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HP Smart Array 6400 Series Controllers User Guide

for HP ProLiant Servers



January 2005 (Fifth Edition)
Part Number 309135-005

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HP Smart Array 6400 Series Controllers User Guide

January 2005 (Fifth Edition)

Part Number 309135-005

Audience assumptions

This document is for the person who installs, administers, and troubleshoots servers and storage systems. HP assumes you are qualified in the servicing of computer equipment and trained in recognizing hazards in products with hazardous energy levels.

Contents

Hardware features 7

Board components....7
Expansion module components....8
Controller specifications and attributes....9

Determining the correct installation procedure for the server 11

Unused autoconfigurable server....11
Unused non-autoconfigurable server....12
Previously configured server....12

Installing the controller hardware 15

Before beginning the installation....15
Preparing the server....15
Installing the controller board....16
Connecting storage devices....17
Connecting internal storage....17
Connecting external storage....18
SCSI cable part numbers....18

Updating the firmware 21

Methods for updating the firmware....21

Configuring the server 23

Configuring the server....23

Configuring an array 25

Introduction....25
Comparing the utilities....26
Using ORCA....27
Using ACU....28
Using CPQONLIN....28
Setting drive rebuild, expand priority, and accelerator ratio....29
Expanding an array....30
Adding or configuring spare drives....30
Migrating RAID level and stripe size online....31

Installing device drivers and Management Agents 33

Installing device drivers 33
Installing Management Agents 34

Upgrading or replacing controller options 35

Replacing a battery 35
Replacing the expansion module 37

Replacing, moving, or adding hard drives 39

Identifying the status of a hard drive 39
Hot-plug SCSI hard drive LED combinations 40
Recognizing hard drive failure 41
Effects of a hard drive failure 41
Compromised fault tolerance 42
Recovering from compromised fault tolerance 42
Replacing hard drives 43
Factors to consider before replacing hard drives 43
Automatic data recovery (rebuild) 45
Upgrading hard drive capacity 46
Moving drives and arrays 47
Adding drives 49

Diagnosing array problems 51

Controller board runtime LEDs 51
Cache module LEDs 53
Diagnostic tools 54

Electrostatic discharge 55

Preventing electrostatic discharge 55
Grounding methods to prevent electrostatic discharge 56

Regulatory compliance notices 57

Federal Communications Commission notice 57
FCC rating label 57
Class A equipment 58
Class B equipment 58
Declaration of conformity for products marked with the FCC logo, United States only 59
Modifications 59
Cables 59
Canadian notice (Avis Canadien) 60
European Union regulatory notice 60
BSMI notice 61
Japanese notice 61

Korean notice A&B 62
Battery replacement notice 62
Taiwan battery recycling notice 63

Acronyms and abbreviations **65**

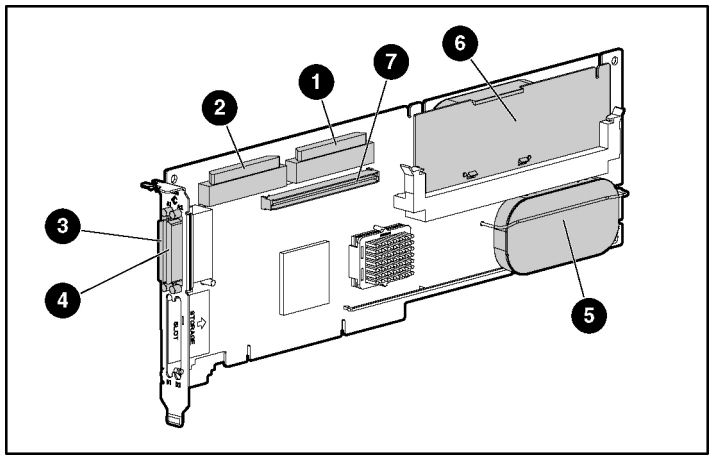
Index **67**

Hardware features

In this section

Board components 7
Expansion module components 8
Controller specifications and attributes 9

Board components

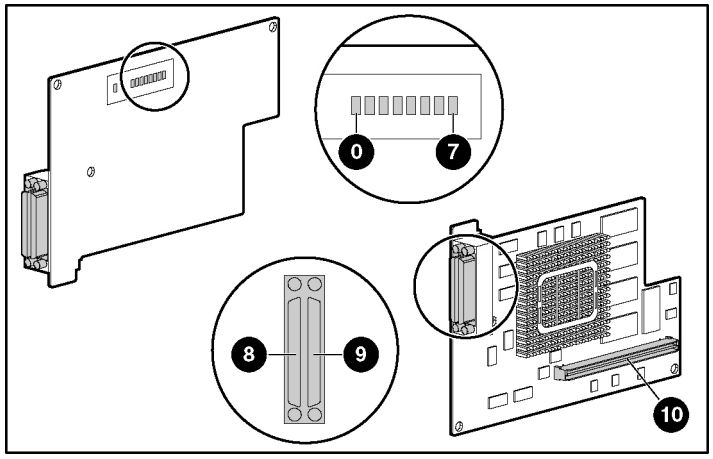


Item ID	Description
1	Internal SCSI connector, port A1 (do not use simultaneously with item 3)
2	Internal SCSI connector, port A2 (do not use simultaneously with item 4)
3	External SCSI connector, port A1 (do not use simultaneously with item 1)
4	External SCSI connector, port A2 (do not use simultaneously with item 2)
5	Controller battery

Item ID	Description
6	Battery-backed cache module
7	Connector for expansion board

Expansion module components

An expansion module is used to add two extra external channels to an SA6402 controller, converting it to an SA6404 controller.



Item ID	Description
0–7	Runtime LEDs (CR10–CR17). These are identical to the controller board runtime LEDs (on page 51).
8	VHDCI connector, port B2
9	VHDCI connector, port B1
10	Connector to controller board

The expansion module is a controller in its own right. Thus, the SA6404 controller is actually two 2-channel controllers sharing one PCI-X connector. This arrangement is referred to as a dual (or twin) controller configuration.

During POST, each component controller loads its own instance of the required driver and sets its own configuration using ORCA. The dual controller is displayed in both Systems Insight Manager and ACU as two separate entities in one slot. In these utilities, the slot number label for the expansion module has a lowercase b suffix, while the slot number label for the main controller has no suffix.

NOTE: When an expansion module is installed, the capacity of the battery-backed write cache on the main board is divided equally between the expansion board and the main board. For more information, refer to customer note CN0316W on the HP website (http://www.hp.com).

Controller specifications and attributes

Dimensions (excluding bracket)	31.2 cm x 10.7 cm x 1.8 cm (12.3 in x 4.2 in x 0.7 in)
Power required	Typically 12–18 W
Ambient room temperature range	Operating: 10° to 35°C (50° to 95°F) Storage: -20° to 55°C (-4° to 131°F)
Relative humidity (noncondensing)	Operating: 10% to 70% Storage: 5% to 90%
RAID levels supported	0, 1, 1+0, 5, ADG
Processor type	PowerPC 405 at 266 MHz
DDR SDRAM bus transfer rate	Up to 2.0 GB/s at 266 MHz (DDR, 72 bit)
Connector type	3.3-V, 64-bit, Wide PCI-X (compatible with PCI slot)
PCI-X transfer rate	Up to 1.0 GB/s at 133 MHz (64 bit)
Number of SCSI channels	**6402:** 2 LVD-only; **6404:** 4 LVD-only
Maximum number of drives per SCSI channel	15 (14 in an external enclosure)
SCSI connector type	68-pin Wide internal, VHDCI external
SCSI termination	Required, and provided on Compaq and newer HP systems
SCSI transfer rate	Up to 320 MB/s (160 MHz DDR) per channel

For more information about the controller features and specifications, and for information about system requirements, refer to the HP website (http://www.hp.com/products/smartarray).

Determining the correct installation procedure for the server

In this section

Unused autoconfigurable server 11
Unused non-autoconfigurable server 12
Previously configured server 12

Unused autoconfigurable server

New HP ProLiant server models self-configure when they are powered up for the first time. For more information about the autoconfiguration process, refer to the server-specific setup and installation guide or the *HP ROM-Based Setup Utility User Guide*. These guides are available on the server Documentation CD.

