4.7 x 9.5 in.)
- Weight: 1.6 kg (3.5 lb.)
- Type: 4.3-Gigabyte, 9.1-Gigabyte, 18.2-Gigabyte, or 36.4-Gigabyte SEW SCSI-2
- SCSI ID: set by slot

Controller Module

- Dimensions: 290 x 58 x 240 mm (11.4 x 2.3 x 9.5 in.)
- Weight: 2.2 kg (4.9 lb.)
- Type: AutoRAID, with 96 Megabytes NVRAM
- SCSI ID: 0–15 (set by control panel)

Power Module

- Dimensions: 120 x 100 x 230 mm (4.7 x 3.9 x 9.1 in.)
- Weight: 2.7 kg (6.0 lb.)
- Type: autoranging, power factor correcting, active current sharing, internal axial fan

Fan Module

- Dimensions: 62 x 120 x 240 mm (2.4 x 4.7 x 9.5 in.)
- Weight: 0.45 kg (1.0 lb.)
- Type: radial blower

Appendix B. Regulatory/Safety Statements

This appendix contains the following information:

- FCC Statement (For U.S.A. Only)
- IEC Statement (Worldwide)
- CSA Statement (For Canada Only)
- VCCI Statement (For Japan Only)
- BCIQ Class A Warning Statement (For Taiwan Only)
- MIC Statement (For Korea Only)
- Spécification ATI Classe A (France seulement)
- Product Noise Declaration (For Germany Only)
- Geräuschemission (For Germany Only)
- Electromagnetic Compatibility
- Safety Specifications
- Declaration of Conformity

FCC Statement (For U.S.A. Only)

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

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense. The end user of this product should be aware that any changes or modifications made to this equipment without the approval of the manufacturer could result in the product not meeting the Class A limits, in which case the FCC could void the user's authority to operate the equipment.

IEC Statement (Worldwide)

This is a CISPR 22 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.

CSA Statement (For Canada Only)

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement

VCCI Statement (For Japan Only)

この装置は、情報処理装置等電波障害自主規制協議会（ＶＣＣＩ）の基準に基づくクラスＡ情報技術装置です。この装置を家庭環境で使用すると電波妨害を引き起こすことがあります。この場合には使用者が適切な対策を講ずるよう要求されることがあります。

This equipment is in the Class A category information technology equipment based on the rules of Voluntary Control Council For Interference by Information Technology Equipment (VCCI). When used in a residential area, radio interference may be caused. In this case, user may be required to take appropriate corrective actions.

Class A Warning Statement (For Taiwan Only)

警告使用者：這是甲類的資訊產品，在居住的環境中使用時，可能會造成射頻干擾，在這種情況下，使用者會被要求採取某些適當的對策。

MIC Statement (For Korea Only)

A급 기기 :

이기기는 업무용으로 전자파 장해검정을 받은
기기이오니 판매자 또는 사용자는 이점을 주의
하시기 바라며, 만약 잘못 구입하셨을 때에는
구입한 곳에서 비업무용으로 교환하시기 바랍
니다.

User Guide (Class A)

Please note that this equipment has been approved for business purposes with regard to electromagnetic interference. If purchased in error for use in a residential area, you may wish to exchange the equipment where you purchased it.

Spécification ATI Classe A (France Seulement)

DECLARATION D'INSTALLATION ET DE MISE EN EXPLOITATION d'un matériel de traitement de l'information (ATI), classé A en fonction des niveaux de perturbations radioélectriques émis, définis dans la norme européenne EN 55022 concernant la Compatibilité Electromagnétique.

Cher Client,

Conformément à la Réglementation Française en vigueur l'installation ou le transfert d'installation, et l'exploitation de cet appareil de classe A, doivent faire l'objet d'une déclaration (en deux exemplaires) simultanément auprès des services suivants:

- Comité de Coordination des Télécommunications 20, avenue de Ségur–75700 PARIS
- Préfecture du département du lieu d'exploitation

Le formulaire à utiliser est disponible auprès des préfectures.

La déclaration doit être faite dans les 30 jours suivant la mise en exploitation.

Le non respect de cette obligation peut être sanctionné par les peines prévues au code des Postes et Télécommunications et celles indiquées dans la loi du 31 mai 1993 susvisée.

Arrêté du 27 Mars 1993, publié au J.O. du 28 Mars–ATI

Product Noise Declaration (For Germany Only)

Acoustic Noise Emissions:

- LpA: 45.0 dB (seeking)
- At bystander position per ISO 7779.
- All data are the results from type tests of the product configuration having the highest acoustic emissions: 12 disk modules.
- All other configurations have lower emission levels.

Geräuschemission (For Germany Only)

- LpA: 45.0 dB (suchend)
- Am fiktiven Arbeitsplatz nach DIN 45635 T. 19.
- Die Daten sind die Ergebnisse von Typprüfungen an Gerätekonfigurationen mit den höchsten Geräuschemissionen:12 Plattenlaufwerke.
- Alle andere Konfigurationen haben geringere Geräuschpegel.
- Für weitere Angaben siehe unter Umgebungsbedingungen.

Electromagnetic Compatibility

- For U.S.A., designed to meet 47 CFR, Part 15 of the FCC rules for Class A digital devices.
- For Europe, complies with the requirements of CISPR 22 Class A, Low Voltage Directive 73/23/EEC, and the EMC directive 89/336/EEC.
- For Canada, complies with CSA EMC Class A requirements.
- For Japan, complies with VCCI Class A requirements.
- For Korea, complies with MIC Class A requirements.
- For Taiwan, complies with BCIQ Class A requirements.

Safety Specifications

This product meets the following safety specifications:

- UL 1950, 3rd Edition
- CSA 22.2 No. 950-95
- IEC 950: 1991 +A1 + A2 + A3 / EN 60950 (1992) + A1 + A2 + A3
- IEC 825-1: 1993 / EN 60825-1: 1994 Class 1 (Laser/LED)
- EMOKO-TSE (74-SEC) 207/94
- TUV EN60950 1992, 2nd Edition

Declaration of Conformity

DECLARATION OF CONFORMITY
according to ISO/IEC Guide 22 and EN 45014

Manufacturer Name:	Hewlett-Packard Company
Manufacturer Address:	Enterprise Storage Solutions Division P.O. Box 15 Boise, Idaho U.S.A. 83707
Declares, that the product	
Product Name:	HP SureStore E Disk Array 12H
Product Number(s):	A3700A/AY, A370XA/AY, A371XA/AY; X = 0-9, Y = A-Z
Product Options:	All
conforms to the following Product Specifications:	
Safety:	IEC 950: 1991 +A1+ A2 +A3 / EN 60950 (1992) + A1 + A2 + A3 IEC 825-1: 1993 / EN 60825-1: 1994 Class 1 (Laser/LED)
EMC::	CISPR 22: 1993 / EN 55022 (1994) Class A EN 50082-1: 1992 – Generic Immunity, including: IEC 801-2: 1991: 4 kV CD, 8 kV AD IEC 801-3: 1984: 3 V/m IEC 801-4: 1988: 1 kV Power Lines, 0.5 kV Data Lines IEC 1000-3-2: 1995 / EN 61000-3-2 (1995): Harmonic Current IEC 1000-3-3: 1994 / EN 61000-3-3 (1995): Voltage Fluctuation and Flicker STSB GB9254-1988 (China)
Supplementary Information:	The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE Marking accordingly. 1.) The product was tested with a Hewlett-Packard NetServer host computer system.

BOISE, IDAHO U.S.A., 09/30/98, Dan T. Michaud / QA Manager

European Contact: Your local Hewlett-Packard Sales and Service Office or Hewlett-Packard GmbH, Department HQ-TRE, Herrenberger Straße 130, 71034 Böblingen (FAX: +49-7031-143143)

Appendix C. Cabinet Configurations

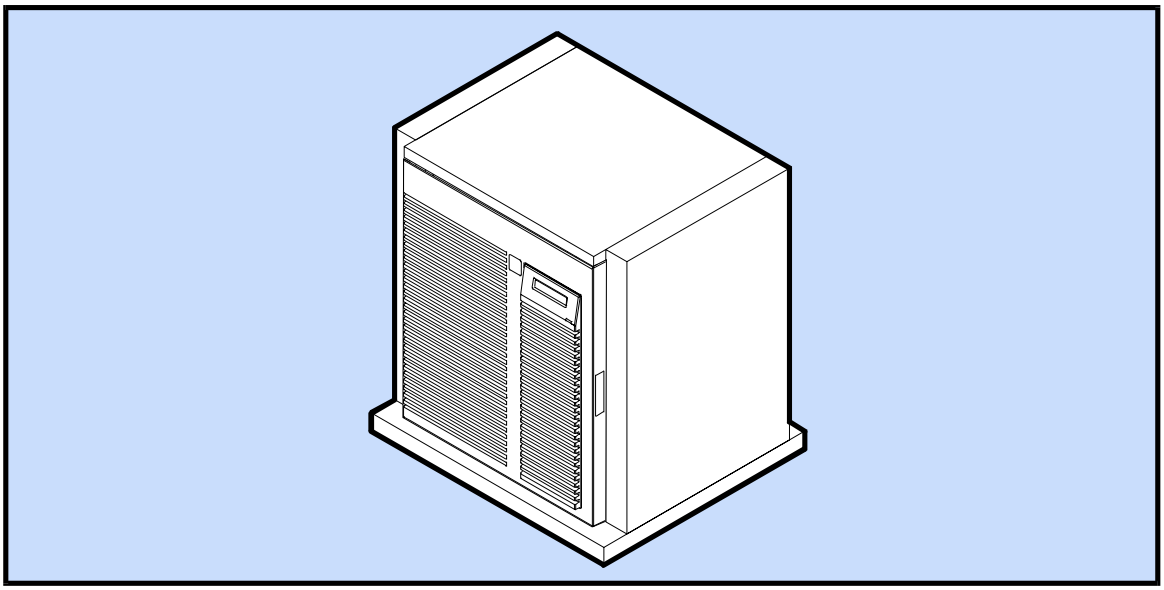
Cabinet Configurations Available

This chapter shows the different disk array cabinet configurations. The disk array can be configured in an EIA cabinet, a 1.1-meter cabinet, a 1.6-meter cabinet, a 2-meter cabinet, or can be enclosed in a deskside cabinet.

Deskside Cabinet

The deskside cabinet is a single disk array enclosure in a cabinet on wheels. The deskside disk array cabinet is shown in Figure 37.

Figure 37. Deskside Cabinet

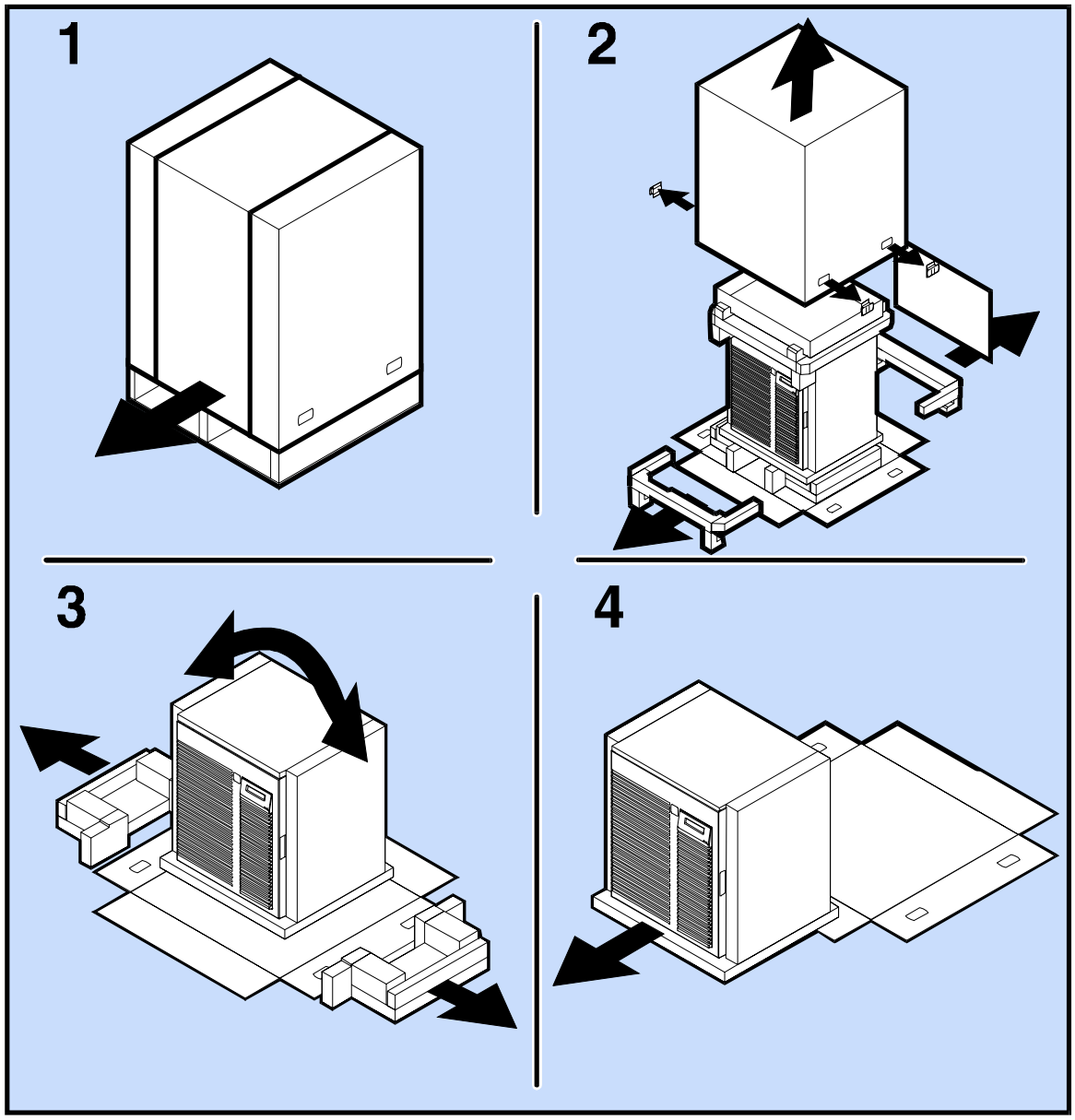


Unpacking the Deskside Cabinet

To unpack the deskside cabinet, perform the following steps:

