

HP Smart Array 5300 Controller User Guide



March 2003 (Sixth Edition)
Part Number 135606-006

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About This Guide

This guide provides step-by-step instructions for installation, and reference information for operation, troubleshooting, and future upgrades for the HP Smart Array 5300 Controller.

Audience Assumptions

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

Important Safety Information

Before installing this product, read the *Important Safety Information* document included with the server.

Symbols on Equipment

The following symbols may be placed on equipment to indicate the presence of potentially hazardous conditions:



WARNING: This symbol, in conjunction with any of the following symbols, indicates the presence of a potential hazard. The potential for injury exists if warnings are not observed. Consult your documentation for specific details.



This symbol indicates the presence of hazardous energy circuits or electric shock hazards. Refer all servicing to qualified personnel.

WARNING: To reduce the risk of injury from electric shock hazards, do not open this enclosure. Refer all maintenance, upgrades, and servicing to qualified personnel.



This symbol indicates the presence of electric shock hazards. The area contains no user or field serviceable parts. Do not open for any reason.

WARNING: To reduce the risk of injury from electric shock hazards, do not open this enclosure



This symbol on an RJ-45 receptacle indicates a network interface connection.

WARNING: To reduce the risk of electric shock, fire, or damage to the equipment, do not plug telephone or telecommunications connectors into this receptacle.



This symbol indicates the presence of a hot surface or hot component. If this surface is contacted, the potential for injury exists.

WARNING: To reduce the risk of injury from a hot component, allow the surface to cool before touching.



These symbols, on power supplies or systems, indicate that the equipment is supplied by multiple sources of power.

WARNING: To reduce the risk of injury from electric shock, remove all power cords to completely disconnect power from the system.



Weight in kg
Weight in lb

This symbol indicates that the component exceeds the recommended weight for one individual to handle safely.

WARNING: To reduce the risk of personal injury or damage to the equipment, observe local occupational health and safety requirements and guidelines for manual material handling.

Rack Stability



WARNING: To reduce the risk of personal injury or damage to the equipment, be sure that:

- The leveling jacks are extended to the floor.
 - The full weight of the rack rests on the leveling jacks.
 - The stabilizing feet are attached to the rack if it is a single-rack installation.
 - The racks are coupled together in multiple-rack installations.
 - Only one component is extended at a time. A rack may become unstable if more than one component is extended for any reason.
-

Symbols in Text

These symbols may be found in the text of this guide. They have the following meanings.



WARNING: Text set off in this manner indicates that failure to follow directions in the warning could result in bodily harm or loss of life.



CAUTION: Text set off in this manner indicates that failure to follow directions could result in damage to equipment or loss of information.

IMPORTANT: Text set off in this manner presents essential information to explain a concept or complete a task.

NOTE: Text set off in this manner presents additional information to emphasize or supplement important points of the main text.

Related Documents

For additional information on the topics covered in this guide, refer to the following documentation:

- *HP Array Configuration Utility 6.0 User Guide* (on the software CD provided with the server, or downloadable from the HP website)
- *HP Servers Troubleshooting Guide* (on the Documentation CD for the server)
- *HP ROM-Based Setup Utility User Guide* (on the Documentation CD for the server, or downloadable from the HP website)

Getting Help

If you have a problem and have exhausted the information in this guide, you can get further information and other help in the following locations.

Technical Support

In North America, call the HP Technical Support Phone Center at 1-800-652-6672. This service is available 24 hours a day, 7 days a week. For continuous quality improvement, calls may be recorded or monitored. Outside North America, call the nearest HP Technical Support Phone Center. Telephone numbers for worldwide Technical Support Centers are listed on the HP website, www.hp.com.

Be sure to have the following information available before you call HP:

- Technical support registration number (if applicable)
- Product serial number
- Product model name and number
- Applicable error messages
- Add-on boards or hardware
- Third-party hardware or software
- Operating system type and revision level

HP Website

The HP website has information on this product as well as the latest drivers and flash ROM images. You can access the HP website at www.hp.com.

Authorized Reseller

For the name of your nearest authorized reseller:

- In the United States, call 1-800-345-1518.
- In Canada, call 1-800-263-5868.
- Elsewhere, see the HP website for locations and telephone numbers.

Reader's Comments

HP welcomes your comments on this guide. Please send your comments and suggestions by e-mail to ServerDocumentation@hp.com.

Board Components and Features

The HP Smart Array 5300 Series of controllers comprises two models, the 5302 and the 5304. Model 5302 has two Wide Ultra3 SCSI channels and 128 MB of cache; model 5304 has four Wide Ultra3 SCSI channels and 256 MB of cache. You can upgrade the 5302 model to have four channels, 256 MB of cache, or both, by means of the appropriate option kits.

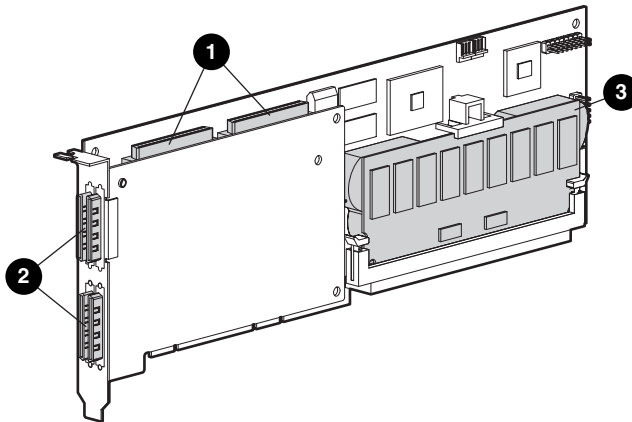


Figure 1-1: Smart Array 5304 Controller

Item	Description
1	Two internal 68-pin Wide SCSI connectors (port 1 nearer the bracket, port 2 nearer the board center)
2	Four external (VHDCI) connectors (ports 1 and 3 nearer the main board)
3	Array accelerator cache

NOTE: On both controller models, ports 1 and 2 each have two connectors (one internal and one external). However, only one connector can be used per port at any given time. Ports 3 and 4 (available on the 5304) can be used only for external drives.