> **IMPORTANT:** Do not power up the server until the hardware configuration is satisfactory, as described in the procedure given in this section.

1. Install the controller hardware ("Installing the controller hardware" on page 15).
2. Install physical drives, if necessary.

   The number of drives in the server determines the RAID level that is autoconfigured when the server is powered up (next step). For details, refer to the server-specific setup and installation guide or the *HP ROM-Based Setup Utility User Guide*.
3. Power up the server. The autoconfiguration process runs.

   > **IMPORTANT:** The expansion module on the SA6404 controller cannot be used as a boot device.
4. Update the system firmware ("Updating the firmware" on page 21).
5. Update the controller firmware ("Updating the firmware" on page 21).

6. Install the operating system and device drivers ("Installing device drivers" on page 33). Instructions are provided with the CD that is supplied in the controller kit.
7. Create and format additional logical drives if desired ("Configuring an array" on page 25).

The server is now ready to use.

Unused non-autoconfigurable server

1. Install the controller hardware ("Installing the controller hardware" on page 15).
2. Update the system firmware ("Updating the firmware" on page 21).
3. Update the controller firmware ("Updating the firmware" on page 21).
4. Configure the server ("Configuring the server" on page 23).

   IMPORTANT: The expansion module on the SA6404 controller cannot be used as a boot device.

5. Create and format at least one logical drive ("Configuring an array" on page 25).
6. Install the operating system and device drivers ("Installing device drivers" on page 33). Instructions are provided with the CD that is supplied in the controller kit.
7. Create and format additional logical drives if desired ("Configuring an array" on page 25).

The server is now ready to use.

Previously configured server

1. Back up any data on the system. (This step is **required** if you are moving drives from a non-array controller to a Smart Array controller.)
2. Update the system firmware ("Updating the firmware" on page 21).

3. If the new controller is to be the boot device, install the device drivers for the operating system ("Installing device drivers" on page 33). Otherwise, continue with step 4.

   IMPORTANT: The expansion module on the SA6404 controller cannot be used as a boot device.

4. Install the controller hardware ("Installing the controller hardware" on page 15).
5. Set the controller order ("Configuring the server" on page 23).
6. Update the controller firmware ("Updating the firmware" on page 21).
7. If the controller is not going to be the boot device, install the device drivers for the operating system ("Installing device drivers" on page 33). Otherwise, continue with the next step.
8. Update the Management Agents ("Installing Management Agents" on page 34), if new versions are available.
9. Create and format additional logical drives if desired ("Configuring an array" on page 25).
10. If migrating from a non-array controller, restore data from the backup.

The server is now ready to use.

Installing the controller hardware

In this section

Before beginning the installation....15
Preparing the server....15
Installing the controller board....16
Connecting storage devices....17

Before beginning the installation

Before beginning the installation procedure, visit the HP website (http://www.hp.com/support) to confirm that you have the latest version of each driver and utility file needed. Compare the version numbers of the files there with those of the same files on the software CD or DVD that is supplied in the controller kit.

Preparing the server

Before installing the controller in the server, back up all data. This step is **required** if you are moving non-arrayed SCSI drives to a Smart Array controller, because data is not preserved during a move between array controllers and non-array controllers.

If the server supports hot-pluggable devices, you can install the controller board without any further preparation ("Installing the controller board" on page 16).

To prepare a server that does not support hot-pluggable devices:

1. Close all applications.
2. Power down the server.



CAUTION: In systems that use external data storage, be sure that the server is the first unit to be powered down and the last to be powered back up. Taking this precaution ensures that the system does not erroneously mark the drives as failed when the server is powered up.

3. Power down all peripheral devices that are attached to the server.
4. Unplug the AC power cord from the outlet and then from the server.
5. Disconnect all peripheral devices from the server.

Installing the controller board



WARNING: To reduce the risk of personal injury or damage to the equipment, consult the safety information and user documentation provided with the server before attempting the installation.

Many servers are capable of providing energy levels that are considered hazardous and are intended to be serviced only by qualified personnel who have been trained to deal with these hazards. Do not remove enclosures or attempt to bypass any interlocks that may be provided for the purpose of removing these hazardous conditions.

1. Remove or open the access panel.
2. Select an available 3.3-V PCI or PCI-X slot.
3. Remove the slot cover or open the hot-plug latch. Save the retaining screw if one is present.
4. Slide the controller board along the slot alignment guide, and press the board firmly into the slot so that the contacts on the board edge are properly seated in the system board connector.
5. Secure the controller board in place with the hot-plug latch or retaining screw. If there is a guide latch on the rear of the board, close the latch.
6. Connect storage devices to the controller ("Connecting storage devices" on page 17).

NOTE: Drives that are to be grouped in the same array should all have comparable capacity for efficient use of total storage capacity.

7. Replace the access panel, and secure it with screws if any are present.



CAUTION: Do not operate the server for long periods without the access panel. Operating the server without the access panel results in improper airflow and improper cooling that can lead to thermal damage.

Connecting storage devices

The controller supports Ultra2, Ultra160 (Ultra3), and Ultra320 drives.

Each peripheral that is connected to the controller must have a unique SCSI ID value within the range of 0 to 15 (except ID 7, which is reserved for controller use). This value determines the priority that is given to the device when it attempts to use the SCSI bus.

The system automatically sets the SCSI IDs for hot-pluggable devices if they are supported. For non-hot-pluggable devices, you must set the ID values manually by using switches or jumpers on the device itself.

SCSI buses require termination on both ends to prevent signal degradation. In HP ProLiant and Integrity servers, however, the controller, SCSI cable, and backplane already provide this termination.

Connecting internal storage

1. If the storage device that you are adding is not hot-pluggable, power down the system.
2. Install drives in the removable media bays on the server.



CAUTION: Do not use hot-pluggable drives on the same SCSI bus as non-hot-pluggable drives.

NOTE: Drives that are to be grouped in the same array should all have comparable capacity for efficient use of total storage capacity.

For additional information about drive installation, refer to the appropriate section in this guide ("Replacing, moving, or adding hard drives" on page 39) and consult the documentation that accompanied the drives.

When you have finished installing drives, continue with the next step.

- If the drives are hot-pluggable, go to step 3.
- If the drives are not hot-pluggable, go to step 4.

3. Attach the internal point-to-point SCSI cable (provided with the server) from the internal connector of the controller to the hot-plug drive cage.

   Installation of the hot-pluggable drives is complete.

4. For each SCSI bus, manually set the SCSI ID on each drive to a unique value in the range of 0 to 15, except 7 (which is reserved for controller use). For detailed instructions, consult the documentation that is provided with the drive.
5. Attach a multi-device SCSI cable from the internal connector of the controller to the non-hot-pluggable hard drives. (The cable may have been provided with the server.)
6. Replace the access panel, and secure it with the thumbscrews if any are present.



CAUTION: Do not operate the server for long periods without the access panel. Operating the server without the access panel results in improper airflow and improper cooling that can lead to thermal damage.

Connecting external storage

1. On the rear of the server, connect the external cable to the VHDCI connector on the controller, and tighten the lock screws on the cable connector.
2. Attach the other end of the cable to the storage enclosure, and tighten the lock screws on the cable connector.

SCSI cable part numbers

NOTE: If you require additional cables, order them by the option kit number.

SCSI cable type	Cable length	Option kit number	Cable assembly number
External VHDCI cable	1.8 m (6 ft)	341174-B21	313374-001
	3.7 m (12 ft)	341175-B21	313374-002
	7.3 m (24 ft)	164604-B21	313374-004
	11.9 m (39 ft)	150214-B21	313374-005
Internal multi-device cable	varies	166389-B21	148785-001

Updating the firmware

In this section

Methods for updating the firmware 21

Methods for updating the firmware

To update the firmware on the server, controller, or hard drives, use Smart Components. These components are available on the Firmware Maintenance CD. A more recent version of a particular server or controller component might be available on the support page of the HP website (http://www.hp.com/support). Components for controller and hard drive firmware updates are also available from the software and drivers page for storage products (http://www.hp.com/support/proliantstorage).