1. Cut the strapping bands, and slide the fully-packaged product off of the pallet as shown in Figure 38, View 1
2. Remove the four plastic clips and lift the carton off of the cabinet. Also, remove the accessory tray and then remove the top, front, and rear foam cushioning as shown in Figure 38, View 2.
3. Lift one edge of the cabinet, and then remove the bottom cushion from the opposite side. Repeat this step for the other side of the cabinet. See Figure 38, View 3
4. Roll the cabinet off of the bottom tray as shown in Figure 38, View 4

Figure 38. Unpacking the Deskside Cabinet

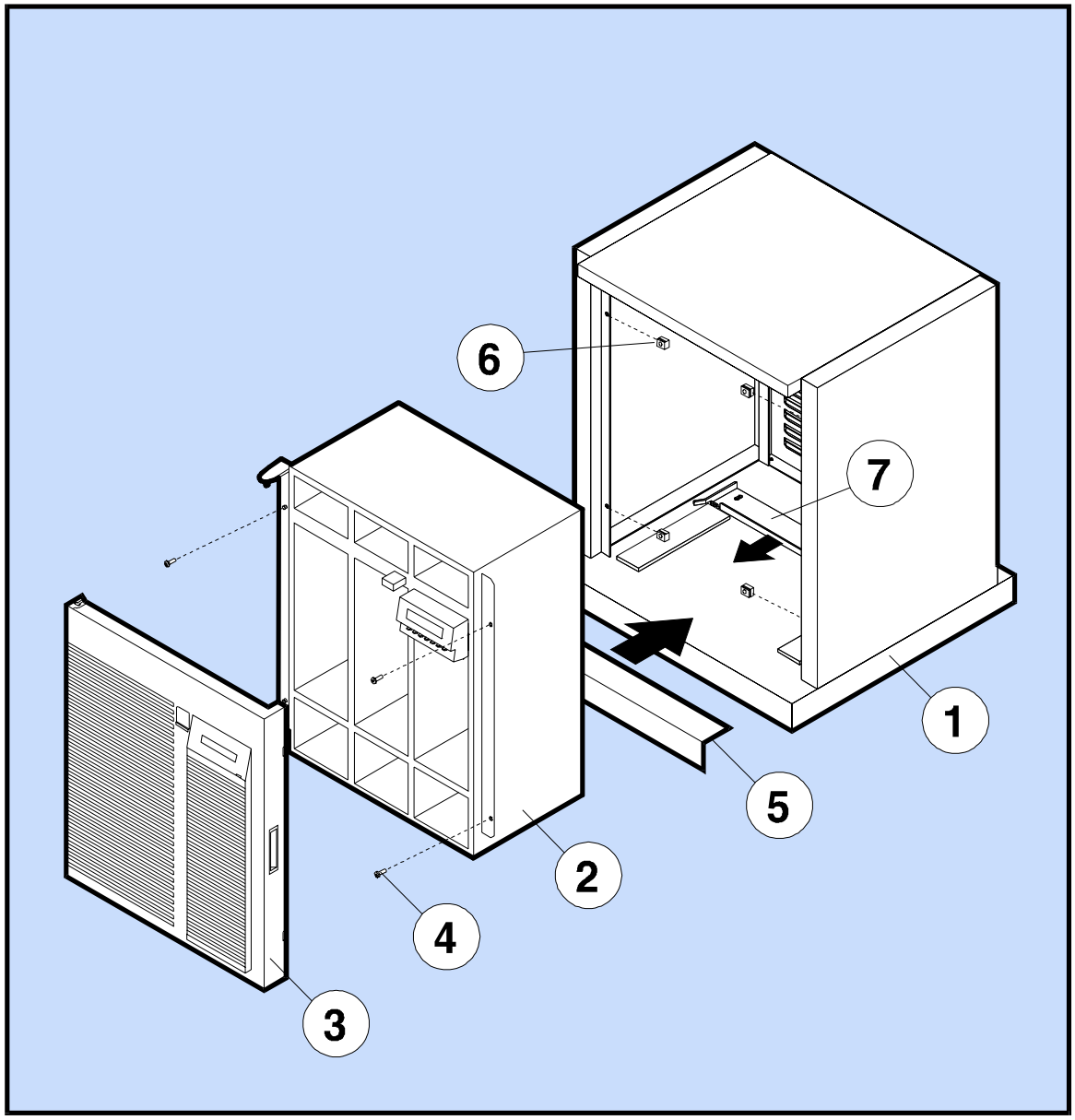


Installing the Disk Array into the Deskside Cabinet

If the disk array is already installed into the deskside cabinet, skip this set of steps. To install the disk array into the deskside cabinet, see Figure 39 and perform the following steps:

1. Attach the edge protector (5) along the lower front of the cabinet as shown in Figure 39. This will protect the cabinet from being scratched when installing the disk array enclosure.
2. Install the four provided clip nuts (6) onto the front of the deskside cabinet as shown in Figure 39.
3. Lift the disk array enclosure into the cabinet, and secure it with the four screws (4) as shown in Figure 39. Remove the edge protector.
4. Loosen the two screws on the clamp (7) at the rear of the deskside cabinet, and slide the clamp forward until the tabs of the clamp engage in the slots in the lower rear corners of the disk array as shown in Figure 39.
5. Loosen the two screws on the clamp at the rear of the deskside cabinet, and slide the clamp forward until the tabs of the clamp engage in the slots in the lower rear corners of the disk array as shown in Figure 39. Retighten the two screws.
6. Install the disk array door (3) as shown in Figure 45.
7. Proceed to the next section to install the cabling.

Figure 39. Installing the Disk Array into the Deskside Cabinet

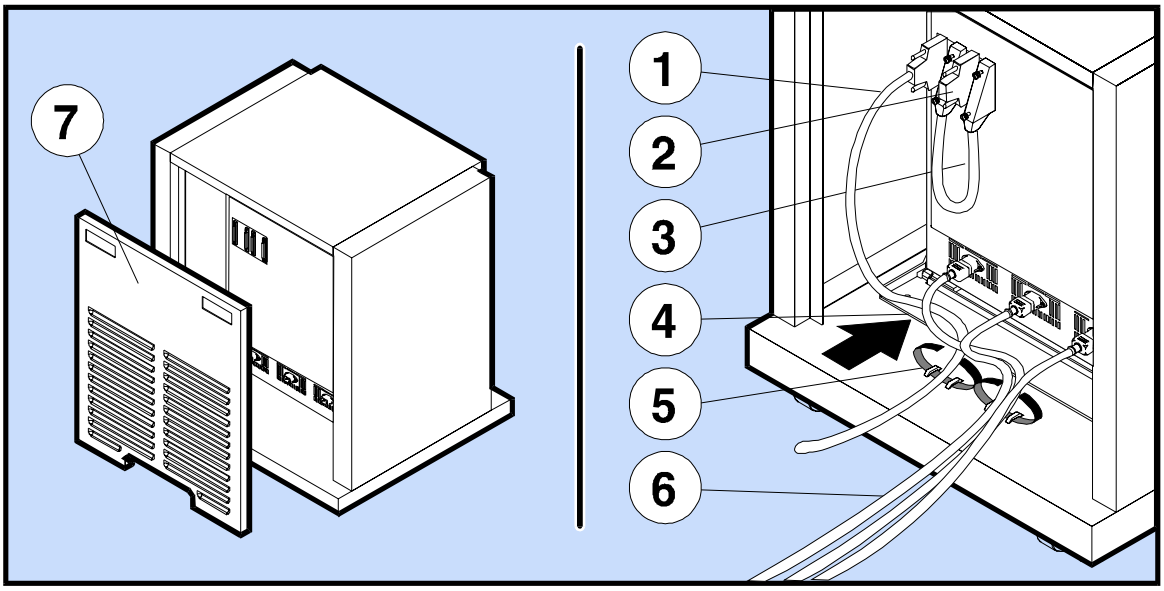


Deskside Cabinet Cabling

To attach the power and SCSI cables to the deskside cabinet, perform the following steps:

1. If present, remove the rear door (7) from the deskside cabinet as shown in Figure 40.
2. Connect the SCSI cables (1) and route them through the hook and loop strap (5) on the left rear of the cabinet.
3. Connect the short SCSI cable (2) if necessary. Refer to “Connecting SCSI Cabling” in the Chapter “Product Description” for more details about SCSI cabling.
4. Connect the power cords (6) to the disk array and route them through the hook and loop strap on the right rear of the cabinet.
5. Reinstall the rear door onto the deskside cabinet.
6. Attach the front door of the disk array as shown in Figure 45.
7. To keep the deskside cabinet from rolling, unscrew the four leveling feet on the bottom four corners of the deskside cabinet until they touch the floor.

Figure 40. Deskside Cabinet Cabling

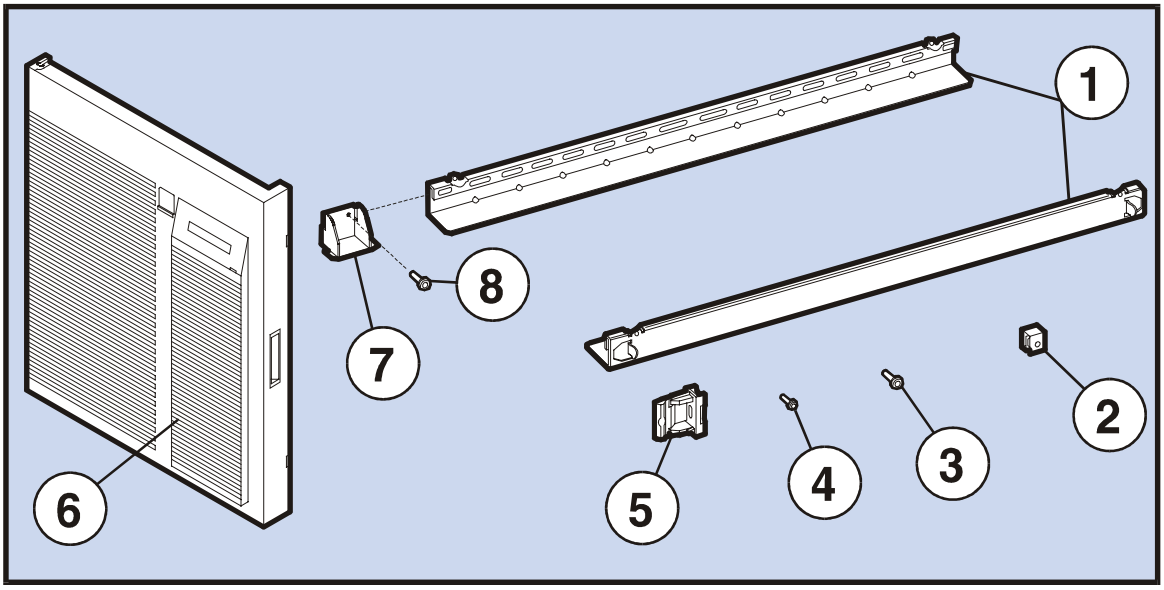


Rackmount Cabinets

Up to four disk array enclosures can be installed into a 1.6-meter cabinet, and up to six disk array enclosures can be installed into a 2.0 meter cabinet. Each disk array requires a cabinet space equal to 13 EIA units. Figure 41 shows the contents of the rackmount kit shipped with the disk array enclosure.

WARNING! The disk array may weigh up to 38.2 kg (84 lb.). To avoid personal injury, remove all modules from the disk array before installing it into the EIA cabinet. Also, to ensure cabinet stability and to avoid personal injury, install disk arrays into the bottom slots of the EIA cabinet first.

Figure 41. Rackmount Accessory Kit



1 – Support Rails (2)
2 – Clip Nut (8)
3 – T-25 Screw (8)
4 – T-15 Screw (1)
5 – Door Snap (1)
6 – Door (1)
7 – Retainer Clip (2)
8 – Screw (2)

Installing the Disk Array into a Rack

1. Install one clip nut (Figure 42, Item 1) on each of the four rail standards on hole number 3. Secure the rails (2) with four T-25 screws (3). See Table 18 for rail standard clip nut spacing for multiple disk arrays. (This spacing begins installation by installing an array in the lowest cabinet, EIA, position.)
2. Install two clip nuts on the front left and two on the front right ear standards; one clip nut (Figure 42, Item 4) on hole number 7 and one clip nut (5) on hole number 33. See Table 18 for ear standard clip nut spacing for multiple disk arrays.
3. Slide the enclosure into the cabinet (see Figure 43). Secure the enclosure with four T-25 screws.
4. Slip the Retainer Clip (Figure 41 Item 7) up against the back of the array enclosure and secure the clip with retainer clip screw.
5. Install the door snap (see Figure 44, Item 3) on the latch bracket (1), using the alignment holes (2) as a guide. Secure the door snap with one T-15 screw (4).
6. Install the enclosure door (see Figure 45, Item 1). Drop the lower corner mounting hole onto the lower hinge bracket pin (2) then swing the upper corner mounting slot into the upper hinge bracket pin (3). Gently press on the upper left corner of the door and snap the upper corner onto the hinge bracket.
7. Repeat steps 1 through 6 to install additional disk arrays.
8. Install two filler panels in the top two EIA slots (see Figure 46).
9. Connect the disk array power cords (see Figure 47) to the cabinet power distribution units (PDUs).
10. Press the cabinet power switch (see Figure 48, Item 1) to switch on the cabinet power. The cabinet power light (2) should be green.