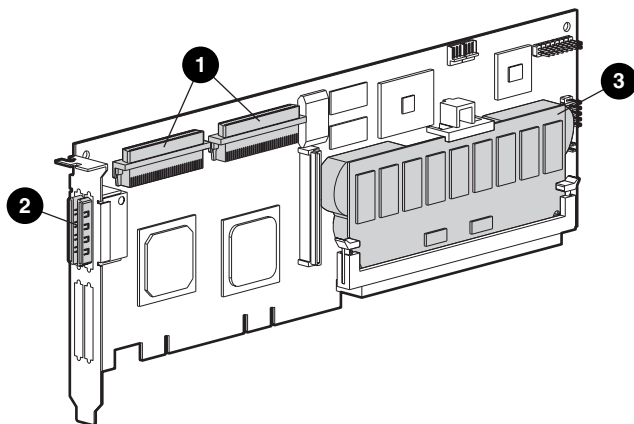


Figure 1-2: Smart Array 5302 Controller

Item	Description
1	Two internal 68-pin Wide SCSI connectors (port 1 nearer the bracket, port 2 nearer the board center)
2	Two external (VHDCI) connectors (port 1 nearer the board)
3	Array accelerator cache

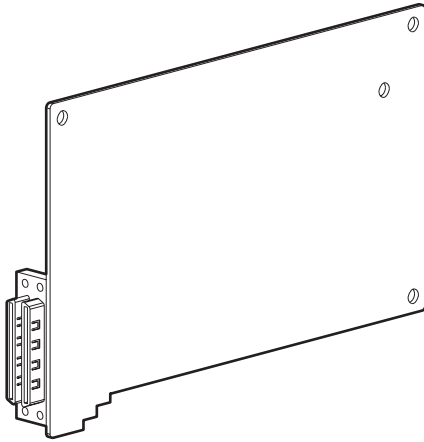


Figure 1-3: Two- to four-channel adapter upgrade option

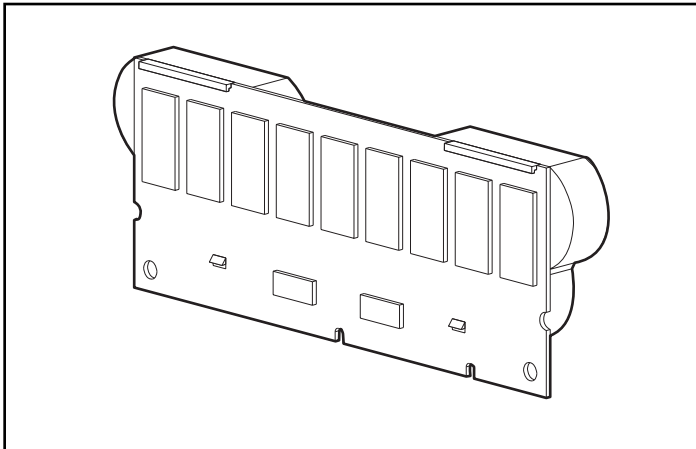


Figure 1-4: Array accelerator cache with batteries

For details of the controller board specifications, refer to Appendix C, “Controller Specifications.”

Overview of Controller Features

- Two or four Wide Ultra3 SCSI channels, supporting up to 56 drives (4 channels, 14 drives per channel)
- Support for HP ProLiant and Intel® Itanium™ Processor Family (IPF) Servers
- Support for Microsoft® Windows® 2000, Windows NT 4.0, Linux, Novell NetWare 5.x, and NetWare 6 operating systems
- Support for the Universal Hot Plug Tape Drive, with storage capacity up to 100 GB and LVD transfer rates up to 12 MB per second
- Support for the StorageWorks SAN Access Module
- Backward compatibility with Wide Ultra2 devices
- Removable array accelerator
- 64-bit, 66-MHz PCI system interface
- Other features supported:
 - RAID fault-tolerance (0, 1+0, 5, ADG). Refer to Chapter 8, “Upgrading and Replacing Options,” for instructions on enabling RAID ADG.
 - Online RAID migration between any two levels
 - Online array capacity expansion
 - Online logical drive capacity extension
 - Hot-pluggable hard drives and tape drives
 - Drive movement
 - Adjustable stripe size
 - Performance monitoring through Insight Manager
 - S.M.A.R.T. hard drives
 - Drive pre-failure notification
 - Multiple online spares per array
 - Tagged command queuing
 - Background initialization

- Multiple logical drives per array

Overview of Array Accelerator Features

The array accelerator is a high performance, battery-backed, 100-MHz SDRAM DIMM cache module.

Array controllers use cache to store read data from the hard drives. The system can later access this read data. The controller firmware uses the read-ahead and most recently used caching algorithms.

Array controllers also use cache to complete drive write operations more quickly. This use of the cache has further performance benefits:

- If the system requires data that still resides in write cache, the controller delivers this data from the cache. This process is quicker than delivering the data from a drive.
- If the system writes new data to the same location, the controller overwrites the cache contents. This eliminates a drive write operation.
- If the system performs a RAID 1 procedure, the controller gets mirrored data from the cache instead of from host memory.
- If the system performs a RAID 5 procedure, the write cache collects enough data blocks from several write accesses to carry out a full stripe write to the hard drives. This operation eliminates the need to calculate and update parity information each time that a data block is written to the drive.

With a battery-backed cache available, the array controller can complete the following operations more rapidly:

- **Array capacity expansion**—the expansion of a logical drive volume to include more hard drives
- **Stripe size migration**—the adjustment of the size of data blocks within a stripe, done to improve performance
- **RAID level migration**—the adjustment of RAID level to improve the fault tolerance of the array

For each of these operations, data has to be reorganized among hard drives, and must be saved to non-volatile storage during the operation. (For further details of these operations, refer to Chapter 6, Appendix D, and Appendix E.) Without battery-backed cache, the data can only be stored at empty locations within the drive array, so these operations cannot occur at all if the array is full.

If the array controller or server fails before cached data can be stored on the array, the array accelerator and its integrated batteries may be removed from one array controller and installed on another controller of the same type. Any data in the array accelerator that has not been written to the hard drive will be transferred to the other array controller.