1. Find the most recent version of the component that you require. Components for controller firmware updates are available in offline and online formats.
2. Follow the instructions for installing the component on the server. These instructions are given with the CD and are provided on the same Web page as the component.
3. Follow the additional instructions that describe how to use the component to flash the ROM. These instructions are provided with each component.

Configuring the server

In this section

Configuring the server 23

Configuring the server

After installing the controller hardware and updating the firmware, use RBSU to configure the server.

> **NOTE:** The 2-channel expansion module is a controller in its own right. Thus, the Smart Array 6404 Controller is actually two 2-channel controllers sharing one PCI-X connector. During POST, each component controller loads its own instance of the required driver and sets its own configuration using ORCA.

1. Power up the server.

   The server runs the POST sequence and briefly displays an RBSU prompt.

2. At the prompt, press the **F9** key to start RBSU.
3. Follow the on-screen instructions to configure the server and set the boot controller order.

   > **IMPORTANT:** The expansion module on the SA6404 controller cannot be used as a boot device.

4. Save the configuration, and exit from the utility.
5. Restart the server for the new settings to take effect.

For more information about using RBSU, refer to the *HP ROM-Based Setup Utility User Guide* or the server setup and installation guide. These documents are both available on the Documentation CD supplied in the server kit.

Configuring an array

In this section

Introduction 25
Comparing the utilities 26
Using ORCA 27
Using ACU 28
Using CPQONLIN 28

Introduction

HP provides three utilities for manually configuring an array on a Smart Array controller:

- ORCA—A simple ROM-based configuration utility
- ACU—A versatile, browser-based utility that provides maximum control over configuration parameters
- CPQONLIN—A menu-based configuration utility specifically for servers using Novell NetWare

NOTE: To copy a particular array configuration to several other servers on the same network, use ACR or the scripting capability of ACU. ACR is provided in the SmartStart Scripting Toolkit, available on the HP website (http://www.hp.com/servers/sstoolkit).

Whichever utility you use, the following limitations apply:

- For the most efficient use of drive space, do not mix drives of different capacities within the same array. The configuration utility treats all physical drives in an array as if they have the same capacity as the smallest drive in the array. The excess capacity of any larger drives is wasted because it is unavailable for data storage.
- The probability that an array will experience a drive failure increases with the number of physical drives in the array. If you configure a logical drive with RAID 5, keep the probability of failure low by using no more than 14 physical drives in the array.

For conceptual information about arrays, logical drives, and fault-tolerance methods, and for information about default array configuration settings, refer to the *HP Array Configuration Utility User Guide.* This document is available on the Documentation CD that is provided in the controller kit.

Comparing the utilities

NOTE: A + in the appropriate column indicates that the feature or procedure is supported, while -- indicates that the feature or procedure is not supported.

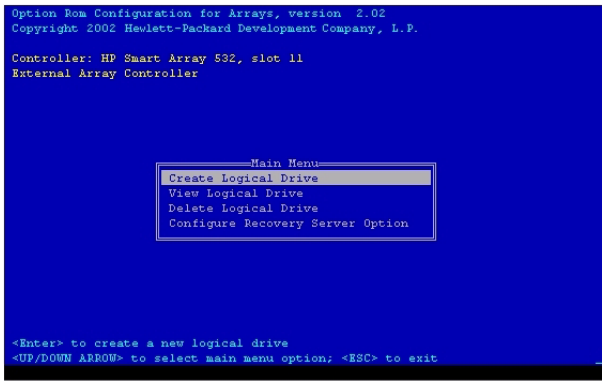
Supported features	**ACU**	**CPQONLIN**	**ORCA**
Uses a graphical interface	+	--	--
Available in languages other than English	+	--	--
Executable at any time	+	+	--
Available on CD	+	+	--
Uses a wizard to suggest the optimum configuration for an unconfigured controller	+	+	--
Describes configuration errors	+	--	--

Supported procedures	**ACU**	**CPQONLIN**	**ORCA**
Creation and deletion of arrays and logical drives	+	+	+
Assignment of RAID level	+	+	+
Sharing of spare drives among several arrays	+	+	--
Assignment of multiple spare drives per array	+	+	--
Setting of stripe size	+	+	--
Migration of RAID level or stripe size	+	+	--
Configuration of controller settings	+	+	--
Expansion of an array	+	+	--
Creation of multiple logical drives per array	+	+	--
Setting of boot controller	--	--	+

Using ORCA

1. Power up the server. POST runs, and any array controllers that are in the server are initialized one at a time. During each controller initialization process, POST halts for several seconds while an ORCA prompt message appears.
2. At the ORCA prompt, press the **F8** key.

   The ORCA main menu appears, enabling you to create, view, or delete a logical drive.



To create a logical drive using ORCA:

1. Select **Create Logical Drive.**

   The screen displays a list of all available (unconfigured) physical drives and the valid RAID options for the system.
2. Use the **Arrow** keys, **Spacebar,** and **Tab** key to navigate around the screen and set up the logical drive, including an online spare drive if one is required.

   NOTE: You cannot use ORCA to configure one spare drive to be shared among several arrays. Only ACU enables you to configure shared spare drives.
3. Press the **Enter** key to accept the settings.
4. Press the **F8** key to confirm the settings and save the new configuration.

   After several seconds, the **Configuration Saved** screen appears.
5. Press the **Enter** key to continue.

You can now create another logical drive by repeating the previous steps.

NOTE: Newly created logical drives are invisible to the operating system. To make the new logical drives available for data storage, format them using the instructions given in the operating system documentation.

Using ACU

For detailed information about using ACU, refer to the *HP Array Configuration Utility User Guide.* This document is available on the Documentation CD that is provided in the controller kit.

Using CPQONLIN

The NetWare Online Array Configuration Utility (CPQONLIN) is an NLM that enables you to configure drive arrays on a NetWare server without powering down the server or storage system. CPQONLIN also provides information about the status of drives attached to the controller.

To run CPQONLIN:

1. Use the software CD provided with the controller to load the drivers (*HPQCISS.HAM* and *CPQSHD.CDM*) and the executable (*CPQONLIN.NLM*) on the server. Detailed instructions are provided with the CD.
2. Enter `cpqonlin` at the console prompt.
3. Use the arrow keys to highlight the Array Configuration Utility menu item, and then press the **Enter** key.
4. From the list of controllers that is presented, select the one that you want to configure.
   - If there are no logical drives connected to the controller, an auto-configuration wizard opens and prompts you for fault-tolerance information.

- If the controller is connected to at least one logical drive, CPQONLIN continues in manual configuration mode. Use the arrow and **Enter** keys to navigate around the screen and set up the logical drive. To get online help at any time, press the **F1** key.

5. When you have finished configuring the array, save the changes.

NOTE: Newly created logical drives are invisible to the operating system. To make the new logical drives available for data storage, format them using the instructions given in the operating system documentation.

The following sections provide details of some typical procedures.

Setting drive rebuild, expand priority, and accelerator ratio

1. Go to the Main Configuration View screen.
2. Highlight the controller.
3. Select the **Controller Settings** option below Controller Options. The Controller Settings screen appears.

Drive rebuild

Drive rebuild occurs after a physical drive fails and is replaced. Only logical drives configured for fault tolerance (RAID 1, RAID 5, ADG) on the array with the failed physical drive will rebuild.

Priority settings

To set the drive rebuild priority:

1. Highlight the controller.
2. Select the controller settings:
   - If you choose low priority for drive rebuild, drive rebuilding occurs when I/O to the drive is inactive.
   - If you choose high priority, drive rebuilding occurs faster, at the expense of normal I/O operations.

Accelerator ratio

The controller has an onboard cache called an Array Accelerator, which performs both write-posting and read-ahead caching. The setting in CPQONLIN determines the amount of memory allocated to the read and write caches.

For example, if the accelerator ratio is set to Read 75%:Write 25%, 75% of Array Accelerator cache is dedicated to read-ahead cache and 25% is dedicated to the write-posting cache. This option can be modified from the Controller Settings menu.