NOTE! For greater power redundancy, you can connect each power module into a separate PDU. This will require ordering the Power Upgrade Kit A4915A to obtain additional PDUs, refer to Appendix D for additional information.

CAUTION! To prevent the current rating of the PDU from being exceeded, observe the maximum current rating of the PDU. Do not connect more enclosures than the PDU rating. You may have to upgrade your PDU to provide enough total current for a full back-to-back rack configuration.

Figure 42. Installing Clip Nuts and Rails

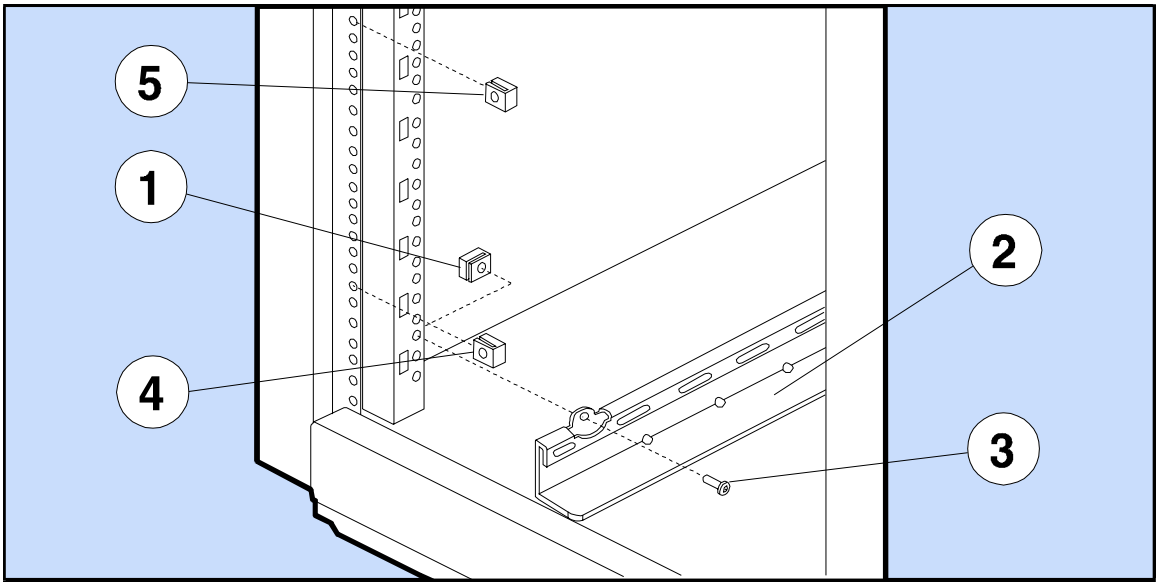


Table 18. Multiple Disk Array Clip Nut Hole Spacing

[1]Enclosure Number	[2]Rail Standard Spacing	[3]Ear Standard Spacing
1	3	7, 33
2	42	46, 72
3	81	85, 111

Note 1: In order of installation from bottom to top.
Note 2: Hole numbers from bottom to top.
Note 3: Hole numbers from bottom to top (two holes per bracket).