Other features of the array accelerator include:

- Cache capacity of 96-MB or 224-MB (32 MB of the cache is used for transfer buffer)
- Adjustable read/write ratio (usually set during array configuration as described in Chapter 6, “Configuring an Array,” but can be changed at any time)
- Error checking and correcting (ECC) memory, providing single-bit data correction

Sometimes, the Automatic Performance Tuning feature disables the array accelerator. You can also disable the array accelerator manually through the Array Configuration Utility (refer to Chapter 6, “Configuring an Array,” for details).

Batteries

The array accelerator cache has two rechargeable and replaceable NiMH battery packs. If the array accelerator is removed from the array controller, the battery packs maintain any cached data on the array accelerator for up to four continuous days.

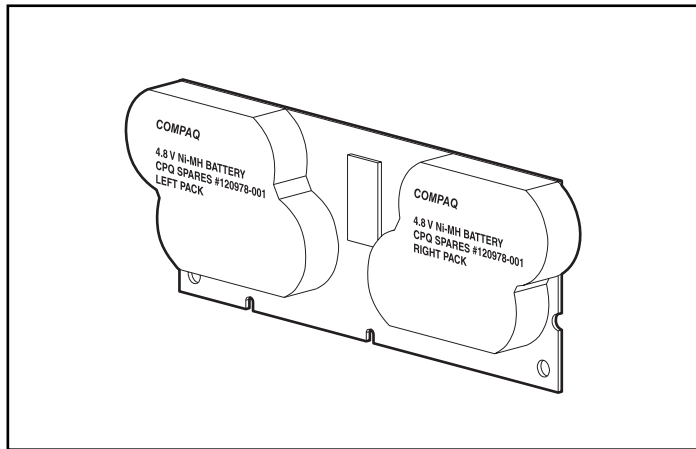


Figure 1-5: Battery packs

This data protection (and the time limit) also applies if an equipment failure or power outage occurs. When power is restored to the system, an initialization process writes the preserved data to the hard drives.

The batteries are continuously recharged using a trickle-charging process whenever the system power is on. Under normal operating conditions, a battery pack lasts for three years before replacement is necessary.

IMPORTANT: The batteries on a new array controller may have a low charge when the controller board is first installed. In this case, a Power-On Self-Test (POST) message is displayed when the server is powered up, indicating that the array accelerator is temporarily disabled. No action is required on your part, since the internal circuitry automatically recharges the batteries and enables the cache. The recharge process takes less than four hours. The array controller will function properly during this time, although without the performance advantage of the array accelerator. When the batteries are charged to an acceptable capacity, the array accelerator is automatically enabled.

For battery replacement instructions, refer to Chapter 8, “Upgrading and Replacing Options.”

PCI System Interface

Smart Array 5300 controllers interface to the server through a high-performance 64-bit PCI bus that:

- Runs at 66 MHz
- Provides a high-speed path (up to 528 MB/s) between the system board and the controller
- Includes two parity protection signals

The Smart Array 5300 Controller is a PCI Bus Master device conforming to Rev. 2.2 of the PCI Local Bus Specification. As a bus master device, it takes control of the PCI bus during high-speed transfers, freeing the system processor to handle application processing or other types of tasks.

For maximum performance, HP recommends that you use only 66-MHz devices on any given 66-MHz PCI bus. Combining 66-MHz and 33-MHz devices on a PCI bus will decrease the overall bandwidth to 33-MHz speeds.

SCSI Support

The Smart Array 5300 Controller supports drives that conform to Wide Ultra3 and Wide Ultra2 standards. Although Wide Ultra2 devices operate at a different maximum speed from Wide Ultra3 devices, operating speeds are unaffected if they are connected to the same SCSI bus because they both use low voltage differential (LVD) signaling.

Fault Management Features

The array controller and the network operating system support several fault management and data reliability features that minimize the impact of hard drive defects on your system.

- **Auto-Reliability Monitoring (ARM)** is a background process that scans hard drives for bad sectors in fault-tolerant logical drives. ARM also verifies the consistency of parity data in logical drives that are using RAID 5 or RAID ADG. This process assures that you can recover all data successfully if a drive failure occurs in the future. ARM operates only when you select a fault-tolerant configuration (RAID 1 or higher).
- **Dynamic sector repair** by the controller automatically remaps any sectors that have media faults (detected either during normal operation or by auto reliability monitoring).
- **S.M.A.R.T.** is an industry-standard diagnostic and failure-prediction feature of hard drives, developed in collaboration with the hard drive industry. It monitors several factors that can be used to predict imminent hard drive failure due to mechanical causes. Such factors include the condition of the read/write head, the seek error rate, and the spin-up time. When a threshold value is exceeded for one of these factors, the drive sends an alert that failure is imminent. Thus, the user can back up data and replace the drive before drive failure occurs.

NOTE: An online spare does not become active and start rebuilding when the imminent failure alert is sent, because the degraded drive has not actually failed yet and is still online. The online spare is activated only after a drive in the array has failed.

- **Drive failure alert features** cause an alert message to be displayed on the system monitor when drive failure occurs. Different server models use different messages for different situations. These messages are described in your server documentation.
- **Interim data recovery** occurs if a drive fails in fault-tolerant configurations (RAID 1 or higher). In this situation, the system will still process I/O requests, but at a reduced performance level. Replace the failed drive as soon as possible to restore performance and full fault tolerance for that logical drive. For example, in a RAID 5 configuration, if another hard drive fails before data has been rebuilt, the logical volume will fail and data will be lost. For more information about recovering from drive failure, refer to Appendix E, “Hard Drive Installation and Replacement.”
- **POST** or the **Array Diagnostics Utility** will also reveal imminent drive failure.

- **Recovery ROM** is a redundancy feature that ensures continuous system availability by providing a backup ROM. This feature protects against corruption of a ROM image (caused, for example, by power fluctuation during ROM upgrade). If corruption occurs, the server automatically restarts using the remaining good copy of the ROM image.

When you upgrade the ROM, the inactive image (the one not being used by the system) is upgraded. There is not normally any noticeable difference in operation. When you use Recovery ROM for the first time, however, both ROM images are upgraded, causing a boot delay of about 60 seconds.

Other options, such as Insight Manager, provide additional drive failure features. Refer to your authorized reseller for more information about these products.