Expanding an array

During an expand, performance may be slightly degraded. In most cases, however, any potential degradation is offset by the addition of physical drives. Some tips for expanding include:

- Perform the expand process during periods of low server use. If you must expand during peak periods, CPQONLIN enables you to set the priority of the expand. Setting the priority to LOW affects performance the least, but it takes longer for the new space to become available.
- When expanding, always add drives with a capacity equal to or greater than the capacity of the smallest drive in the array. Adding larger drives wastes space because only the space that is equal to the smallest drive size can be used.

Adding or configuring spare drives

When adding a spare drive to an array, an unassigned drive must exist or a drive already assigned as a spare must exist on another array. You can assign a single spare to any number of arrays or assign separate spares.

When you select **Assign Spare Drive**, only drives that qualify appear (for example, only those spares that are large enough appear). If drives that you expect to see do not appear, switch to the physical drive view (**Tab** key), and check the size of the drives. The capacity of the spare must be equal to or greater than the capacity of the smallest drive in the array.

Migrating RAID level and stripe size online

Using CPQONLIN, you can modify both the RAID level and stripe size of an existing logical drive while online. To migrate a drive:

1. Select the drive setting option under the logical drive menu for the drive you intend to modify.
2. Select the new RAID level and/or stripe size from the choices presented. If the new settings are valid, the migration begins when you save the changes.

Installing device drivers and Management Agents

In this section

Installing device drivers.....33
Installing Management Agents.....34

Installing device drivers

The drivers for the controller are located on the Support Software CD or the SmartStart CD that is provided in the controller kit. Updates are posted to the HP website (http://www.hp.com/support).

> **NOTE:** The 2-channel expansion module is a controller in its own right. Thus, the Smart Array 6404 Controller is actually two 2-channel controllers sharing one PCI-X connector. During POST, each component controller loads its own instance of the required driver and sets its own configuration using ORCA.

Using the Support Software CD: Instructions for installing the drivers from the Support Software CD are given in the leaflet that is supplied with the CD. Note that the exact procedure depends on whether the server is new or already contains the operating system and user data.

Using the SmartStart CD: If you use the Assisted Installation path feature of SmartStart to install the operating system on a new server, the drivers are automatically installed at the same time.

You can also use SmartStart to update the drivers manually on older systems. For more information, refer to the SmartStart documentation.

Installing Management Agents

NOTE: The 2-channel expansion module is a controller in its own right. Thus, the Smart Array 6404 Controller is actually two 2-channel controllers sharing one PCI-X connector. This dual controller is displayed in both Systems Insight Manager and ACU as two separate entities in one slot. In these utilities, the slot number label for the expansion module has a lowercase b suffix, while the slot number label for the main controller has no suffix.

If you use the Assisted Installation path feature of SmartStart to install the operating system on a new server, the Management Agents are automatically installed at the same time.

You can update the Management Agents by using the latest versions of the agents from the HP website (http://www.hp.com/servers/manage). The procedure for updating the agents is provided on the same Web page.

If the new agents do not function correctly, you might also need to update Systems Insight Manager. The latest version of Systems Insight Manager is available for download at the HP website (http://www.hp.com/servers/manage).

Upgrading or replacing controller options

In this section

Replacing a battery 35
Replacing the expansion module 37

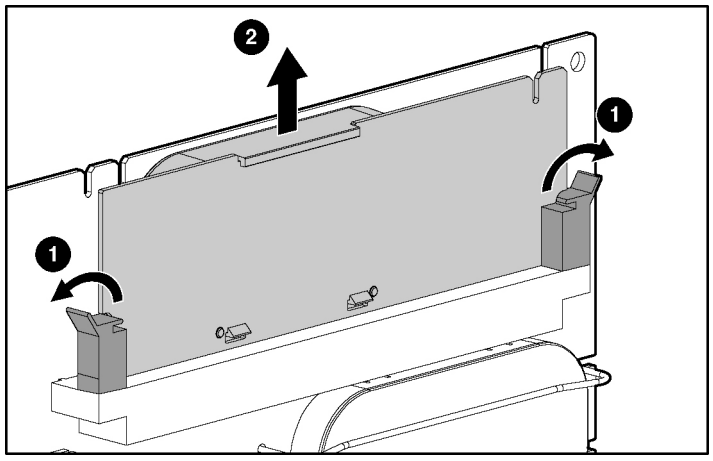
Replacing a battery

WARNING: There is a risk of explosion, fire, or personal injury if the battery pack is not properly handled. Refer to "Battery replacement notice (on page 62)" before installing or removing any item that contains a battery pack.

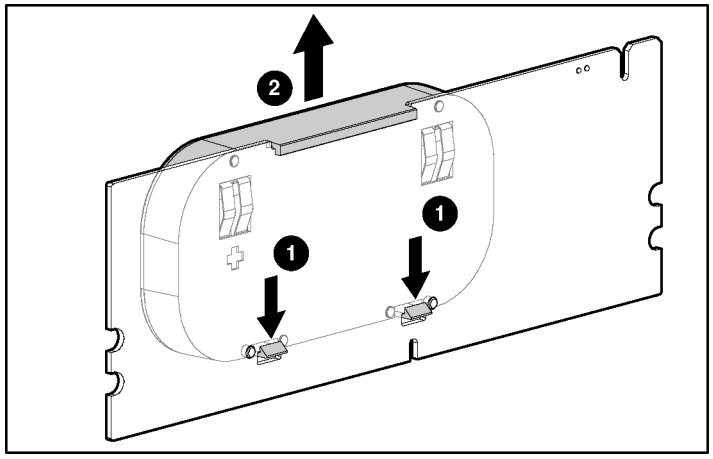
IMPORTANT: Whether you are replacing the main cache battery or the secondary (lower) cache battery, remove both batteries so that the board circuitry recognizes the new battery pack.

1. Close all applications, and then power down the server. This procedure flushes all data from the cache.
2. Remove the cache module:
   a. Open the ejector latches on each side of the DIMM connector (1).

b. Pull the cache module out of the DIMM slot (2).

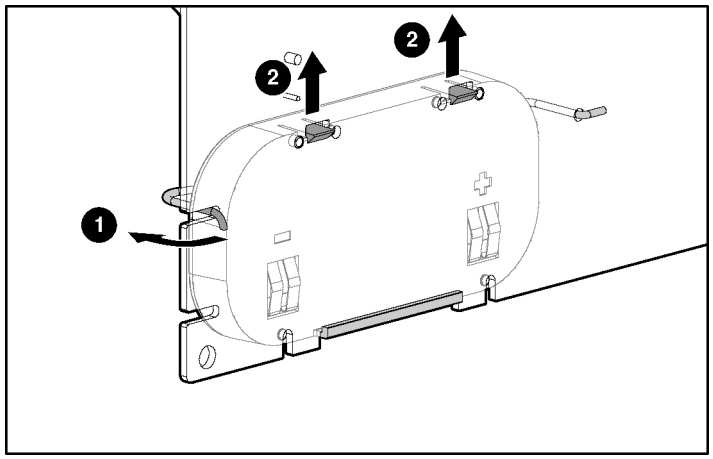


3. If the main cache battery must be replaced:
   a. Press the battery retainer tabs down, and push them through to the other side of the cache board (1).
   b. Lift the battery pack off the cache board (2).



4. Remove the secondary cache battery pack:
   a. Unhook the wire retainer that holds the battery pack to the controller board (1).

b. While holding the battery in one hand, pull the plastic retainer tabs up and push them through to the other side of the controller board (2).



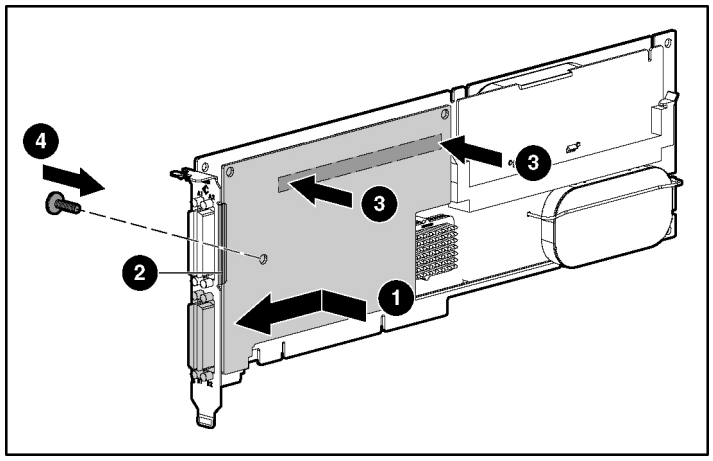
5. Replace whichever battery is degraded.
6. Reinstall the batteries on the cache board and the controller board.
7. Reinstall the cache board and its battery on the controller.