Figure 43. Sliding the Enclosure into the Rackmount Cabinet

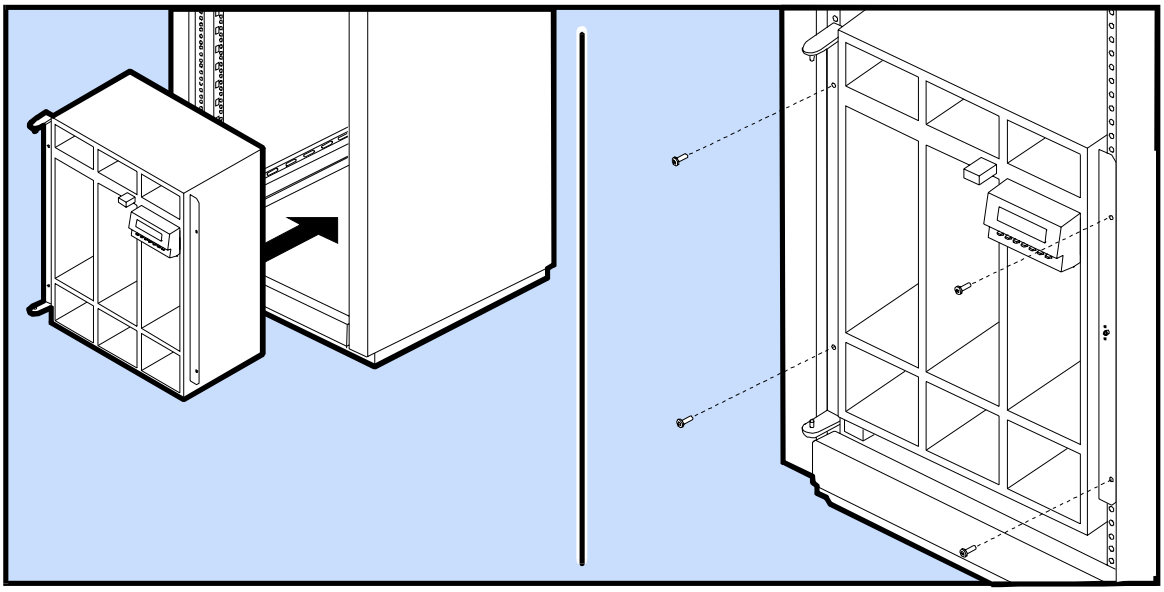


Figure 44. Installing the Door Snap

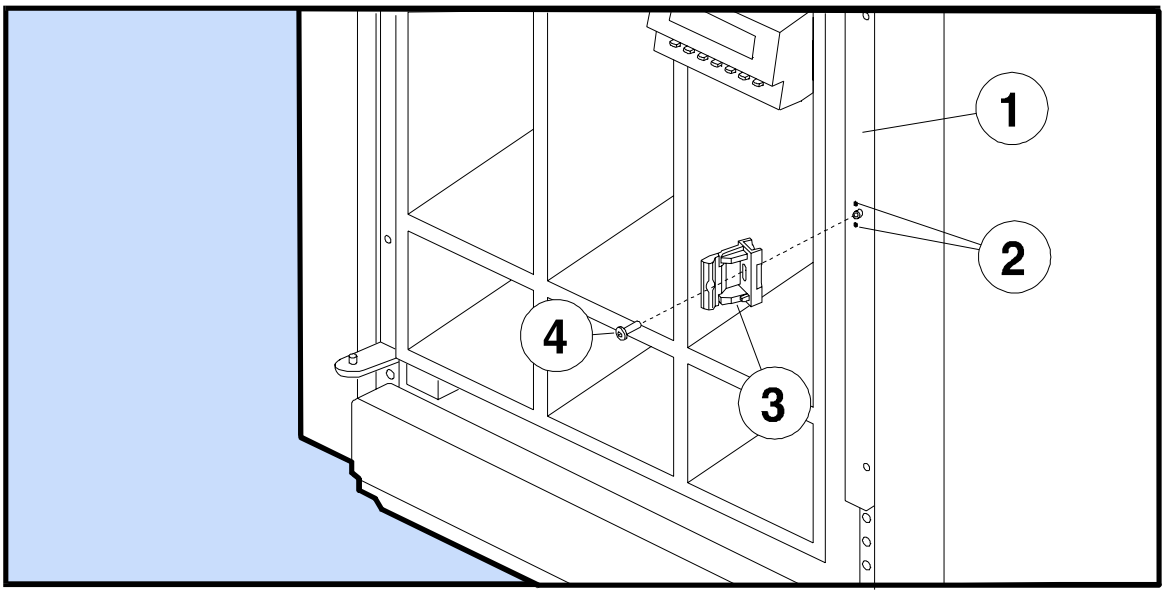


Figure 45. Installing the Enclosure Door

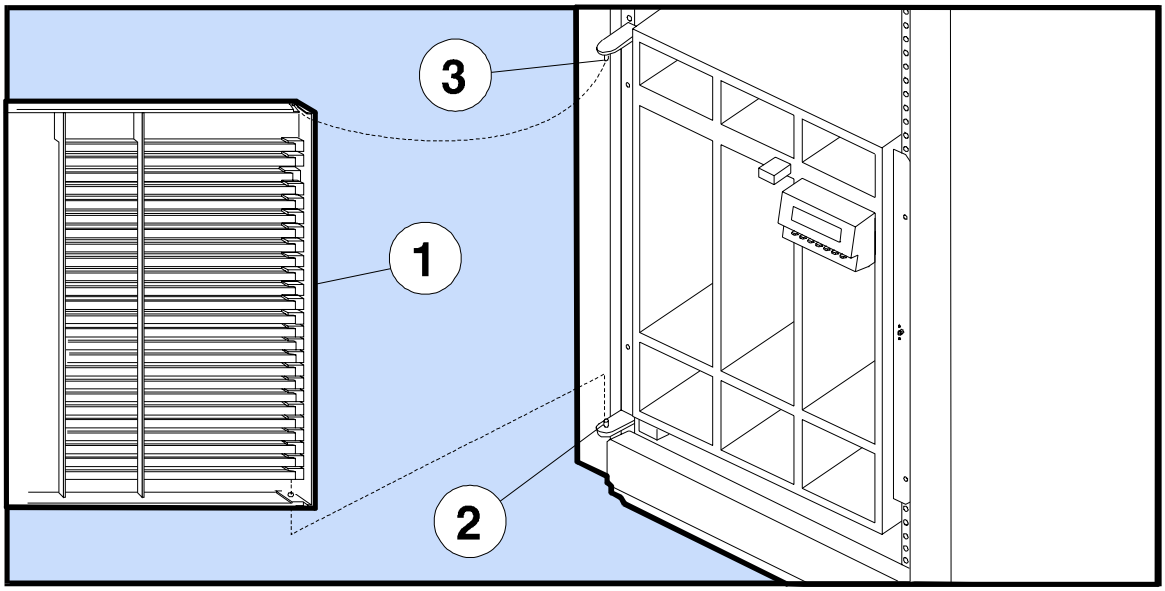


Figure 46. Installing Filler Panels

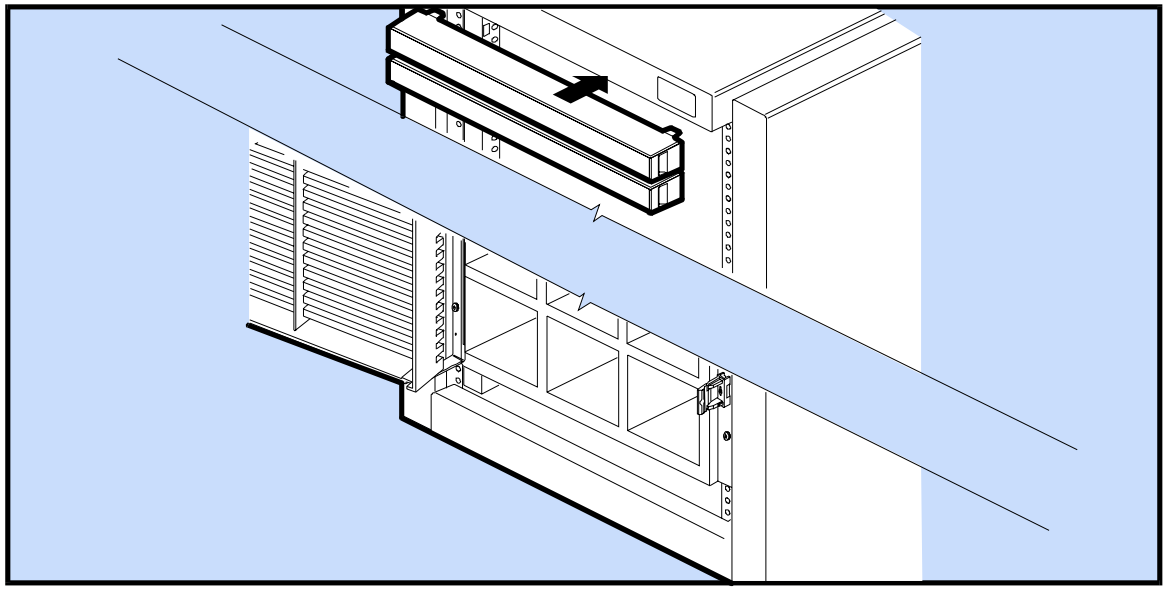


Figure 47. Connecting Enclosure Power Cords to the PDU

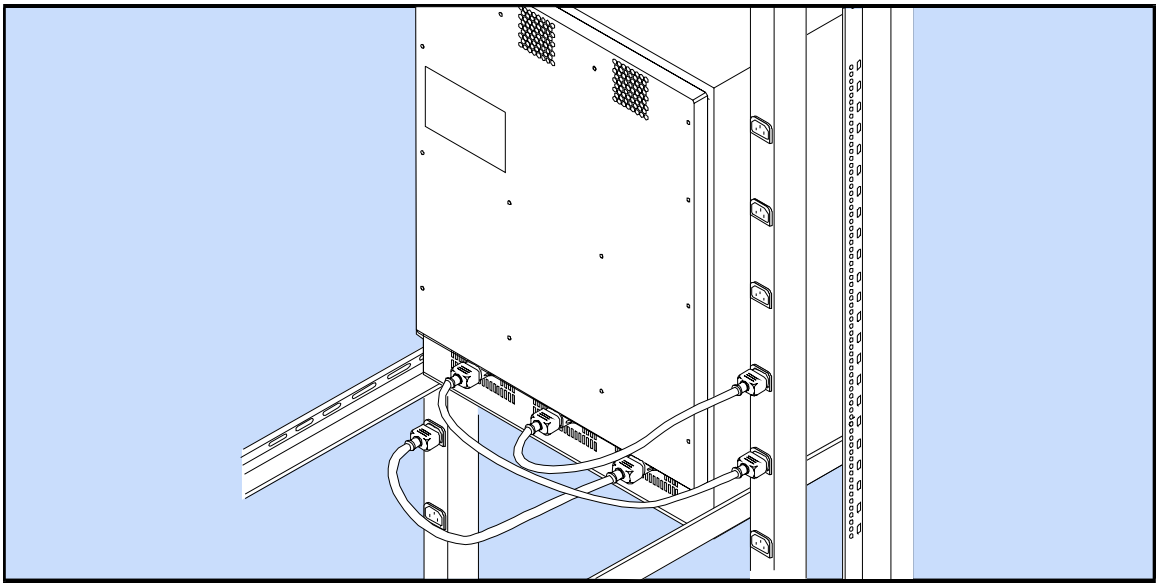
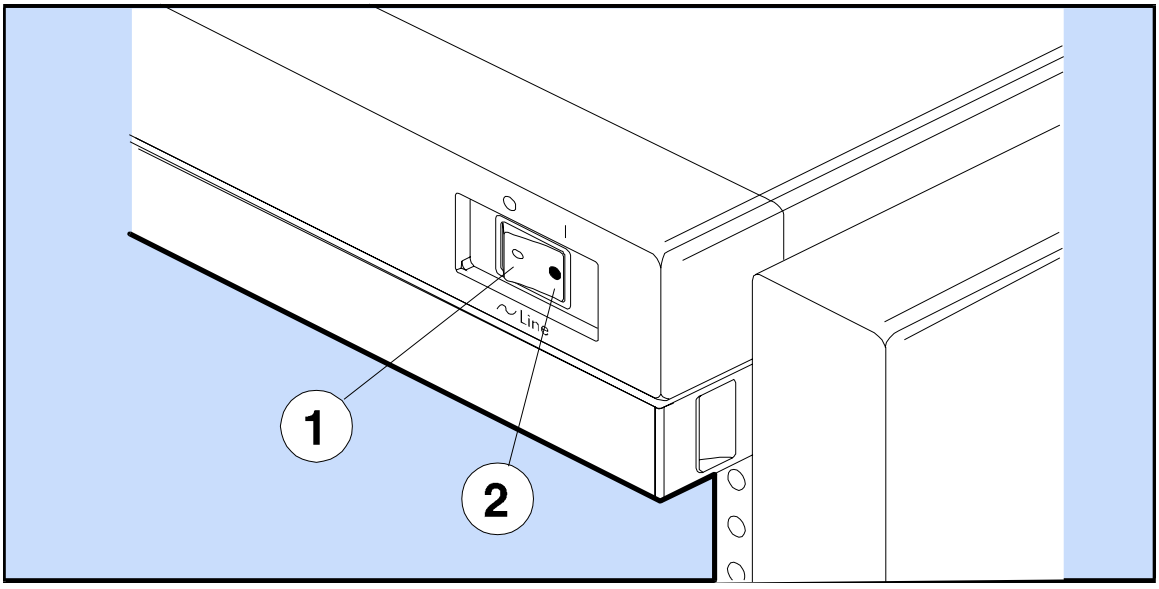


Figure 48. Switching on Rackmount Cabinet Power



Appendix D. Back-to-Back Racking

This appendix explains how to install disk arrays back-to-back in either a 1.6-meter rack (C2786A) or a 2.0 meter rack (C2787A). The following information is included:

- Product description
- Installation
- Troubleshooting
- Removal and replacement
- Specifications

Product Description

Customers may obtain maximum disk storage capacity with a minimum use of floor space by filling their Hewlett-Packard computer/instrument racks completely with the maximum number of array enclosures. This solution is known as back-to-back racking, because both front and back areas of the rack are used, and the disk arrays are oriented “back-to-back” in the rack.

Back-to-Back installation of disk arrays requires several modifications be made to the rack prior to installing the additional arrays. These modifications include:

Installation of power upgrade kit, three 19” PDU assemblies (replacing the existing 56” PDUs),

Installing a high volume exhaust fan assembly, and

Removing the rear rack door and hardware

Field upgrade kits are available for the above modifications and need to be available prior to beginning the installation (see Table 19. Upgrade Kits and Components).

Prior to modifying the rack for back-to-back installation you need to determine if the maximum number of disk arrays can be installed. Six disk arrays completely fill a 2.0-meter rack and four disk arrays fill a 1.6 meter rack, known as high-density configuration. Depending on the service access method, the maximum number of arrays that can be installed varies. If the rack is located to allow a side panel to be removed for service access (for example, if the rack is located at the end of a row or can be rolled out) then the rack can be filled completely (high density). If the rack is situated such that side access is not possible then one position (one disk enclosure space) must remain open to allow for service access (see Figure 49).

NOTE The 1.6 meter rack (C2786A) has a total height of 32 EIA units and the 2-meter rack (C2787A) has a total height of 41 EIA units. (One EIA unit is equal to 1.75 inches or 44.45 mm.) The disk array enclosure has a height of 13 EIA units.

In addition to the power upgrade and exhaust fan kits mentioned above, additional rail kits, power cords and SCSI cabling should be identified and ordered as required (see Table 19).

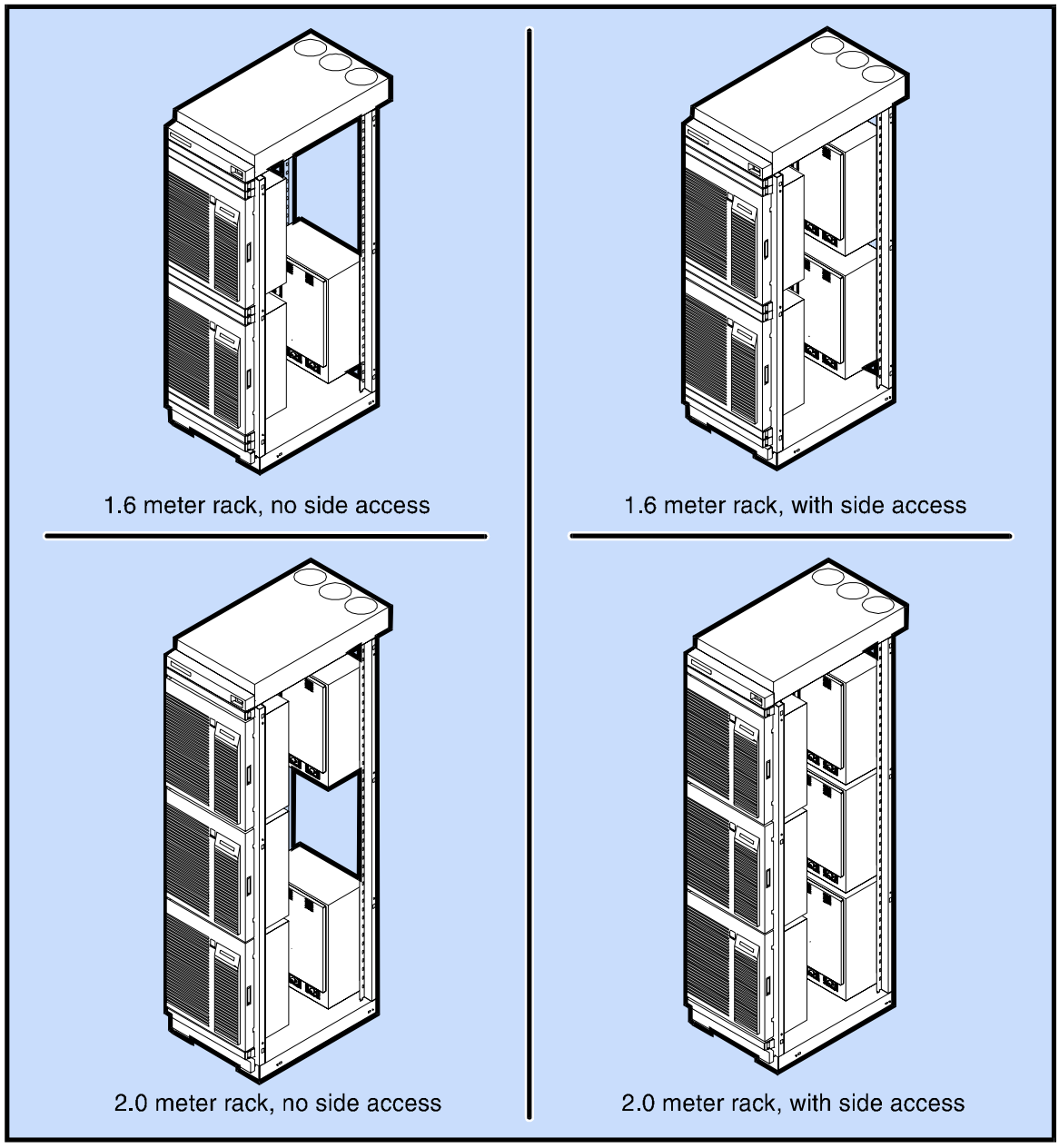
Components

The following kits and components are used for back-to-back racking. To more accurately determine the components you need for your installation, review the “Installation Procedure,” below.

Table 19. Upgrade Kits and Components

Item	Part Number
Exhaust Fan Assembly (includes 3 fans, LED fault circuit, and 1 EIA unit air scoop)	E7687A
240 VAC Power Distribution Units (PDUs) 10 IEC-320 receptacles (Unterminated line cord)	A4915A (See Table 20 for specific option)
Computer rail kits, as needed	C2788A
SCSI cables, as needed	See Table 17 “Replaceable Parts”
Power cables, as needed	
Disk array to PDU	8120-6514
PDU to AC power (supplied with 4915A Upgrade Kit):	
Opt ABA	E7803-60001
Opt ABB	8120-6895
Opt 024	8120-6961
Rail Kits	C2788A
Filler panels, as needed: 1 EIA space	40101A
2 EIA spaces	40102A
3 EIA spaces	40103A
4 EIA spaces	40104A
5 EIA spaces	40105A
6 EIA spaces	40106A
7 EIA spaces	40107A

Figure 49. Back-to-Back Rack Configurations



Other Documentation

This document constitutes an overview of the back-to-back racking installation. Detailed installation instructions accompany the other kits. Other documentation includes:

E7687-90001	7687A HP 200-240V Exhaust Fan Assembly Installation Guide
A4915-96000	HP SureStore E Disk Array 12H Power Upgrade Kit, Quick Installation Guide
E7670-90001	Power Distribution Unit Kit Installation Instructions
C2785-90002	Computer Support Rail Kit Installation Instructions

Features

The exhaust fan module contains three cooling fans. The module operates in a redundant power configuration; that is, the module draws power from two of the rack's PDUs (one fan draws from one PDU, the other two fans draw power from another PDU). If power from one of the PDUs fails, one or two fans drawing power from the other PDU will continue to provide cooling for the rack. If one of the fans fails physically, the remaining fans in the fan module will continue to cool the rack. However, after a fan failure, it is recommended that the failed unit be replaced within 48 hours, so that disk drive reliability is not compromised.

LED Indicators

Front panel indicator LEDs show normal operation and fan failures. Power failures are indicated by no LEDs being lit.

Power Redundancy

The disk arrays in the rack can be configured for power redundancy. In redundant mode, if power to one of the rack's PDUs fails, the other two PDUs will continue to power all disk array units. To provide power redundancy, each PDU must be connected to a separate, dependable (or UPS) power source.

Installation

WARNING! Back-to-back rack mounting of the HP AutoRAID Disk Array should be performed by factory-trained personnel only. Customers should not attempt to perform this procedure.

Installation Strategy

The following general information and strategy applies to both the 1.6-meter and 2.0 meter racks. To determine detailed components required for installation, refer to the "Installation Procedures" section later in this appendix.

1. Upgrade the rack's power

The HP A4915A SureStore E Disk Array 12H Power Upgrade kit is supported only for 240 VAC power systems. This upgrade provides three 10-receptacle 240 VAC PDUs. PDUs for non-US installations must be ordered with the appropriate plugs, refer to the Table 20 below.

Table 20. A4915A Power Upgrade Kit, Power Options

PDU	Description	Use
A4915A Opt ABA	200-240 VAC North American PDU 10 IEC-320 receptacles line cord is unterminated	US installations; PDUs for High Availability
A4915A Opt ABB	200-240 VAC International PDU 10 IEC-320 receptacles line cord is unterminated	Non-US installations; PDUs for High Availability
A4915A Opt 024	200-240 VAC UPS PDU 10 IEC-320 receptacles 4.5M line cord is unterminated	US or Non-US installations; UPS PDUs for High availability

2. Upgrade the rack's cooling capacity

Back-to-Back racking requires that the cooling capacity of the rack be upgraded. The cooling upgrade requires installation of a new Exhaust Fan Assembly (product E7687A). This assembly contains three fans, an LED fault indication circuit and a 1- EIA unit air scoop. This is required to promote maximum airflow through the center of the rack. Also, to promote additional air flow, the rear cabinet door will be removed and set aside.