Installation Overview

The details of the steps required to install the controller depend on the server model and whether the server is a new or existing one. The following flowcharts summarize the installation procedures for the most common scenarios.

Procedure for a New, Autoconfigurable System

Some new HP ProLiant server models self-configure when they are powered up for the first time. During the autoconfiguration process, the system language is set to English by default, and Microsoft Windows 2000 is selected as the default operating system. (However, you must still **install** the operating system. This is done later in the overall controller installation procedure.) If you want to use a different system language or operating system, you can press the **F9** key at any time. This action opens RBSU, which allows you to manually configure the server.

Also, if the server has fewer than seven physical drives installed, ORCA automatically configures the drives into an array, builds a logical drive, and sets a RAID level suitable for the number of drives.

To determine if your server is autoconfigurable, refer to the server-specific setup and installation guide.

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

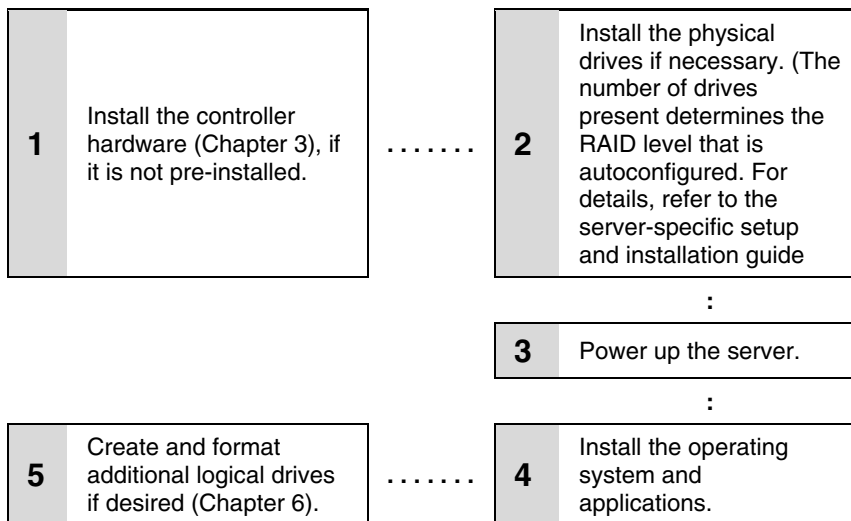


Figure 2-1: Controller installation in a new, autoconfigurable system

Procedure for a New, Non-autoconfigurable System

ProLiant Servers

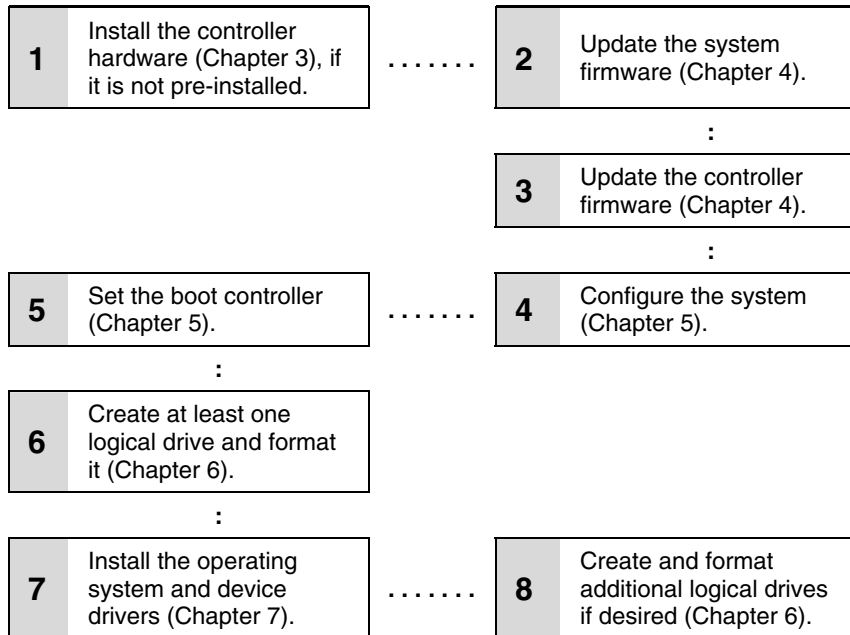


Figure 2-2: Controller installation in a new, non-autoconfigurable system

Intel IPF Servers

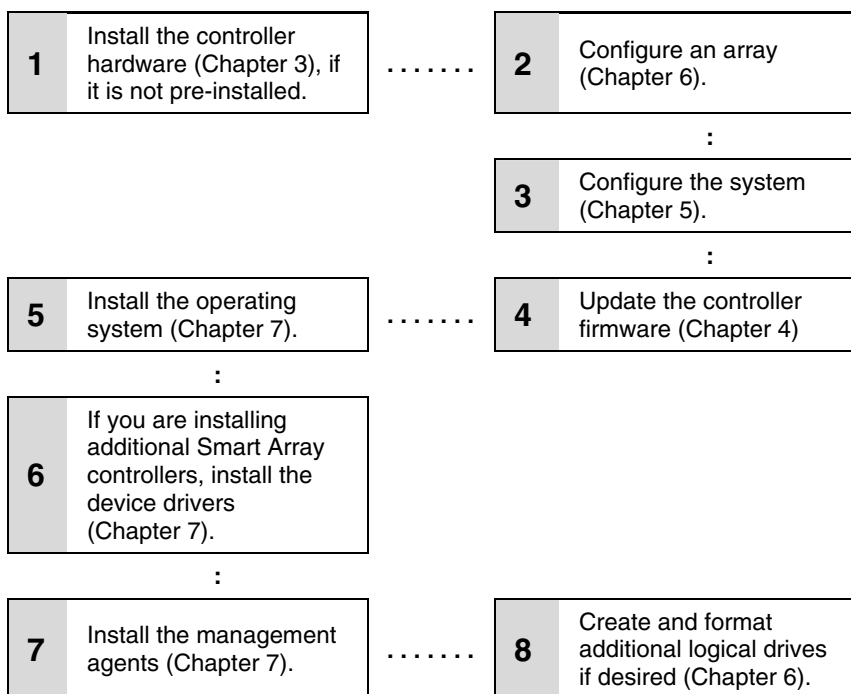


Figure 2-3: Controller installation in a new, non-autoconfigurable system

Procedure for a Preconfigured System

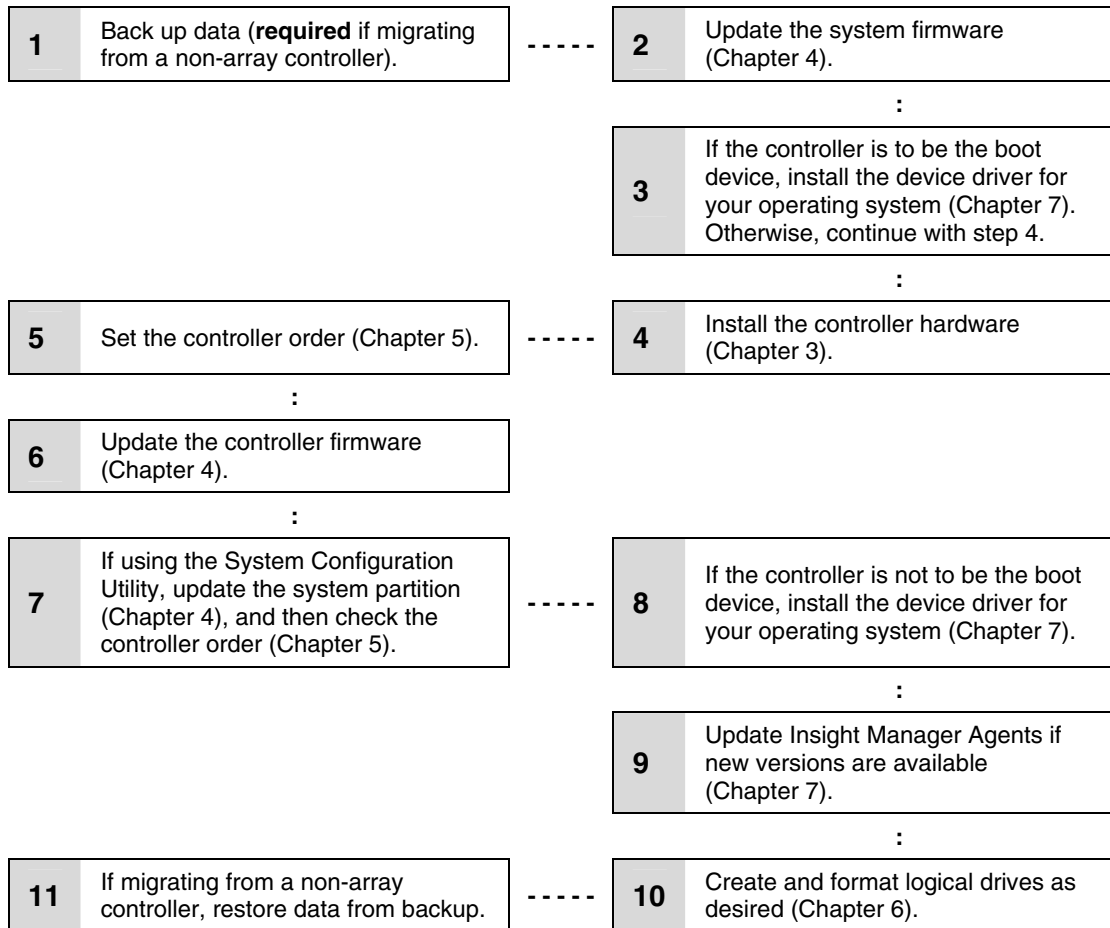


Figure 2-4: Controller installation in a preconfigured system

Installing the Hardware

Preparing the Server

Before installing the controller in the server, back up all data. This step is **mandatory** 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.



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