Replacing the expansion module

To install the expansion module:

1. Insert the VHDCI connector into the empty slot on the controller bracket (1), sliding the expansion module under the bracket lip (2).
2. Press firmly on the back of the expansion module to seat the expansion module connector securely in the socket on the controller board (3).

3. Secure the expansion module to the controller board by inserting and tightening the appropriate screw (provided in the kit) in the back of the controller board (4).



To remove the expansion module, reverse this procedure.

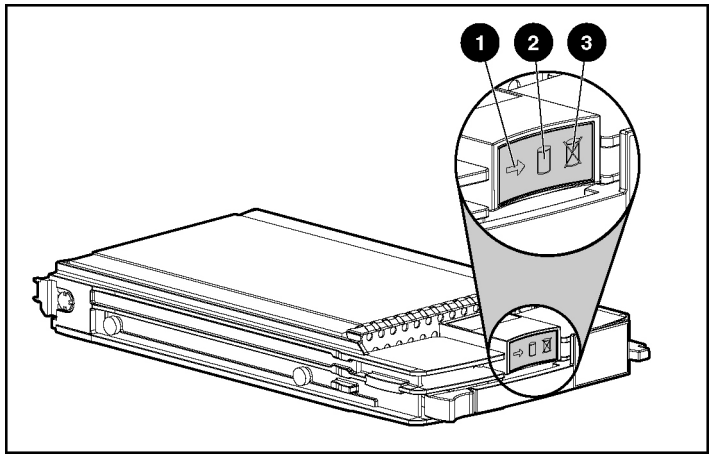
Replacing, moving, or adding hard drives

In this section

Identifying the status of a hard drive 39
Recognizing hard drive failure 41
Replacing hard drives 43
Moving drives and arrays 47
Adding drives 49

Identifying the status of a hard drive

When a drive is configured as a part of an array and connected to a powered-up controller, the condition of the drive can be determined from the illumination pattern of the hard drive status lights (LEDs). The table ("Hot-plug SCSI hard drive LED combinations" on page 40) describes the meanings of the different illumination patterns.



Hot-plug SCSI hard drive LED combinations

Activity LED (1)	Online LED (2)	Fault LED (3)	Interpretation
On, off, or flashing	On or off	Flashing	A predictive failure alert has been received for this drive. Replace the drive as soon as possible.
On, off, or flashing	On	Off	The drive is online and is configured as part of an array. If the array is configured for fault tolerance and all other drives in the array are online, and a predictive failure alert is received or a drive capacity upgrade is in progress, you may replace the drive online.
On or flashing	Flashing	Off	**Do not remove the drive. Removing a drive may terminate the current operation and cause data loss.** The drive is rebuilding or undergoing capacity expansion.
On	Off	Off	**Do not remove the drive.** The drive is being accessed, but (1) it is not configured as part of an array; (2) it is a replacement drive and rebuild has not yet started; or (3) it is spinning up during the POST sequence.
Flashing	Flashing	Flashing	**Do not remove the drive. Removing a drive may cause data loss in non-fault-tolerant configurations.** Either (1) the drive is part of an array being selected by an array configuration utility; (2) Drive Identification has been selected in HP SIM; or (3) drive firmware is being updated.
Off	Off	On	The drive has failed and has been placed offline. You may replace the drive.
Off	Off	Off	Either (1) the drive is not configured as part of an array; (2) the drive is configured as part of an array, but it is a replacement drive that is not being accessed or being rebuilt yet; or (3) the drive is configured as an online spare. If the drive is connected to an array controller, you may replace the drive online.

Recognizing hard drive failure

A steadily glowing Fault LED indicates that that drive has failed. Other means by which hard drive failure is revealed are:

- The amber LED on the front of a storage system illuminates if failed drives are inside. (However, this LED also illuminates when other problems occur, such as when a fan fails, a redundant power supply fails, or the system overheats.)
- A POST message lists failed drives whenever the system is restarted, as long as the controller detects at least one functional drive.
- ACU represents failed drives with a distinctive icon.
- Systems Insight Manager can detect failed drives remotely across a network. (For more information about Systems Insight Manager, refer to the documentation on the Management CD.)
- ADU lists all failed drives.

For additional information about diagnosing hard drive problems, refer to the *HP Servers Troubleshooting Guide.*

CAUTION: Sometimes, a drive that has previously been failed by the controller may seem to be operational after the system is power-cycled or (for a hot-pluggable drive) after the drive has been removed and reinserted. However, continued use of such marginal drives may eventually result in data loss. Replace the marginal drive as soon as possible.

Effects of a hard drive failure

When a hard drive fails, all logical drives that are in the same array are affected. Each logical drive in an array may be using a different fault-tolerance method, so each logical drive can be affected differently.

- RAID 0 configurations cannot tolerate drive failure. If any physical drive in the array fails, all non-fault-tolerant (RAID 0) logical drives in the same array will also fail.

- RAID 1+0 configurations can tolerate multiple drive failures as long as no failed drives are mirrored to one another.
- RAID 5 configurations can tolerate one drive failure.
- RAID ADG configurations can tolerate simultaneous failure of two drives.

Compromised fault tolerance

If more hard drives fail than the fault-tolerance method allows, fault tolerance is compromised, and the logical drive fails. In this case, all requests from the operating system are rejected with unrecoverable errors. You are likely to lose data, although it can sometimes be recovered (refer to "Recovering from compromised fault tolerance" on page 42).

One example of a situation in which compromised fault tolerance may occur is when a drive in an array fails while another drive in the array is being rebuilt. If the array has no online spare, any logical drives in this array that are configured with RAID 5 fault tolerance will fail.

Compromised fault tolerance can also be caused by non-drive problems, such as a faulty cable or temporary power loss to a storage system. In such cases, you do not need to replace the physical drives. However, you may still have lost data, especially if the system was busy at the time that the problem occurred.

Recovering from compromised fault tolerance

If fault tolerance is compromised, inserting replacement drives does not improve the condition of the logical volume. Instead, if the screen displays unrecoverable error messages, perform the following procedure to recover data:

1. Power down the entire system, and then power it back up. In some cases, a marginal drive will work again for long enough to enable you to make copies of important files.

   If a 1779 POST message is displayed, press the **F2** key to re-enable the logical volumes. Remember that data loss has probably occurred and any data on the logical volume is suspect.
2. Make copies of important data, if possible.

3. Replace any failed drives.
4. After you have replaced the failed drives, fault tolerance may again be compromised. If so, cycle the power again. If the 1779 POST message is displayed:
   a. Press the **F2** key to re-enable the logical drives.
   b. Recreate the partitions.
   c. Restore all data from backup.

To minimize the risk of data loss that is caused by compromised fault tolerance, make frequent backups of all logical volumes.

Replacing hard drives

The most common reason for replacing a hard drive is that it has failed. However, another reason is to gradually increase the storage capacity of the entire system ("Upgrading hard drive capacity" on page 46).

If you insert a hot-pluggable drive into a drive bay while the system power is on, all disk activity in the array pauses while the new drive is spinning up. This spin-up process usually lasts for approximately 20 seconds. When the drive has achieved its normal spin rate, data recovery to the replacement drive begins automatically (as indicated by the blinking Online LED on the replacement drive) if the array is in a fault-tolerant configuration.

If you replace a drive belonging to a fault-tolerant configuration while the system power is off, a POST message is displayed when the system is next powered up. This message prompts you to press the **F1** key to start automatic data recovery. If you do not enable automatic data recovery, the logical volume remains in a ready-to-recover condition and the same POST message is displayed whenever the system is restarted.

Factors to consider before replacing hard drives

- In systems that use external data storage, be sure that the server is the first unit to be powered down and the last to be powered back up. Taking this precaution ensures that the system does not erroneously mark the drives as failed when the server is powered up.