To maintain cooling efficiency, filler panels should be installed in any unfilled spaces in the front and back of the rack (see Table 19).

3. Add rail kits

The upgrade requires enough **rail kits** (part C2788A) to accommodate the number of disk storage enclosures to be racked.

A 2.0 meter rack requires three rail kits, and a 1.6 meter rack requires two rail kits.

If the rack is completely filled with front-racked disk storage enclosures, then no additional rail kits are required.

4. Add power cables and SCSI cables

The upgrade requires ordering enough power and SCSI cables to serve all installed disk enclosures.

Standard HP power cables (8120-6514) will meet all power cable requirements.

Standard HP SCSI cables will meet all SCSI cable requirements.

5. Back-to-Back Array Density

Depending on whether service accessibility is available through the side of the rack or not, determines the number of disk arrays that can be installed. Side access requires that the facility housing the racks allow HP service personnel sufficient room at either side of the rack. This space should be approximately 2 feet. This clearance will allow HP service personal to remove the side panel of the rack and gain access to the components inside. If side access is not possible, then the capacity of back-to-back racking is reduced. Refer to Figure 49.

Brief Summary of Installation Steps

The sequence below describes the general approach for installing the field upgrade for back-to-back racking. These steps may vary slightly, depending on the particular installation. The installation process is described in more detail in the following, "Installation Procedure" section.

1. Confirm power requirements
2. Take disk arrays offline and power down rack
3. Disconnect all power to the rack
4. Remove the rack top, sides, and back door and door hinges and latch catch (the door will not be re-installed and can be set aside)
5. Remove existing 56" PDUs
6. If necessary, remove array enclosures (array enclosures may need to be removed to be repositioned, see step 4, below)
7. Install the exhaust fan assembly
8. Install rail kits as needed
9. Install replacement 19" PDU angle brackets
10. Install/re-install disk enclosures
11. Install replacement 19" PDUs
12. Install the power cables
13. Install the SCSI cables
14. Complete the installation

Some of the installation procedures identify the installation of kits. The detailed installation procedures for these kits are included in documentation supplied with the kit (such as, the exhaust fan assembly kit, rail kit, and power (PDU) upgrade kit).

Installation Procedure

1. Confirm power requirements

Ensure that the installation site meets the following requirements.

- Input voltage: 200/230/240 VAC single phase
- Input frequency: 50 Hz/60 Hz
- Input current: 16 A maximum, operating (per PDU)

US installations

Standard 20A Square D circuit breakers are adequate for all authorized configurations of back-to-back racking.

European circuit breakers

In Europe, some sites may require upgraded circuit breakers. This is because inrush current for a single disk enclosure may be has high as 57.16 amps peak for up to three milliseconds.

Note the figures in the following comparison chart:

Tripping characteristic code	Current multiplier	Total trip current	Back-to-Back Rack usability
B	6X	96A	Do not use with BTBR
C	12X	192A	Up to 5 redundant disk enclosures
D	25X	400A	Up to 5 redundant disk enclosures or up to 8 non-redundant disk enclosures
Z	4X	64A	Do not use with BTBR
K	17X	272A	Up to 5 redundant disk enclosures or 8 non-redundant disk enclosures

In Europe, therefore, site preparation must include 16 amp circuit breakers, preferably with the D or K tripping characteristic code.

CAUTION! Intermittent power losses will occur if improper circuit breakers are used.

2. Take disk arrays offline, power down rack and remove existing components

Of the items that are removed, some are removed to be replace by new components. Some may need to be removed, such as the disk array enclosures to allow the enclosure rails to be repositioned (since back-to-back racking in the 2-meter rack utilizes all EIA units, including the bottom unit). For additional clarification, refer to the detailed installation steps following this step.

a) Unmount all file systems associated with the devices in the rack.

b) Bring devices in the rack offline.

c) Power down the devices in the rack.

d) Unplug the rack's PDU cables from the power source.

e) Remove the rack's rear door and side panels.

f) Remove the rear door, hinges, and latch catch. (These will not be used again)

g) Remove the PDUs (56 inch) and brackets from the rack. (These will be replaced with new PDUs) .

h) If necessary, remove disk array enclosures (see step 4 below). The disk array enclosures are heavy. Prior to removing the enclosure, the individual disk modules should be removed. Also, when re-installing the disk modules, they should be installed back into the same enclosure from which they were removed (but not necessarily the same slot). Thus, when removing the disk modules, identify on the module from which array enclosure it was removed.

i) Remove the top cap from the rack.

j) Remove any fans (these will be replace by high-volume exhaust fans).

3. Install the exhaust fan assembly

Install this assembly as described in the Exhaust Fan Assembly Installation Guide (E7687-90001)

4 Install rail kits and/or reposition rails as needed

Install new rail kits as needed to hold the number of disk enclosures to be racked. Ensure that the rails are installed as indicated in Table 21 for either the 1.6-meter or the 2-meter rack. (Rail installation is described in Appendix C of this document.) Refer to Figure 50 Rack Array/Component Positioning for a visual representation of the placement of the arrays/components. Also, install the clip nuts for the array enclosure flange as indicated in Table 21.

Remember, if the rack has side access, you can install disk enclosures in the high-density configuration; if side access is not an option, one enclosure space must remain vacant, see Figure 49.

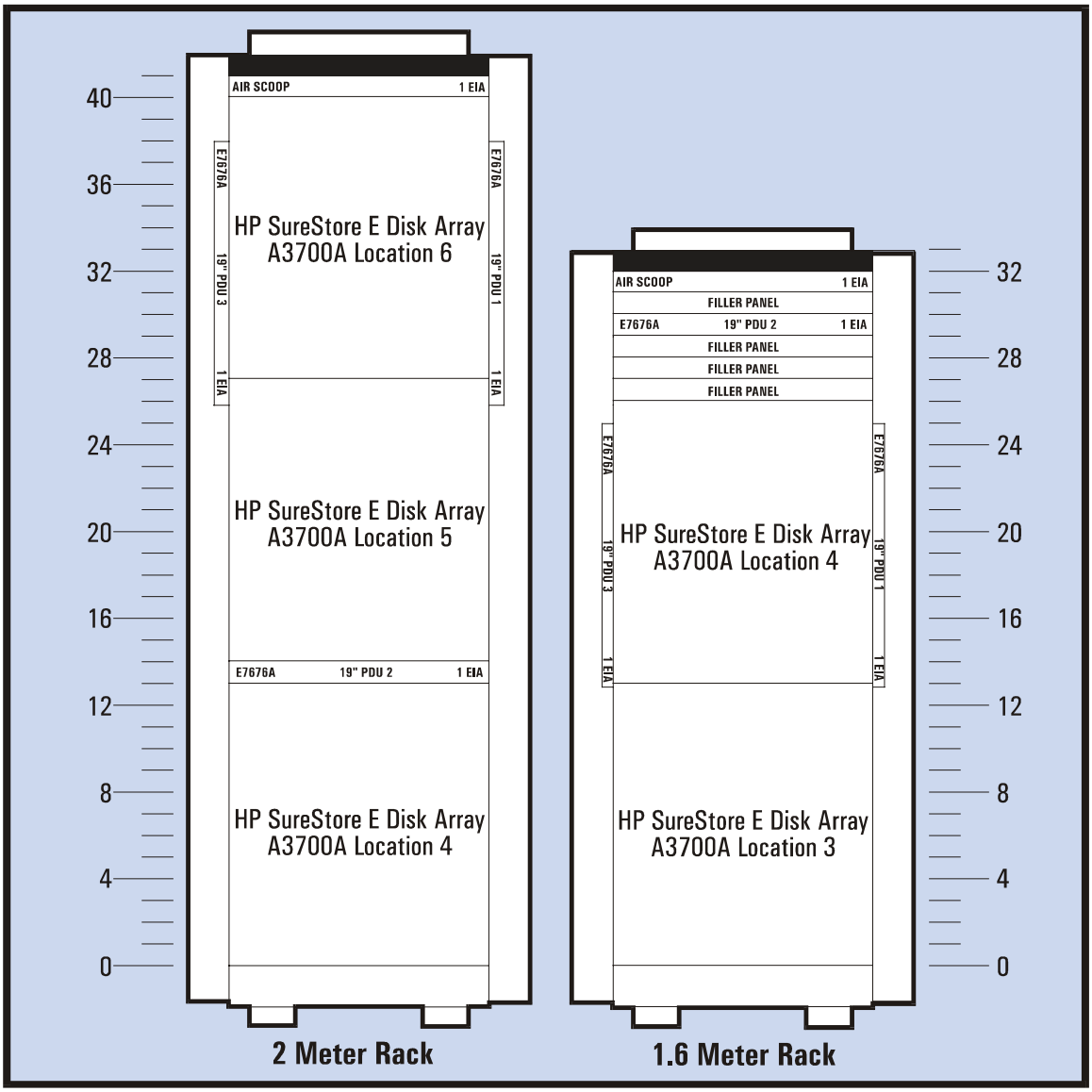
Table 21. Disk Array/Component Positioning

EIA Space[1]	Component[2] Installed in Front of Rack	Component[2] Installed in Back of Rack	Rail - Clip Nut, ear Standard, Hole Position[1]	Array Enclosure Flange - Clip Nut, ear Standard, Hole Positions[1]
2-meter Rack				
1-13	Array #1	Array #4	3	7, 33
14	Filler	PDU	n/a	n/a
15-27	Array #2	Array #5	45	49, 75
28-40	Array #3	Array #6	84	88, 114
41	Filler	Air Scoop	n/a	n/a
1.6 Meter Rack				
1-13	Array #1	Array #3	3	7, 33
14-26	Array #2	Array #4	42	46, 72
27-29	Filler/s	Filler/s	n/a	n/a
30	Filler	PDU	n/a	n/a
31	Filler	Filler	n/a	n/a
32	Filler	Air Scoop	n/a	n/a

1 – EIA spaces and holes are numbered from the bottom of the rack, up.

2 - Arrays are numbered from the bottom up beginning on the front of the rack, 1 through 3 (or 1 through 2), then from the back of the rack, bottom up 4 through 6 (or, 3 through 4).

Figure 50. Rack EIA Array and Component Positioning



5. Install Replacement PDU brackets

Install the PDU angle brackets supplied in the A4915A HP Power Upgrade Kit as described below (see Figure 51):

a) Install the PDU brackets at the rear of the cabinet as described in the A4915A Upgrade Kit Quick Installation Guide. However, when installing the brackets, two on the right column and two on the left column, install them in the positions as indicated in the table below, not as described in the quick installation guide.

Rack	Accessory Holes (as counted from the top of the rack, down)
1.6 Meter Rack -	12 and 33
2-meter Rack -	16 and 37

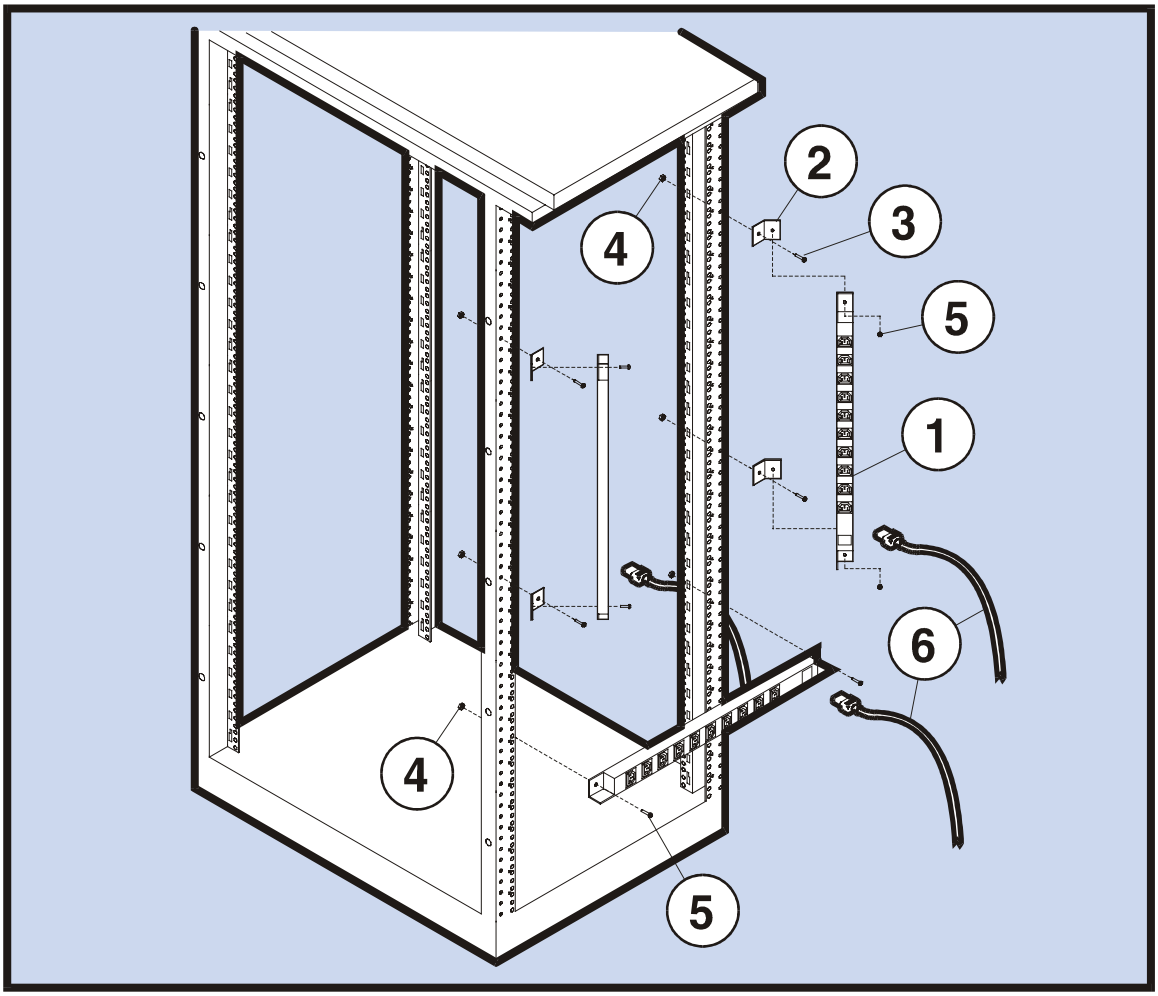
NOTE -.Do not install the PDUs until after the disk array enclosures have been installed.