Many computers are capable of producing energy levels that are considered hazardous. These computers are intended to be serviced by qualified personnel trained to deal with those hazards. Do not remove enclosures or attempt to bypass any interlocks that may be provided for the purpose of removing these hazardous conditions.

If your server supports hot-pluggable devices, go directly to the section, “Installing the Smart Array Controller.”

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

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



CAUTION: In systems using external data storage, be sure that the server is the first unit powered down and the last unit to be powered back up. Doing this ensures that the system will not erroneously mark the drives as “failed.”

3. Power down any peripheral devices that are attached to the server.

4. Unplug the AC power cord from the outlet, and then from the server.

IMPORTANT: If you will be replacing an existing Smart Array controller with a Smart Array 5300 controller, see the “External Cabling for HP Servers” section to determine the external cabling requirements.

5. Disconnect any peripheral devices from the server.



WARNING: To reduce the risk of personal injury from hot surfaces, allow the internal system components and hot-plug hard drives to cool before touching them.



CAUTION: Electrostatic discharge (ESD) can damage electronic components. Be sure that you are properly grounded before continuing the installation procedure. Refer to Appendix B, “Electrostatic Discharge,” for ESD information.

Installing the Smart Array Controller

1. Remove or open the access panel.
2. Select an available 66-MHz PCI slot. Slots that use a 64-bit interface may provide higher performance.

NOTE: In IPF servers, the ID number of the slot in which you insert the controller determines the boot controller order. Follow the recommendations in the server-specific documentation to obtain the required controller order.

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.

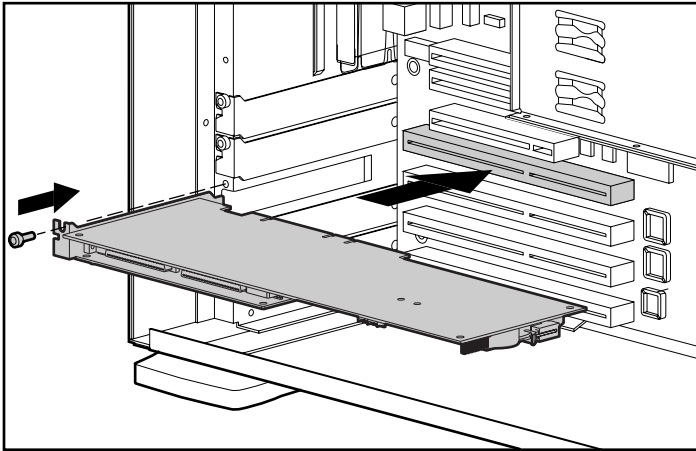


Figure 3-1: Installing a Smart Array 5300 Controller

NOTE: Your server may look slightly different from the one illustrated.