- If you set the SCSI ID jumpers manually:
  - Check the ID value of the removed drive to be sure that it corresponds to the ID of the drive marked as failed.
  - Set the same ID value on the replacement drive to prevent SCSI ID conflicts.

Before replacing a degraded drive:

- Open Systems Insight Manager and inspect the Error Counter window for each physical drive in the same array to confirm that no other drives have any errors. (For details, refer to the Systems Insight Manager documentation on the Management CD.)
- Be sure that the array has a current, valid backup.
- Use replacement drives that have a capacity at least as great as that of the smallest drive in the array. The controller immediately fails drives that have insufficient capacity.

To minimize the likelihood of fatal system errors, take these precautions when removing failed drives:

- Do not remove a degraded drive if any other drive in the array is offline (the Online LED is off). In this situation, no other drive in the array can be removed without data loss.

  Exceptions:

  - When RAID 1+0 is used, drives are mirrored in pairs. Several drives can be in a failed condition simultaneously (and they can all be replaced simultaneously) without data loss, as long as no two failed drives belong to the same mirrored pair.
  - When RAID ADG is used, two drives can fail simultaneously (and be replaced simultaneously) without data loss.
  - If the offline drive is a spare, the degraded drive can be replaced.
- Do not remove a second drive from an array until the first failed or missing drive has been replaced **and** the rebuild process is complete. (The rebuild is complete when the Online LED on the front of the drive stops blinking.)

  These cases are the exceptions:

- In RAID ADG configurations, any two drives in the array can be replaced simultaneously.
- In RAID 1+0 configurations, any drives that are not mirrored to other removed or failed drives can be simultaneously replaced offline without data loss.

Automatic data recovery (rebuild)

When you replace a hard drive in an array, the controller uses the fault-tolerance information on the remaining drives in the array to reconstruct the missing data (the data that was originally on the replaced drive) and write it to the replacement drive. This process is called automatic data recovery, or rebuild. If fault tolerance is compromised, this data cannot be reconstructed and is likely to be permanently lost.

If another drive in the array fails while fault tolerance is unavailable during rebuild, a fatal system error may occur, and all data on the array is then lost. In exceptional cases, however, failure of another drive need not lead to a fatal system error. These exceptions include:

- Failure after activation of a spare drive
- Failure of a drive that is not mirrored to any other failed drives (in a RAID 1+0 configuration)
- Failure of a second drive in a RAID ADG configuration

Time required for a rebuild

The time required for a rebuild varies considerably, depending on several factors:

- The priority that the rebuild is given over normal I/O operations (you can change the priority setting by using ACU)
- The amount of I/O activity during the rebuild operation
- The rotational speed of the hard drives
- The availability of drive cache
- The brand, model, and age of the drives
- The amount of unused capacity on the drives

- The number of drives in the array (for RAID 5 and RAID ADG)

Allow approximately 15 minutes per gigabyte for the rebuild process to be completed. This figure is conservative, and newer drive models usually require less time to rebuild.

System performance is affected during the rebuild, and the system is unprotected against further drive failure until the rebuild has finished. Therefore, replace drives during periods of low activity when possible.



CAUTION: If the Online LED of the replacement drive stops blinking and the amber Fault LED glows, or if other drive LEDs in the array go out, the replacement drive has failed and is producing unrecoverable disk errors. Remove and replace the failed replacement drive.

When automatic data recovery has finished, the Online LED of the replacement drive stops blinking and begins to glow steadily.

Failure of another drive during rebuild

If a non-correctable read error occurs on another physical drive in the array during the rebuild process, the Online LED of the replacement drive stops blinking and the rebuild abnormally terminates.

If this situation occurs, reboot the server. The system may temporarily become operational long enough to allow recovery of unsaved data. In any case, locate the faulty drive, replace it, and restore data from backup.

Upgrading hard drive capacity

You can increase the storage capacity on a system even if there are no available drive bays by swapping drives one at a time for higher capacity drives. This method is viable as long as a fault-tolerance method is running.



CAUTION: Because it can take up to 15 minutes per gigabyte to rebuild the data in the new configuration, the system is unprotected against drive failure for many hours while a given drive is upgraded. Perform drive capacity upgrades only during periods of minimal system activity.

To upgrade hard drive capacity:

1. Back up all data.
2. Replace any drive. The data on the new drive is recreated from redundant information on the remaining drives.

   CAUTION: Do not replace any other drive until data rebuild on this drive is complete.
3. When data on the new drive has been rebuilt (the Activity LED turns off), repeat the previous step for the other drives in the array, one at a time.

When you have replaced all drives, you can use the extra capacity to either create new logical drives or extend existing logical drives. For more information about these procedures, refer to the *HP Array Configuration Utility User Guide*.

Moving drives and arrays

You can move drives to other ID positions on the same array controller. You can also move a complete array from one controller to another, even if the controllers are on different servers.

Before you move drives, the following conditions must be met:

- If moving the drives to a different server, the new server must have enough empty bays to accommodate all the drives simultaneously.
- The move will not result in more than 14 physical drives per controller channel.
- No controller will be configured with more than 32 logical volumes.
- The array has no failed or missing drives.
- The array is in its original configuration.

- The controller is not reading from or writing to any of the spare drives in the array.
- The controller is not running capacity expansion, capacity extension, or RAID or stripe size migration.
- The controller is using the latest firmware version (recommended).

If you want to move an array to another controller, you must also consider the following additional limitations:

- All drives in the array must be moved at the same time.
- In most cases, a moved array (and the logical drives that it contains) can still undergo array capacity expansion, logical drive capacity extension, or migration of RAID level or stripe size. An exception occurs when the array meets **all** of these conditions:
  - It was originally created on a SMART-2/P, SMART-2DH, SA-3200, SA-3100ES, SA-4200, SA-4250ES, or SA-530x controller.
  - It is moved to a controller that does not have a battery-backed cache.
  - It has less than 4 MB of unused capacity.
- If a controller contains a RAID ADG logical volume, none of the arrays on the controller can be moved **directly** to a controller that does not support RAID ADG. The arrays can be moved **indirectly**, as described by the instructions in this section.

When all the conditions have been met:

1. Back up all data before removing any drives or changing configuration. This step is **required** if you are moving data-containing drives from a controller that does not have a battery-backed cache.
2. Power down the system.
3. If you are moving an array from a controller that contains a RAID ADG logical volume to a controller that does not support RAID ADG:
   a. Remove or disconnect the drives that contain the RAID ADG logical volume.
   b. Reboot the server.

c. Open ACU and navigate to the controller that contained the RAID ADG volume.

   ACU displays the missing RAID ADG volume using a different icon to indicate that the volume is unavailable.

d. Delete the RAID ADG volume.

e. Accept the configuration change, and then close ACU.

f. Power down the system.

4. Move the drives.
5. Power up the system. If a 1724 POST message is displayed, drive positions were changed successfully and the configuration was updated.

   If a 1785 (Not Configured) POST message is displayed:

   a. Power down the system immediately to prevent data loss.

   b. Return the drives to their original locations.

   c. Restore the data from backup, if necessary.

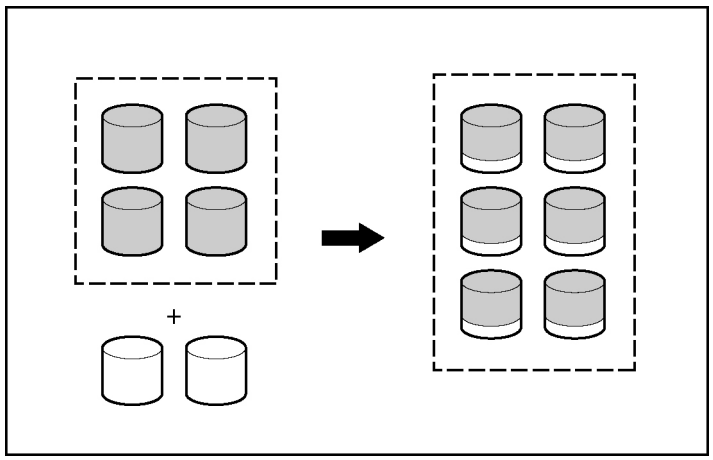
6. Check the new drive configuration by running ORCA or ACU ("Configuring an array" on page 25).