6. Install the disk enclosures

Replace any array enclosures you removed from the rack and install any new arrays. Refer to appendix C of this document for array enclosure installation. Remember, when installing the disk modules, ensure that they are installed back into the same enclosure from which they were removed.

NOTE! For optimum cooling efficiency, array enclosures should be racked from top to bottom in the front of the rack and from bottom to top in the back of the rack. If side access to the rack is not going to be possible, install the bottom and then the top array enclosure, leaving the array position in the middle or top, open (middle for a 2-meter rack or top for a 1.6 meter rack).

Figure 51. PDU Installation



1 – PDU 10 Plug	- A7676-63001 (3ea.)	6 – Power Cord	
2 – Bracket	- A4915-00001 (4 ea.)	Opt ABA	- E7803-60001 (3 ea.)
3 – Screw, 5/8” TORX	- 2680-0323 (4 ea.)	Opt ABB	- 8120-6895 (3 ea.)
4 – Nut, #10-32	- 2740-0003 (6 ea.)	Opt 024	- 8120-6961 (3 ea.)
5 – Screw, ½” Pozidriv	- 2680-0055 (6 ea.)		

7. Install Replacement PDUs

a) Attach two PDUs vertically to the brackets installed in the previous step. Position the PDU with its large power receptacle toward the bottom and install as described in the A4915A Power Upgrade Kit Quick Installation Guide.

b) Install the horizontal PDU with the large power receptacle to the right (facing the rear of the rack). Install the PDU in the holes indicated below, for the specific cabinet, as described in the power upgrade kit quick installation guide:

Rack	EIA Holes (as counted from the bottom of the rack
1.6 Meter Rack -	89 (middle hole of EIA unit 30)
2-meter Rack -	41 (middle hole of EIA unit 14)

8. Install the power cables

Connect each power cable from an array power supply (P1, P2, and P3) to a different PDU (PDU #1, PDU#2, and PDU #3) as shown in Figure 52 Power Cable Schematic.

To help ensure that individual array supplies get power from a different PDU, divide the cabinet into vertical thirds, looking from the back. All power supplies on the right side go to PDU#1 mounted on the upper right side; all power supplies in the middle of the arrays go to PDU #2 the horizontal PDU; and, all power supplies to the left go to PDU #3 on the upper left side.

Figure 52 illustrates the cabling for a 2-meter rack with 6 units. However, this diagram applies to any configuration, a 2-meter with 5 units or 1.6 meter with 3 or 4 units. Simply follow the cabling for the number of arrays you have installed.

Route the cables from the back of the disk array, out and around the outside of the rack column, and into the PDU as shown in Figure 53. Do not connect more than 8 power cables into one PDU.

9. Install the SCSI cables

Use 0.5 meter flexible SCSI cables to make connections between Bay A and Bay B of each storage enclosure and between storage enclosures. Install the SCSI cables to conform to the system requirements Refer to “Connecting SCSI Cabling” in the Chapter “Product Description” for more details about SCSI cabling.

10. Complete the installation

a) Install filler panels to completely fill any unused space in the front and back of the rack (this is important to maintain cooling).

b) Re-install the side panels (the rear rack door is not required for this installation; it should not be installed and can be set aside).

c) Connect the PDUs to the power source. For redundant configurations, the PDU cables must be connected to separate circuits or UPS for high availability power.

d) Bring the array enclosures on line and mount the file systems.

Figure 52. Power Cable Schematic

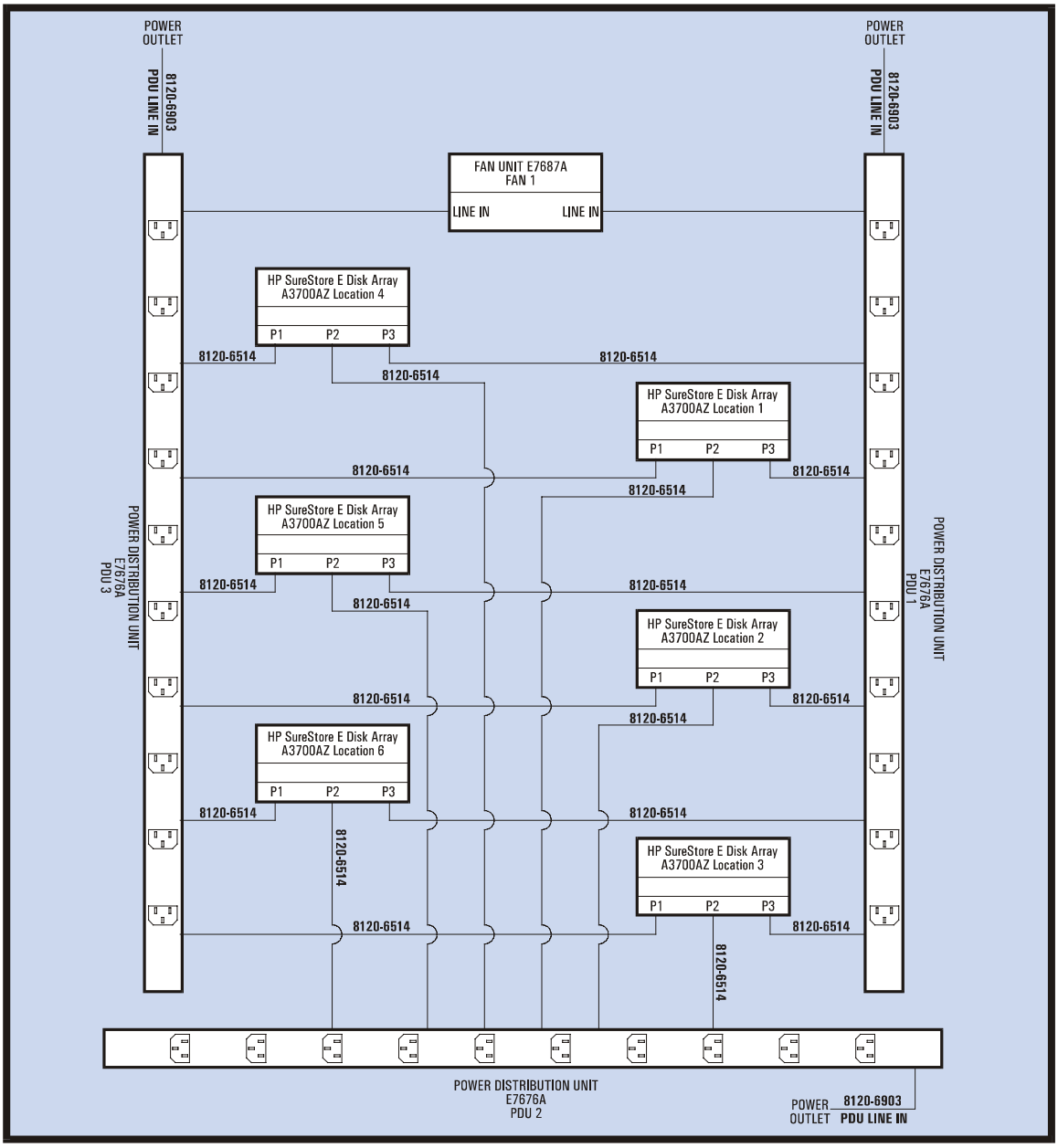
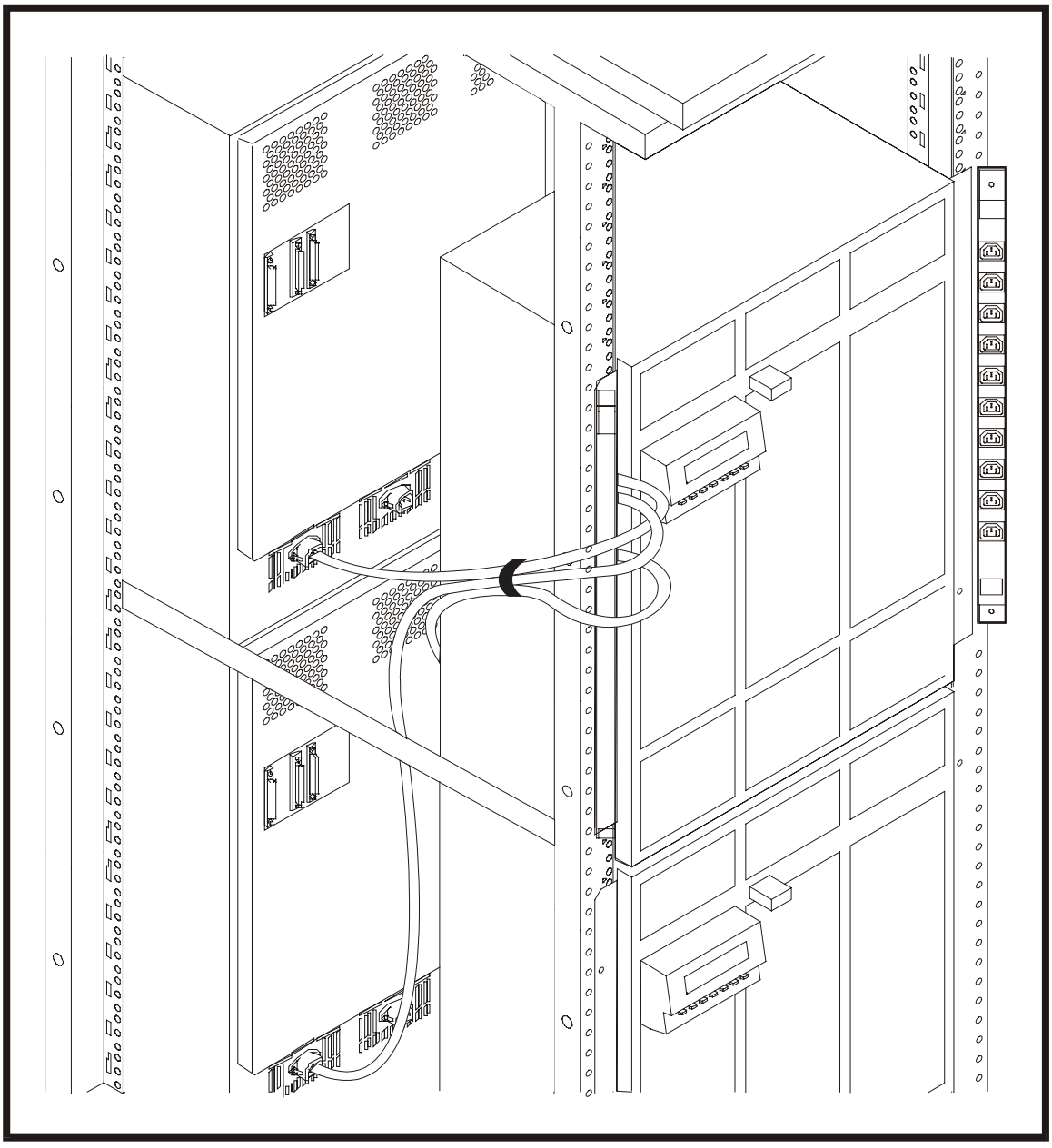


Figure 53. Power Cabling Diagram



Troubleshooting

A computer/instrument rack which has been field-upgraded for back-to-back racking has improved cooling and power features. In addition, the upgrade (the exhaust fan assembly) provides circuitry which can report fan failures and provide an indication of power failures. Fan and power failures are reported via indicator LEDs on the front of the fan assembly. If a failure occurs, the rack will continue to operate with its remaining non-failed components. To isolate a possible power or fan failure, use one of the following procedures, based on the status of the indicator LEDs.