5. Press the controller board firmly into the slot so that the contacts on the board edge are properly seated in the system board connector.
6. Secure the board in place with the hot-plug latch or retaining screw.
7. Continue by following the instructions given in “Connecting the Cables.”

Connecting the Cables

Each port on the controller supports up to 14 drives. Ports 1 and 2 each have two SCSI connectors, one for external storage units and one for internal hard drives in the server. The two connectors for a given port cannot be used simultaneously. Ports 3 and 4 (present on the 5304 model, and also on the 5302 model with an attached 2- to 4-channel adapter) are only for external storage units.

Peripherals attached to any of the connectors must have a unique SCSI ID value in the range of 0 to 15 (except ID 7, which is reserved for controller use). The SCSI ID value determines the priority given to the device when it attempts to use the SCSI bus.

On HP and Compaq-branded products that support hot-pluggable drives, the SCSI IDs for peripherals are automatically set. For non-hot-pluggable devices, the IDs must be set manually by using switches or jumpers on the device itself.

IMPORTANT: When replacing an existing Smart Array controller with a Smart Array 5300 controller without reconfiguring the arrays, all of the drives should be connected exactly as they were on the old controller (port 1 to port 1, controller 1 to controller 1, and so on).

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

Internal Cabling for HP Servers

1. If the device is not hot pluggable, power down the system.
2. Install drives in the removable media bays on the server. Drives that are to be grouped in the same array should have the same capacity.

For detailed drive installation instructions, consult the documentation that accompanied your drives.

The exact procedure from this point depends upon whether the device is hot pluggable.

- 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 your server) from an internal port of the controller to the hot-plug drive cage.

For duplex drive cage options, use both internal ports.

The hot-pluggable drives are now ready to use.

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 the multi-device SCSI cable from the internal port 1 or port 2 of the Smart Array controller to the non-hot-pluggable hard drives.
6. Replace the access panel and secure it with the thumbscrews, as required.



CAUTION: Do not operate the server with the access panel removed for extended periods of time. This precaution protects thermally sensitive components by ensuring the proper airflow through the server and minimizes personal contact with hazardous energy levels.

For additional information about drive installation, see Appendix E, “Hard Drive Installation and Replacement.”

External Cabling for HP Servers

All HP and Compaq-branded Storage Enclosure models include external SCSI cables. Check the connector type on your storage device to identify the cable type needed. See Figure 3-2 and Table 3-1 for details.

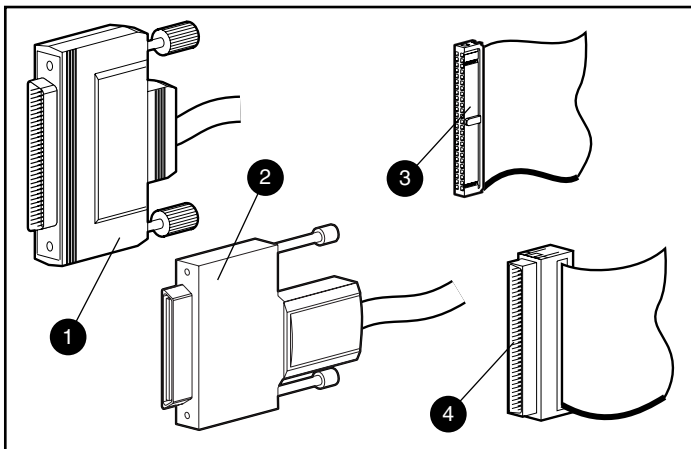


Figure 3-2: Identifying SCSI cable connectors

Item	Description
1	External 68-pin Wide
2	External offset VHDCI
3	Internal 50-pin narrow
4	Internal 68-pin Wide

Up to four SCSI ports may be available for connection to external storage devices depending on whether the 2- to 4-channel adapter is attached and whether internal drives are connected to the array controller.

7. On the rear of the server, connect the cable to the VHDCI connector on the Smart Array controller, and then tighten the lock screws on the cable connector.

IMPORTANT: Offset VHDCI cables **must** be used with the Smart Array 5300 controller. Early versions of the VHDCI cables do not accommodate side-by-side connection of the cables to the Smart Array 5300 controller. If your storage enclosure did not include the Offset VHDCI cables, you may need to order these. See Table 4-1 for part numbers.

NOTE: Do not use a port externally if it is already being used internally.

8. Attach the other end of the cable to the storage enclosure, and then tighten the lock screws on the cable connector.

SCSI Cable Part Numbers

Table 3-1: Internal and External SCSI Cable Part Numbers

Cable type*	Length	Option kit number	Cable assembly number
External cables			
VHDCI to VHDCI (all server models)	1.8 m/6 ft	341174-B21	313374-001
	3.6 m/12 ft	341175-B21	313374-002
	7.2 m/24 ft	164604-B21	313374-004
	11.7 m/39 ft	150214-B21	313374-005
VHDCI to Wide (ProLiant servers)	1.8 m/6 ft	341176-B21	313375-001
	3.6 m/12 ft	341177-B21	313375-002
Internal cables			
ProLiant, multi-device	--	166389-B21	148785-001
IPF (rx5670)		A9828A	--
• Single port	18 cm	--	A9828-63001
• Dual port	20 cm	--	A9828-63002
IPF (rx2600)		A9827A	--
• Single port	49 cm	--	A7231-63024
• Dual port	58 cm	--	A7231-63025
*If additional cables are required, order by the option kit number.			

Updating the Firmware

To update the firmware, you can use the Smart Components that are available on the HP website (<http://www.hp.com/support>).

1. Locate the Smart Component for the operating system and controller that the server is using.
2. Follow the instructions for installing the component on the server. These instructions are given on the same Web page as the components.
3. Follow the additional instructions that describe how to use the component to flash the ROM. These instructions are provided with the component itself.