Adding drives

You can add hard drives to a system at any time, as long as you do not exceed the maximum number of drives that the controller supports. You can then either build a new array from the added drives or use the extra storage capacity to expand the capacity of an existing array.

To perform an array capacity expansion, use ACU. If the system is using hot-pluggable drives, you can expand array capacity without shutting down the operating system (that is, with the server online) if ACU is running in the same environment as the normal server applications. (For more information, refer to the *HP Array Configuration Utility User Guide*.)

The expansion process is illustrated in the following figure, in which the original array (containing data) is shown with a dashed border and the newly added drives (containing no data) are shown unshaded. The array controller adds the new drives to the array and redistributes the original logical drives over the enlarged array one logical drive at a time. This process liberates some storage capacity on each of the physical drives in the array. During this procedure, the logical drives each keep the same fault-tolerance method in the enlarged array that they had in the smaller array.



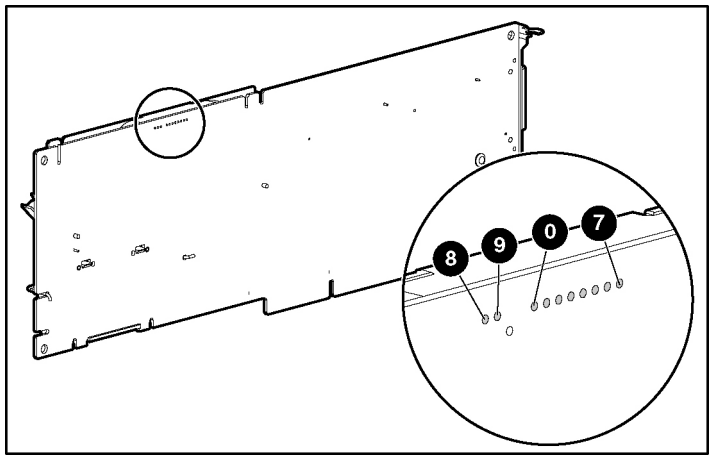
When the expansion process has finished, you can use the liberated storage capacity on the enlarged array to create new logical drives. Alternatively, you can enlarge one of the original logical drives. This latter process is called **logical drive capacity extension** and is also carried out using ACU.

Diagnosing array problems

In this section

Controller board runtime LEDs 51
Cache module LEDs 53
Diagnostic tools 54

Controller board runtime LEDs



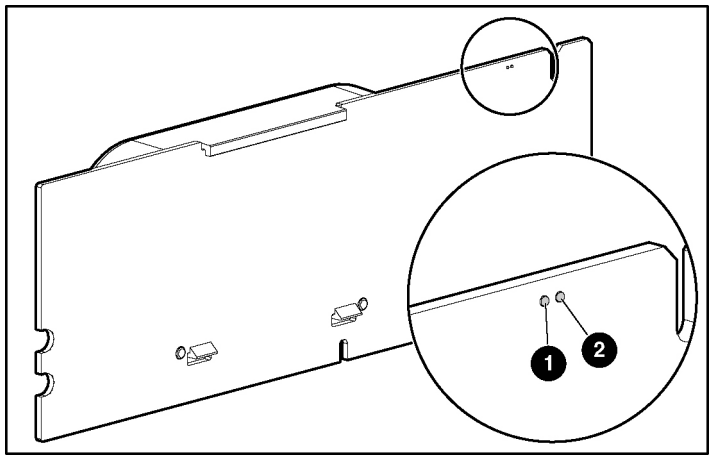
NOTE: During server power-up, each runtime LED illuminates randomly until POST has finished.

LED ID	Color	LED name and interpretation
0	Amber	CR100: Diagnostics Error LED.
1	Amber	CR101: Drive Failure LED. A physical drive connected to the controller has failed.
2	Blue	CR102: SCSI Bus Active LED. At least one of the SCSI buses on the controller is active.
3	Green	CR103: XOR Active LED. The controller is calculating parity data.

LED ID	Color	LED name and interpretation
4	Green	CR104: Command Outstanding LED. The controller is working on a command.
5	Blue	CR105: Heartbeat LED. This LED flashes every 2 seconds, unless the controller is malfunctioning.
6	Green	CR106: Gas Pedal LED. This LED, together with item 7, indicates the amount of controller CPU activity. For details, refer to the following table.
7	Green	CR107: Idle Task LED. This LED, together with item 6, indicates the amount of controller CPU activity. For details, refer to the following table.
8	Amber	CR11: Battery Status LED. For interpretation, refer to Cache module LEDs (on page 53).
9	Green	CR10: Battery Charging LED. For interpretation, refer to Cache module LEDs (on page 53).

Controller CPU activity level	Item 6 status	Item 7 status
0–25%	Off	Blinking
25–50%	Blinking	Off
50–75%	On steadily	Off
75–100%	On steadily	On steadily

Cache module LEDs



Item 1 (amber LED)	Item 2 (green LED)	Interpretation
--	Steady glow	The cache batteries are being charged.
--	Fast blink	The cache microcontroller is waiting for the host controller to communicate.
Steady glow	--	One of the following situations is occurring: • There is a short circuit across the battery terminals or within the battery pack. • The host controller is updating the cache microcontroller firmware.
Fast blink		There is an open circuit across the battery terminals or within the battery pack.
Slow blink (once every 16 seconds)		This display pattern might occur after the system is powered down. It indicates that the cache contains data that has not yet been written to the drives. Restore system power as soon as possible to prevent data loss. (The battery lifetime depends on the cache module size. For further information, refer to the controller QuickSpecs on the HP website (http://www.hp.com).)

Diagnostic tools

Several diagnostic tools provide feedback about problems with arrays. The most important are:

- **ADU**

  This utility is available on the SmartStart CD. The meanings of the various ADU error messages are provided in the *HP Servers Troubleshooting Guide.*

- **POST messages**

  Smart Array controllers produce diagnostic error messages at reboot. Many of these POST messages are self-explanatory and suggest corrective actions. For more information about POST messages, refer to the *HP Servers Troubleshooting Guide.*

- **Server Diagnostics**

  To use Server Diagnostics:

  a. Insert the SmartStart CD into the server CD-ROM drive.

  b. Click **Agree** when the license agreement is displayed, and select the **Maintenance** tab.

  c. Click **Server Diagnostics,** and follow the on-screen prompts and instructions.

Electrostatic discharge

In this section

Preventing electrostatic discharge 55
Grounding methods to prevent electrostatic discharge.....56

Preventing electrostatic discharge

To prevent damaging the system, be aware of the precautions you need to follow when setting up the system or handling parts. A discharge of static electricity from a finger or other conductor may damage system boards or other static-sensitive devices. This type of damage may reduce the life expectancy of the device.

To prevent electrostatic damage:

- Avoid hand contact by transporting and storing products in static-safe containers.
- Keep electrostatic-sensitive parts in their containers until they arrive at static-free workstations.
- Place parts on a grounded surface before removing them from their containers.
- Avoid touching pins, leads, or circuitry.
- Always be properly grounded when touching a static-sensitive component or assembly.

Grounding methods to prevent electrostatic discharge

Several methods are used for grounding. Use one or more of the following methods when handling or installing electrostatic-sensitive parts:

- Use a wrist strap connected by a ground cord to a grounded workstation or computer chassis. Wrist straps are flexible straps with a minimum of 1 megohm ±10 percent resistance in the ground cords. To provide proper ground, wear the strap snug against the skin.
- Use heel straps, toe straps, or boot straps at standing workstations. Wear the straps on both feet when standing on conductive floors or dissipating floor mats.
- Use conductive field service tools.
- Use a portable field service kit with a folding static-dissipating work mat.

If you do not have any of the suggested equipment for proper grounding, have an authorized reseller install the part.

For more information on static electricity or assistance with product installation, contact an authorized reseller.