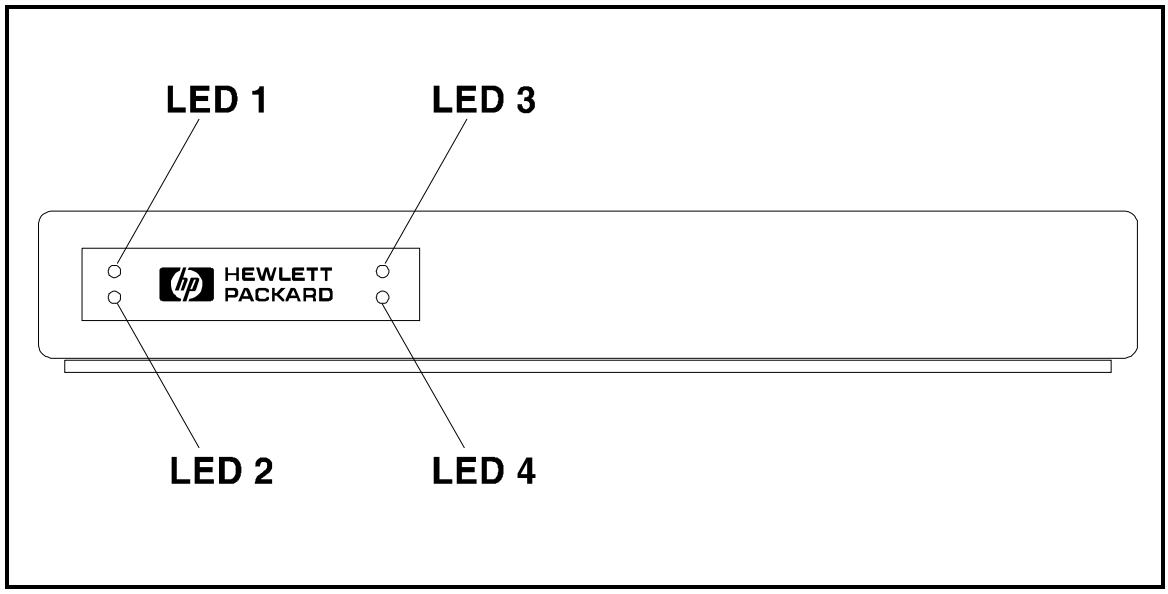
NOTE The two exhaust fan assembly power cables need to be connected into two separate PDUs, such as PDU #1 and PDU #2.

The new PDUs installed from the power upgrade kit are not wired through the rack power switch. The rack power switch, at the top of the rack, is disconnected and no longer provides power switching. To disconnect power to the rack you must unplug each of the three PDUs.

Indicator LEDs

The exhaust fan assembly has four indicator LEDs located at the top front of the rack. The LEDs show the condition of the exhaust fan assembly and power to the fan assembly.

Figure 54. Rack Indicator LEDs



LED 1	Green	PDU 1 and PDU 1 fans normal
LED 2	Amber	PDU 1 fan failure
LED 3	Green	PDU 2 and PDU 2 fans normal
LED 4	Amber	PDU 2 fan failure

Indicator LED States

Both green LEDs lit	This is the rack's normal operating state. Power is being delivered from both PDUs and to all the fans. Fans should be running normally.
One amber LED lit	One or two of the three fans are not operating, probably due to a physical failure.
Two amber LEDs lit	Two or three fans have failed. This condition is unlikely to occur.
One bank of LEDs not lit	When one bank of LEDs is not lit (no green, no amber), power from one of the PDUs has failed. One or two of the cooling fans are not spinning. This is a likely indication that the PDU is not supplying power to the rack. For redundant solutions, some power is likely being delivered to array enclosures from the, remaining, PDUs.
No LEDs lit	All power to the fan assembly has failed. Also, it is likely that two PDUs have failed and are not providing power to the arrays.

Problem Resolution

No LEDs lit

All power to the fan assembly has failed. This is an indication the two of the PDUs and possibly the third are not supplying power to the arrays, thus indicating that none of the array enclosures are operating.

This could be caused by a general power failure at the site, tripped circuit breakers for the circuits delivering power to the rack, or unplugged power cables. If these are not the causes, problem diagnosis of the rack is as follows:

1. **Are the PDU circuit breakers tripped?** Check the PDU circuit breakers. The PDUs are located at the back of the rack. The circuit breakers are black buttons located at the bottom of each PDU.

   When a circuit breaker is tripped, the black buttons will be popped out. Locate and remove the cause of any overload. Reset the circuit breaker by pushing in on the black buttons.

2. **Are both plugs of the exhaust fan assembly plugged in?** Although unlikely, it is possible that the exhaust fan assembly is not plugged in. If necessary, plug the exhaust fan assembly power cords into their receptacles.

CAUTION! This condition is critical, as the fans are not cooling the disk storage units in the rack, and disk drive reliability may be compromised.

When the power fail condition is corrected, both green LEDs on the rack front should light, indicating that at least two of the PDUs are functioning.

One bank of LEDs not lit

When one bank of LEDs is not lit (no green and no amber), power to one of the PDUs has failed. One or two of the cooling fans are not spinning. The remaining two PDUs are likely to be providing power to the arrays.

This could be caused by tripped circuit breakers for the circuits delivering power to the rack, or unplugged power cables. If these are not the causes, problem diagnosis of the rack is as follows:

1. **Is a PDU circuit breaker tripped?** Check the PDU circuit breakers. The PDUs are located at the back of the rack. The circuit breakers are black buttons located at the bottom of each PDU.

   When the circuit breakers are tripped, the black buttons will be popped out. Locate and remove the cause of any overload. Reset the circuit breakers by pushing in on the black buttons.

2. **Are both plugs of the exhaust fan assembly plugged in?** Although unlikely, it is possible that one of the power cords for the exhaust fan assembly is not plugged in. If necessary, plug the exhaust fan assembly power cord into its receptacle. (Plug each of the fan assembly power cords into a different PDU.)

When the power fail condition is corrected, the green LED on the rack front that was not lit should now light.

One amber LED lit

One or two of the three fans is not operating, probably due to a physical failure. A power failure is ruled out, as that would cause the complete bank of LEDs to not light.

1. **Which fan is not spinning?** The exhaust fan assembly is located at the back, top of the. Inspect the assembly visually to see which fan is not spinning. Replace the exhaust fan assembly.

Two amber LEDs lit

Two or three fans have failed. This condition is unlikely to occur. A power failure is ruled out, as that would cause both banks of LEDs to not light.

1. **Have all fans failed?** The exhaust fan assembly is located at the back of the rack, at the top. Inspect the assembly visually to confirm that no fans are spinning. Replace the exhaust fan assembly.

CAUTION! This condition is critical, as the fans are not cooling the array enclosures in the rack, and disk drive reliability may be compromised. The exhaust fan assembly should be replaced within 48 hours.

Removal and Replacement

The exhaust fan assembly can be removed and replaced without powering down the rack. The replacement part number for the exhaust fan assembly is E7687- 63001.

WARNING! Avoid contact with any electrical parts inside the exhaust fan assembly while power is applied, as there is an electrical shock hazard present.

1. Remove the old exhaust fan assembly

a) Unplug the exhaust fan assembly power cords from the two PDUs.

b) Wait for the fans to stop spinning.

c) Remove the two mounting screws at the top rear of the rack.

d) Lift the back of the exhaust fan assembly slightly and then pull the assembly back a few inches.

e) Lift the exhaust fan assembly off the rack.

NOTE! It is not necessary to remove the 1U air scoop when replacing the exhaust fan assembly.

2. Install the new exhaust fan assembly

a) Working from the rear of the rack, raise the exhaust fan assembly above the rack.

b) Tilt the front edge of the exhaust fan assembly (the side that is farthest away from you) into the top of the frame opening. Align the exhaust fan assembly's edges with the rack frame.

c) Slide the exhaust fan assembly forward, engaging the tabs of the exhaust fan assembly into the slots in the front of the rack.

d) Route the two power cords inside the rack frame. When you have done this correctly, the assembly's power cords should be oriented around any installed array enclosures and, with the assembly's power cord plugs near the PDUs.

e) Lower the back end of the exhaust fan assembly into place.

f) Replace the two mounting screws in the exhaust fan assembly.

Specifications

Electrical

- Input Voltage: 200/230/240 VAC @ 16 A max per PDU
- Input Frequencies: 50 Hz /60 Hz single-phase
- Current: 16 A maximum per PDU

Exhaust fan assembly

- Number of fans: 3
- Fan capacity: 233 CFM per fan

Acoustic

- Sound pressure: 7.2 Bels in idle mode at 25° C ambient

Frequently-asked Questions

What site preparation is required?

Power. There must be a source of 240 VAC power for each of the rack's two PDUs. Each PDU draws a maximum of 16A. European locations may require upgraded circuit breakers, as described in the previous section. Redundant power configurations require redundant power sources (that is, power to the rack's two PDUs must come from separate circuits).

Location. The rack location must allow sufficient clearance for access to array enclosures and access to service. Normally, about 2 feet (0.61 meters) clearance between the rack's back and any wall is sufficient.

Does the installation change the height of the rack?

Yes. Installing the Exhaust Fan Assembly increases the height of both the 1.6 meter rack and the 2.0 meter rack by 1 EIA unit (1.75" or 44.45 mm).

Do I have to use filler panels?

Yes. If the rack is not fully populated with array enclosures, you must install enough filler panels to close the remaining open spaces in the front and back of the rack. This is to optimize cooling efficiency.

What if I have an uninterruptible power supply (UPS) at my site?

The indicator LEDs are unlikely to report power outage conditions. They will still report power outage conditions if power from the UPS to the rack PDUs has failed. They will still report fan failure conditions.

How do I rack less than the maximum number of array enclosures?

For optimum cooling efficiency, array enclosures should be racked from top to bottom in the front of the rack and from bottom to top in the back of the rack. If side access to the rack is not going to be possible, install the bottom and then the top array enclosure, leaving the array position in the middle or top, open (middle for a 2-meter rack or top for a 1.6 meter rack).

What replacement parts are there?

The only replacement part is the exhaust fan assembly (part number E7687-63001). A failed exhaust fan assembly must be replaced by the Hewlett-Packard service provider.

How rapidly must I replace a failed exhaust fan assembly?

One failed fan in an exhaust fan assembly will not cause a critical cooling condition immediately. However, it's best to replace the exhaust fan assembly as soon as possible. For racks fully-populated with disk storage units, replace the exhaust fan assembly within 48 hours.

Glossary

Active Hot Spare

An Active Hot Spare is a portion of the disk array capacity reserved to perform a rebuild. An Active Hot Spare ensures that the disk array can maintain *Data Redundancy* if a disk fails. Until it is needed, the disk array uses the Active Hot Spare space as *RAID 0/1* capacity, which improves array performance. An Active Hot Spare does not sit idle; it is used to increase the disk array performance until it is needed.

Adapter

A printed circuit assembly that translates data between the host processor's internal bus and a different bus, such as SCSI.

Arbitrated Loop

See *Fibre Channel–Arbitrated Loop.*

Auto Configuration

Most disk arrays require disk drives to be of matched capacities, performance, and often, manufacturers. A d*isk array* is not restricted to use disks of the same capacity or even performance to function in the array. A process of *Auto Configuration* permits the *Disk Array Controller* to recognize and include disks of varying capacity and performance. This means that future disk drives of higher capacity and better performance may be supported for use in the disk array.

Auto Failover

When two controllers are present, one serves as the *Primary Array Controller*, and the other becomes the *Secondary Array Controller*: If either controller fails, the other controller has the ability to assume the role of *Primary Array Controller*, thus allowing uninterrupted access to all user data with no downtime. Meanwhile, the failed controller can be removed, then replaced by a new array controller, without any downtime, loss of data, or interruption to the host computer system.

***AutoRAID*™ Array Technology**

AutoRAID™ is a trademark of Hewlett-Packard Company for the *disk array* product. HP *AutoRAID*™ implements *RAID* technology automatically, without requiring you to know all the complexities of determining and setting up different *RAID* modes.

Auto Rebuild — Auto Rebuild begins immediately if a disk failure occurs, as long as enough space is available to perform the rebuild. No operator intervention is required to perform an Auto Rebuild. Once the Auto Rebuild has completed, the disk array is once again *Fault-tolerant*, since all user data is once again redundant.

Availability — Availability is achieved by using redundant data to prevent the loss of use of a storage system in the event of a disk failure.

Balancing — Balancing is the process of automatically spreading data equally across all disks to increase performance. When a fixed amount of data is either written or read from multiple disks instead of to or from just one disk, the throughput or speed of the process increases greatly.

Block Mirroring — Block Mirroring is a technique in which duplicate copies of blocks of data are stored on an array of disks.

Cache — An on-board cache, or memory buffer, greatly enhances the speed of data transfers to and from disk devices, since the next block of data required by the host computer is often already available in high-speed cache memory. Caching does require controller overhead, however, so unlike traditional *RAID* systems that often utilize huge cache space, the *disk array* is tuned with an optimum cache. The disk array contains *SIMMs* with *Error Correction Code (ECC),* which are capable of both error detection and correction on the *Disk Array Controller*. Most *RAID* systems use *SIMMs* without *ECC*.

Channel — A Channel refers to a *SCSI* bus on the *Disk Array Controller*. Each *Disk Array Controller* is connected to one channel.

Configuration — See *Auto Configuration* and *Self Configuring*.

Data Redundancy — Data Redundancy protects the disk array from lost data if a disk fails. With Data Redundancy, the array can reconstruct the data that was on the failed disk. If a disk fails, Data Redundancy is lost until the array rebuilds the data that was on the failed disk.

Data Redundancy Capacity Data Redundancy Capacity is the capacity required to support the *RAID 0/1* and *RAID 5* storage techniques used by the disk array for Data Redundancy. This capacity is managed by the *Disk Array Controller* and cannot be altered or reduced.

Data Transfer Rate The Data Transfer Rate is the speed at which data is transferred between a host computer system and a peripheral.

Disk Array Controller The Disk Array Controller implements the HP *AutoRAID™ Array Technology* and *Balancing* of the data. The Disk Array Controller manages all data transfers to and from the host computer and also to and from each *Disk Module*.