An alternative method for updating the firmware on ProLiant servers is to use the software CD that is supplied in the controller kit. However, the Smart Components may contain more recent firmware upgrade files than those given on the CD. Before using the CD, check the Smart Components on the website to see whether newer versions of the firmware upgrade files are available.

ProLiant Servers

IMPORTANT: If you are updating the firmware on a system that was configured using SCU, you must update the system partition (refer to “Using SCU” in Chapter 5, “Configuring the Server”) immediately after you have finished updating the firmware.

Using the SmartStart CD

1. Insert the CD into the CD-ROM drive of the server.
If you want to update the firmware with the server offline, restart the server and wait for controller initialization to finish.
2. Select the language and keyboard that you want to use.
The license agreement (EULA) screen is displayed.
3. Click **Agree**.
The **MyProLiant Server** screen is displayed.
4. Click the **Maintenance** tab.
5. Click **ROM Update Utility**.
6. Select **Express** or **Custom** mode, and follow the on-screen prompts and instructions to update the firmware on the system and the controller.
7. If you want to use Smart Components to apply the most current updates, refer to the “Using the Smart Components with a CD” section in this chapter.
8. Restart the server for the updates to take effect.

Using the Support Software CD

1. Insert the CD into the CD-ROM drive of the server.
If you want to update the firmware with the server offline, restart the server and wait for controller initialization to finish.
The license agreement (EULA) screen is displayed.
2. Click **Agree**.
The **Home** screen is displayed.
3. Click **ROM Update Utility**.
4. Select **Express** or **Custom** mode, and follow the on-screen prompts and instructions to update the firmware on the system and the controller.

5. If you want to use Smart Components to apply the most current updates, refer to the “Using the Smart Components with a CD” section in this chapter.
6. Restart the server for the updates to take effect.

Using the Smart Components with a CD

1. Return to the **ROM Update Utility** screen and click the **Supplemental Disk** tab.
The URL from which you can download the Smart Components is provided at the top of the screen.
2. Visit the Smart Components Web page.
 - a. Locate the most recent Smart Component for the controller that the server is using.
 - b. Download the component to diskette as described on the Web page.
 - c. If the component was downloaded using a different computer, insert the diskette into the diskette drive of that server.
3. Click the **Use Disk** button.
The firmware update is copied (but not yet installed) to your drive, and the Smart Component ID number is given on the **Supplemental Disk** screen.
4. Click the **Updates** tab. If an update is necessary, the new firmware needed is listed here.
5. Click the **Update Now** button.
6. When the update is complete, click the **Results** tab to view a summary of the flashed firmware.
7. To update firmware for more components:
 - a. Return to the **Supplemental Disk** screen.
 - b. Click the **Rescan** button to refresh the screen view.
 - c. Repeat steps 2 through 5.
8. Restart the server for the updates to take effect.

IPF Servers

If the IPF server uses a supported Microsoft Windows operating system, an alternative method to the Smart Components for updating the firmware is to use the DVD from the controller kit, as follows:

1. On the main menu of the EFI-based configuration utility on the DVD, select **Maintain Firmware**.
2. Select the firmware that you want to update.
3. Follow the on-screen prompts and instructions to complete the firmware updates.
4. Reboot the server for the firmware updates to take effect.

For more information about IPF servers, for technical support, or for updated firmware, drivers, and utilities, refer to the HP website (<http://www.hp.com/support/itaniumservers>).

Configuring the Server

ProLiant Servers

After installing the controller hardware and updating the firmware, configure the server by using either RBSU or SCU. (A brief description of the procedure is given in this section. For more information, refer to the *HP ROM-Based Setup Utility User Guide* or the server setup and installation guide.)

Using RBSU

RBSU is a system configuration utility that is embedded in the system ROM. It is customized for the server on which it is installed.



CAUTION: Not all servers support RBSU. Do not flash an RBSU-ROM image onto a server that is already configured with SCU unless the update instructions specifically state that upgrading from SCU to RBSU is supported. If the upgrade is not supported, the consequences of upgrading are unpredictable, and you may lose data.

To use RBSU:

1. Power up the server.
2. Press the **F9** key when prompted during system startup.
The main RBSU screen is displayed.
3. Configure the system. (For more information, refer to the *ROM-Based Setup Utility User Guide*.)

4. Select **Boot Controller Order** on the main RBSU screen and follow the on-screen prompts to set the boot controller.
5. When you have finished using RBSU, press the **Esc** key, and then press the **F10** key to confirm that you want to exit.

The server reboots with the new configuration.

Using SCU

If you updated the firmware in a used system that was not configured using RBSU, you must use the System Configuration Utility (SCU) to update the system partition.

1. Locate the page on the HP website (<http://www.hp.com/support>) that contains SCU, and then follow the on-screen instructions to create four SCU diskettes.
2. Insert SCU diskette #1 into the server diskette drive.
3. Restart the system.
4. Select **System Configuration Utility** from the menu or list of icons that is displayed.
5. Follow the on-screen instructions to update or create and populate a system partition.
6. Exit from SCU. If the server does not reboot or a CD error message is displayed, press the **Ctrl+Alt+Del** keys to reboot the server manually.

When you have finished using SCU to configure the system, use ORCA immediately afterward to confirm that the controller order is unchanged, as follows:

1. Reboot the server. The POST sequence begins, and an ORCA prompt message is briefly displayed.
2. Press the **F8** key to start ORCA.

NOTE: The ORCA prompt is displayed for only a few seconds. If you do not press the **F8** key during this time, you must restart the server to obtain the prompt again.

3. On the **Main Menu** screen, select **Select as Boot Controller**.
4. Follow the remaining prompts to set the currently selected controller as the boot controller for the system.

If you want to use ORCA to create logical drives, you do not need to exit the utility at this point. Continue as described in Chapter 6, “Configuring an Array.”

IPF Servers

When you have finished configuring an array, you can create partitions on the system. For IPF servers that use a supported Microsoft Windows operating system, you can use the DVD that is supplied in the controller kit.

1. Insert the DVD into the DVD-ROM drive.
2. Follow the on-screen prompts and instructions to create an EFI system partition.
3. When creation of the system partition is complete, follow the on-screen prompts and instructions to create an HP service partition.