Regulatory compliance notices

In this section

Federal Communications Commission notice 57
Canadian notice (Avis Canadien) 60
European Union regulatory notice 60
BSMI notice 61
Japanese notice 61
Korean notice A&B 62
Battery replacement notice 62

Federal Communications Commission notice

Part 15 of the Federal Communications Commission (FCC) Rules and Regulations has established Radio Frequency (RF) emission limits to provide an interference-free radio frequency spectrum. Many electronic devices, including computers, generate RF energy incidental to their intended function and are, therefore, covered by these rules. These rules place computers and related peripheral devices into two classes, A and B, depending upon their intended installation. Class A devices are those that may reasonably be expected to be installed in a business or commercial environment. Class B devices are those that may reasonably be expected to be installed in a residential environment (for example, personal computers). The FCC requires devices in both classes to bear a label indicating the interference potential of the device as well as additional operating instructions for the user.

FCC rating label

The FCC rating label on the device shows the classification (A or B) of the equipment. Class B devices have an FCC logo or ID on the label. Class A devices do not have an FCC logo or ID on the label. After you determine the class of the device, refer to the corresponding statement.

Class A equipment

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, 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 personal expense.

Class B equipment

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit that is different from that to which the receiver is connected.
- Consult the dealer or an experienced radio or television technician for help.

Declaration of conformity for products marked with the FCC logo, United States only

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

For questions regarding this product, contact us by mail or telephone:

- Hewlett-Packard Company
  P. O. Box 692000, Mail Stop 530113
  Houston, Texas 77269-2000
- 1-800-HP-INVENT (1-800-474-6836). (For continuous quality improvement, calls may be recorded or monitored.)

For questions regarding this FCC declaration, contact us by mail or telephone:

- Hewlett-Packard Company
  P. O. Box 692000, Mail Stop 510101
  Houston, Texas 77269-2000
- 1-281-514-3333

To identify this product, refer to the part, series, or model number found on the product.

Modifications

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Hewlett-Packard Company may void the user's authority to operate the equipment.

Cables

Connections to this device must be made with shielded cables with metallic RFI/EMI connector hoods in order to maintain compliance with FCC Rules and Regulations.

Canadian notice (Avis Canadien)

Class A equipment

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 sur le matériel brouilleur du Canada.

Class B equipment

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

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

European Union regulatory notice

CE

This product complies with the following EU Directives:

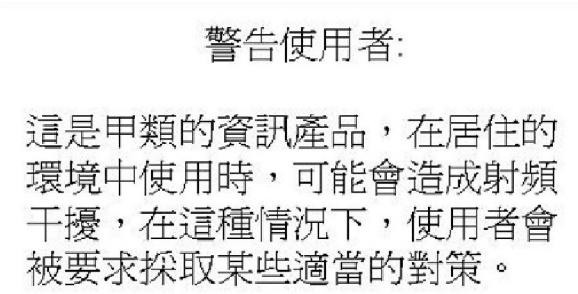
- Low Voltage Directive 73/23/EEC
- EMC Directive 89/336/EEC

CE(xxxx*)①

*For a notified body number refer to the product regulatory label.

Compliance with these directives implies conformity to harmonized European standards (European Norms) which are listed on the EU Declaration of Conformity issued by Hewlett-Packard for this product or product family.

BSMI notice



Japanese notice

ご使用になっている装置にVCCIマークが付いていましたら、次の説明文をお読み下さい。

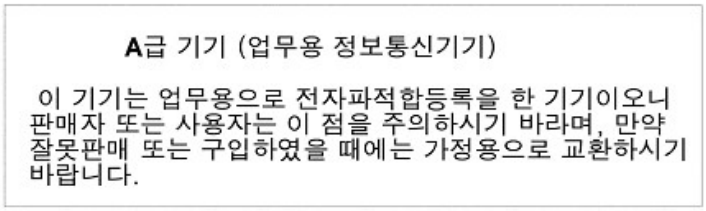
この装置は、情報処理装置等電波障害自主規制協議会（VCCI）の基準に基づくクラスB情報技術装置です。この装置は、家庭環境で使用することを目的としていますが、この装置がラジオやテレビジョン受信機に近接して使用されると、受信障害を引き起こすことがあります。
取扱説明書に従って正しい取り扱いをして下さい。

VCCIマークが付いていない場合には、次の点にご注意下さい。

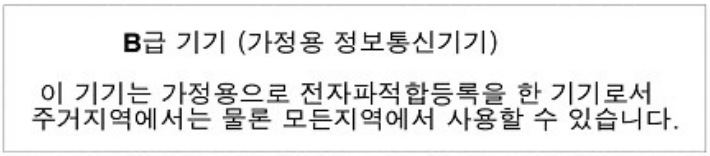
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Korean notice A&B

Class A equipment



Class B equipment



Battery replacement notice

This component uses a nickel metal hydride (NiMH) battery pack.

WARNING: There is a risk of explosion, fire, or personal injury if a battery pack is mishandled. To reduce this risk:

- **Do not attempt to recharge the batteries if they are disconnected from the controller.**
- **Do not expose the battery pack to water, or to temperatures higher than 60°C (140°F).**
- **Do not abuse, disassemble, crush, or puncture the battery pack.**
- **Do not short the external contacts.**
- **Replace the battery pack only with the designated HP spare.**

Battery disposal should comply with local regulations.



Batteries, battery packs, and accumulators should not be disposed of together with the general household waste. To forward them to recycling or proper disposal, use the public collection system or return them by established parts return methods to HP, an authorized HP Partner, or one of their agents.

For more information about battery replacement or proper disposal, contact an authorized reseller or an authorized service provider.

Taiwan battery recycling notice

The Taiwan EPA requires dry battery manufacturing or importing firms in accordance with Article 15 of the Waste Disposal Act to indicate the recovery marks on the batteries used in sales, giveaway or promotion. Contact a qualified Taiwanese recycler for proper battery disposal.



Acronyms and abbreviations

ACR

Array Configuration Replicator

ACU

Array Configuration Utility

ADG

Advanced Data Guarding (also known as RAID 6)

ADU

Array Diagnostics Utility

BBWC

battery-backed write cache

CPQONLIN

NetWare Online Array Configuration Utility

ORCA

Option ROM Configuration for Arrays

POST

Power-On Self-Test

RAID

redundant array of inexpensive (or independent) disks

RBSU

ROM-Based Setup Utility

SA

Smart Array

SIM

Systems Insight Manager

Index

A

ACU (Array Configuration Utility) 28
adding drives 30, 49
ADU (Array Diagnostic Utility) 54
array capacity expansion 49
array configuration, copying 25
array controller installation overview 11
array, configuring 25, 30
automatic data recovery (rebuild) 43, 45

B

batteries, replacing 35
battery replacement notice 62
board components 7
BSMI notice 61

C

cables 59
cache module LEDs 53
cache, features of 53
Canadian notice 60
compromised fault tolerance 42
configuring an array 25
controller board, features of 7
controller board, installing 15
controller installation, overview of 11
controller LEDs 51
CPQONLIN 28

D

data recovery 42, 45
data transfer rate 9
diagnostic tools 54
drive failure, detecting 41
drive LEDs 39, 40
drivers 33
drives, configuring 30

E

electrostatic discharge 55
error messages 41, 54
European Union notice 60
expanding an array 49
extending logical drive capacity 49

F

failure of hard drive 41, 46
fault tolerance, compromised 42
Federal Communications Commission (FCC) notice 57, 59
firmware, updating 21

G

grounding methods 56

H

hard drive LEDs 39, 40
hard drive, failure of 41
hard drive, replacing 43
hard drives, adding 49
hard drives, determining status of 39
hard drives, installing 17

J

Japanese notice 61

K

Korean notices 62

L

LEDs, cache module 53
LEDs, controller 51

LEDs, hard drive 39, 40
logical drive capacity extension 49
logical drive, creating 25

O

ORCA (Option ROM Configuration for Arrays) 27
overview of installation process 11

P

POST error messages 41, 54
power requirements 9

R

rebuild, time required for 45
regulatory compliance notices 57
replacing hard drives 39, 43
replacing the batteries 35
ROM, updating 21

S

Server Diagnostics utility 54
SmartStart Scripting Toolkit 25
specifications, controller 9
static electricity 55
status lights, cache module 53
status lights, controller 51
status lights, hard drive 39
storage devices, connecting 17
storage, external 18

T

Taiwan battery recycling notice 63
troubleshooting 54

U

updating the firmware 21
upgrading drive capacity 46

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