Disk Module The disk array enclosure holds up to twelve Disk Modules. Each Disk Module contains a single hard disk assembly.

Disks Not in Use A Disk Not in Use is any disk that is installed in the array enclosure but is not included in the array configuration.

Disk Stamp A unique identifying code written to each disk. The Disk Stamp identifies the disk as belonging to the set of disks installed in the array. The stamp is written to the disk when it is included in the array.

Downing A Disk The process of logically removing a disk from the array configuration. Typically done before testing a disk, downing a disk has much the same effect as physically removing it from the array enclosure.

DRR DRR, or Disable Remote Reset. When DRR is ON or enabled (default), it prevents a host SCSI reset from resetting both disk array SCSI buses. With DRR set to ON, disk array controllers are not allowed to reset their own SCSI bus, even if the host resets that controller. If DRR is set to OFF, a host SCSI reset will also allow that controller to reset both disk array SCSI buses.

Dynamic Data Migration Dynamic Data Migration is the process of moving data that is accessed frequently (according to both the *Disk Stamp* and the *Time Stamp*, which is updated when the data is written) into *RAID 0/1* space, which is optimized for performance, and also moving data that is accessed less often into *RAID 5* space, which is optimized for its higher storage density.

	In either *RAID 0/1* or *RAID 5* mode, the data is stored with *Data Redundancy*, so that at any time, a single disk failure will cause no loss of user data and no interruption of data transfer. While Logical Drive space is defined and thus fixed, the available amount of free space can vary, because Dynamic Data Migration is able to switch user data from *RAID 0/1* to *RAID 5* mode as the *Disk Modules* become full. Similarly, installation of additional *Disk Modules* allows more data to be stored in *RAID 0/1* mode, thus increasing the disk array performance.
Enclosure	The box, or set of boxes containing one or more SCSI devices. It may provide the power, cooling, mechanical support, and external electronic interfaces for those devices.
EPROM	Erasable Programmable Read-Only Memory.
FC Device	A device that uses Fibre Channel technology.
Fast/Wide	Fast/Wide SCSI is a 68-pin bus implementation that utilizes some of the data lines of the bus for address lines.
Fibre Channel–Arbitrated Loop	One of three existing Fibre Channel (FC) topologies, in which two to 126 devices are interconnected serially in a single loop circuit. The arbitrated loop topology supports all classes of service and guarantees in order of delivery of frames when the source and destination are on the same loop.
Format	The process of reinitializing the disk media. A format destroys all data on the portion of the disk media being formatted. Two types of formats are available: a hard format that overwrites all data on the disk media, and a soft format that simply rewrites the headers.
HBA	The HBA, or Host Bus Adapter, is an internal card that is located in the host computer. Each HBA can connect to several *SCSI* devices.
Hot Pluggable	Devices are Hot Pluggable if they can be removed while the host computer system is running. When the disk array is configured with redundant controllers and power supplies, all devices are Hot Pluggable.

I/O Operation

An Input/Output (I/O) Operation is an operation initiated by a host computer system during which data is either written to or read from a peripheral.

Including A Disk

The process of adding a *Disk Module* to the array configuration is called *Including A Disk*. The disk array cannot use a *Disk Module* until it has been included. Once included, the disk array begins using the *Disk Module* for data storage, even if you have not created a *Logical Drive* with the newly added disk capacity.

JBOD

As opposed to disk enclosures that offer *Data Redundancy*, an enclosure without a *Disk Array Controller* (or another type of *RAID*) is called Just a Bunch Of Disks, or JBOD. When a JBOD enclosure has a disk failure, data is lost.

Load Balancing

See *Balancing.*

L-DRV

See *Logical Drive*.

Logical Drive

A Logical Drive is a portion of the array capacity that appears to the operating system as a physical disk. The entire array capacity can be divided into up to eight Logical Drives. Only capacity that has been assigned to a Logical Drive is available to the operating system.

The data contained in each Logical Drive is spread across all disks in the array, so there is no direct correlation between a Logical Drive and any single physical disk in the array.

Logical Drive Number

A unique number (0–7) assigned to each *Logical Drive* on the disk array. This number is used by your operating system to identify each array *Logical Drive*.

Loop Address

The unique ID of a node in Fibre Channel loop topology, sometimes referred to as a Loop ID. Also a status type in the FC Status Menu, showing the Loop Address of the FC-SCSI MUX.

LUN

Logical Unit Number. For consistency with UNIX terminology, LUN is used interchangeably with *Logical Drive*. See *Logical Drive*.

Maximum Environmental Limit The maximum limit of temperature, humidity, vibration, shock, and altitude, which should not be exceeded during operation of an the product. See *Recommended Operating Range.*

Migration Migration is the movement of data between one *RAID* mode and another *RAID* mode.

Mirrored Disks A Mirrored Disk is an entire duplication of data. Traditional mirrored disks require disks of identical capacity. The disk array uses a special type of mirroring called *RAID 0/1* mode, or *Block Mirroring*.

Multiplexer A device that allows two or more signals to be transmitted simultaneously on a single channel.

MUX A multiplexer enables SCSI devices to interface directly with hosts that have Fibre Channel technology. The MUX contains one or two FC ports and up to four fast/wide SCSI differential ports.

Offline Taking a SCSI adapter offline means terminating inputs/outputs and suspending all transactions going from the MUX to the specified SCSI devices. The SCSI adapter is no longer active or available for access.

Taking the MUX offline indicates that all SCSI and FC adapters in the MUX are offline.

Online For a SCSI adapter, online indicates the SCSI adapter is active and available for access and input/output processing.

For the MUX, online indicates that at least one adapter in the MUX is active and available for access.

Previously Used Disk A disk that has been used in another disk array. The *Disk Stamp* indicates that this disk was once part of another array. Including it will destroy any data on the disk.

Primary Array Controller In disk arrays with two controllers, the Primary Array Controller is the one that manages the disk array hardware devices, such as the fan modules and the control panel display module.

RAID	RAID stands for "Redundant Array of Independent Disks." The disk array implements this technology to connect several disk drives to one Disk Array Controller. Several different forms of RAID implementations have been defined. The RAID implementations supported by the disk array include *RAID 0/1* and *RAID 5*.
RAID 0/1	RAID 0/1 is a disk array operating mode that provides high performance, but is somewhat inefficient in its use of disk space. RAID 0/1 implements *Data Redundancy* by keeping a separate copy of all data. This "mirroring" technique consumes half of the disk capacity for *Data Redundancy*, but provides maximum performance for servicing disk writes. Distributing data across all disks, called *Block Mirroring*, provides a performance boost.
RAID 5	A disk array operating mode that is efficient in its use of disk space, but suffers a performance penalty when performing write I/Os. As the disk array begins to fill up, less frequently updated data is moved to RAID 5 space.
Read Verify	A diagnostic test that checks the integrity of the disk media by reading data from random locations on the disk. A Read Verify test is non-destructive; that is, it will not alter or destroy any of the data on the disk. The disk undergoing the test remains in use by the disk array while the test is in progress.
Rebuild	A Rebuild is the process of recovering data that was on a failed disk. The disk array reconstructs the data that was on the failed disk using redundant data from the remaining disks. Until a Rebuild is complete, the disk array is operating in a non-redundant mode, and is vulnerable to a second disk failure. See also *Auto Rebuild.*
Rebuild Priority	Rebuild Priority sets the priority of a *Rebuild* equal to (high) or lower than (low) host I/Os. The Rebuild Priority is able to balance the speed of the *Rebuild* with host system performance.
Recommended Operating Range	The range of temperature, humidity, vibration, shock, and altitude, recommended for extended periods of operation of a disk array. See *Maximum Environmental Limit*.
Redundancy	See *Data Redundancy*.

Reload

Traditionally, *RAID* systems required the entire user data set to be rewritten in order to add more capacity or adjust the *RAID* mode. The disk array does not require a Reload to make use of additional disk space because of the automatic *Balancing* and *Dynamic Data Migration* inherent in HP *AutoRAID*™ *Array Technology*.

Relocated Blocks

Relocated Blocks are data blocks that are relocated from *RAID 0/1* to *RAID 5* (or vice versa) when performing a write.

Restart

The process of bringing the array back on line. Typically done following a *Shutdown*, a restart copies vital configuration information from the disks to *NVRAM* on the array controller.

SCSI

SCSI stands for "Small Computer System Interface." This is an industry-standard interface that defines the mechanical, electrical, and functional requirements for connections and communication between small computers and disk drives and other peripherals.

The SCSI ID (identification or address) uniquely identifies the device on the SCSI channel.

SCSI HBA

The SCSI *HBA* (Host Bus Adapter) is the card installed in the server that provides the connection for the disk array. The SCSI HBA manages the transfer of data between the server and the disk array. Multiple *SCSI* devices can be connected to each *HBA*.

SCSI ID

The SCSI ID is a unique number assigned to each device connected to a SCSI bus. This number is used by the *HBA* to address each device on the bus. Each controller in the disk array is assigned its own SCSI ID.

SDTR

SDTR stands for "Synchronous Data Transfer Request." SDTR controls the data rate on the *SCSI* bus used by the host and the array. SDTR also determines the negotiation protocol of the host. If SDTR is enabled, the array will initiate negotiation protocol; if disabled, the host will initiate negotiation protocol. In either case, the disk array will always respond to any requests made by the host.

Secondary Array Controller — In disk arrays with two controllers, one controller is called the *Primary Array Controller* and the other is called the Secondary Array Controller. The Secondary Array Controller offers redundant controller operation should the primary array controller ever fail. The Secondary Array Controller offers redundant controller operation (full access to all data) and it also monitors the status of the *Primary Array Controller*. If the status of the *Primary Array* Controller is ever questionable, the Secondary Array Controller is able to *become* the *Primary Array Controller*. The Secondary Array Controller can also improve the performance (throughput) of the disk array (host-dependent).

Self Configuring — No *RAID* knowledge is required to use the disk array, since the logistics of *RAID* are all managed by the *Disk Array Controller*.

Self-test — Self-test is an internal diagnostic test sequence that is performed whenever the power is switched on. The results of the Self-test, pass or fail, are displayed by a status light on the front panel of each device.

Shutdown — Shutdown is a coordinated process of taking the disk array offline. During a Shutdown, vital configuration information is copied from the array controller *NVRAM* to the disks. This provides more permanent storage for this information. In the shut down state, the disk array can still execute some *SCSI* commands from the host, but the host cannot access any data on the array.

SIMMs — The disk array allows a total of three 32-Megabyte *SIMMs* on the *Disk Array Controller*. The maximum capacity is therefore 96 Megabytes. The *SIMMs* provide Error Correction Code (ECC).

Status Light — The Status Light is a light on the front panel of each disk module, power module, and fan. The status light is used to indicate normal operating conditions and fault conditions of a particular device.

Stripe Depth — The Stripe Depth used by the disk array in *RAID 5* mode is 64K blocks. Normally, *RAID* 5 mode incurs a performance penalty, since in order to determine the proper parity, previously- written data must be read. This is called the read/modify/write penalty. However, when the data to be written exceeds the size of the stripe depth, or 64K, no read/modify/write penalty is incurred because all of the data (including parity) already exists in RAM.

Target A SCSI device (usually the peripheral) that responds to an operation requested by a SCSI initiator (usually the host system). SCSI peripherals are targets, but for some commands (for example, a COPY command), the peripheral may need to act temporarily as an initiator.

Terminator Block An electrical connection at each end of the SCSI bus composed of a set of resistors (or possibly other components). Its function is to provide a pull-up for open-collector drivers on the bus, and also impedance matching to prevent signal reflections at the ends of the cable. The SCSI bus requires termination at both ends of the bus. One end of the SCSI bus is terminated by the adapter's internal termination. The other end should have a terminator placed on the 68-pin high density SCSI connector on the last SCSI peripheral. If this device is not terminated, data errors may occur.

Time Stamp All data blocks stored on the disk array are written along with a Time Stamp. The Time Stamp allows the *Disk Array Controller* to determine how frequently blocks of data have been accessed.

Unallocated Capacity Array capacity that has not been assigned to a *Logical Drive*, and therefore is not available to the server. The disk array uses all Unallocated Capacity to improve array performance by using it for *RAID 0/1* storage.

Uninterruptable Power Supply An Uninterruptable Power Supply is a power supply that is capable of maintaining power even if the input ac mains supply loses its source of power.

VEB VEB (Very Early Busy) is a SCSI parameter. VEB instructs the disk array to return a BUSY response during its power-on sequence. Following a power-on, it can take the disk array up to three minutes to complete its internal self-test sequence. During this time, the disk array will not respond to host commands if VEB is disabled. This may cause some host systems to time out while waiting for the disk array to respond. If VEB is enabled, the disk array will return a BUSY status to the host rather than simply ignore any commands during this interval. This will alert the host system to the presence of the disk array and thus avoid the possibility of the host system "timing out" before the disk array is ready.

WDTR

WDTR (Wide Data Transfer Request) controls whether or not the additional eight bits on a wide bus will be utilized in most data phases of a SCSI command. WDTR also determines the negotiation protocol of the host. If WDTR is enabled, (default) the disk array will initiate for negotiation for wide transfer. If WDTR is disabled, the host will initiate negotiation protocol. In either case, the disk will always respond to any requests made by the host.

Write Working Set

The Write Working Set is the number of unique data blocks written to the disk array over a period of time. To maintain performance, the write working set should not consistently exceed the amount of *RAID 0/1* space available.

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