When creation of the HP service partition is complete, you are ready to install the operating system. Refer to Chapter 7, “Installing the Device Drivers.”

Configuring an Array

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

- Array Configuration Utility (ACU)—A versatile, browser-based utility that provides maximum control over configuration parameters
- Option ROM Configuration for Arrays (ORCA)—A simple ROM-based configuration utility that runs on all operating systems

Whichever utility you use, the following limitations apply:

- For the most efficient use of drive space, do not mix drives of different capacity 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 details, refer to Appendix F, “Probability of Logical Drive Failure”).

For conceptual information about arrays, logical drives, and fault tolerance methods, refer to Appendix D, “Drive Arrays and Fault Tolerance.”

NOTE: To copy a particular array configuration to several other servers on the same network, use the Array Configuration Replicator (ACR) utility 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>).

Table 6-1: Comparison of Utilities for Configuring an Array

Feature	ACU*	ORCA*
Uses a graphical interface	y	n
Available in languages other than English	y	n
Executable at any time	y	n
Available on CD	y	n
Uses a wizard to suggest the optimum configuration for an unconfigured controller	y	n
Describes configuration errors	y	n
Supports these operating systems:		
Windows Server 2003	y	y
Windows 2000	y	y
Windows NT	y	y
Novell NetWare	y [†]	y
Linux	y [†]	y
Allows these procedures:		
Creation and deletion of arrays and logical drives	y	y
Assignment of RAID level	y	y
Sharing of spare drives among several arrays	y	n
Assignment of multiple spare drives per array	y	n
Setting of stripe size	y	n
Migration of RAID level or stripe size	y	n
Configuration of controller settings	y	n
Expansion of an array	y	n

continued

Table 6-1: Comparison of Utilities for Configuring an Array *continued*

Creation of multiple logical drives per array	y	n
Setting of boot controller	n	y

*y = feature is supported; n = feature is not supported

†NetWare can use ACU only when the system is offline.

‡IPF systems cannot run ACU in a Linux environment.

Using ACU

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

NOTE: IPF servers that are running the Linux operating system cannot use ACU. In this case, use ORCA.

Using ORCA

When a server is powered up, part of the startup sequence is the Power-On Self-Test (POST). Any array controllers that are in the system are initialized while POST is running. If the array controller supports ORCA, POST temporarily halts, and an ORCA prompt message is displayed for about five seconds. (If ORCA is not supported, the prompt message is not displayed, and the system continues with the startup sequence.)

While the prompt is displayed, press the **F8** key to start ORCA. The ORCA main menu is displayed, allowing you to create, view, or delete a logical drive. (On a ProLiant system, you can also use ORCA to set the currently selected controller as the boot controller.)

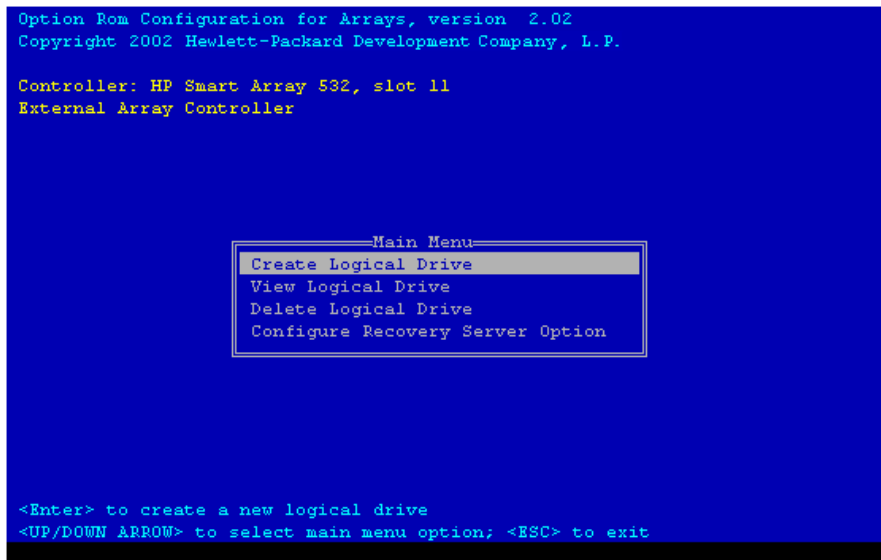


Figure 6-1: ORCA main menu screen

To create a logical drive:

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, space bar, 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 allows you to configure shared spare drives.

While configuring the logical drive, one of the settings allows you to use either 4 GB or 8 GB as the maximum boot drive size. Selecting 8 GB allows a larger boot partition for operating systems such as Windows NT 4.0 that use cylinders, heads, and sectors of a physical drive to determine the drive size. The larger boot drive size also lets you increase the size of the logical drive at some later time. However, logical drive performance is likely to decrease if the larger boot drive size is enabled.

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 is displayed.

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 new logical drives available for data storage, format them using the instructions given in the operating system documentation.

Installing the Device Drivers and Management Agents

ProLiant Servers

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>).

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.

Management Agents

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 on older servers by using the latest versions of the agents from one of these sources:

- The Management CD, obtainable from your local HP reseller or authorized service provider
- The SmartStart CD
- The HP website (<http://www.hp.com/servers/manage>)

For the procedure to update the agents, refer to the documentation on the Management CD or on the HP website.

If the new agents do not function correctly, you may also need to update Insight Manager. The latest versions of Insight Manager are also available for download at the HP website.

IPF Servers

Operating System

For definitive instructions, refer to the operating system documentation.

Device Drivers

If you want to install additional Smart Array controllers in the server, you also need to install device drivers. For servers that use a supported Microsoft Windows operating system, these drivers are present on the DVD that is provided in the controller kit.

IMPORTANT: If you are configuring a new server, install the operating system before installing the device driver.

1. Power down the server and disconnect the power cords.
2. Install the new controller and connect it to storage devices.
3. Power up the server.
The operating system recognizes the controller and launches the **Found New Hardware** wizard.
4. In the **Files Needed** dialog box, select the option to automatically search for the driver.
5. When the driver installation process is complete, click **Finish** to exit the wizard, and then click **Yes** to confirm that you want to reboot the server.
6. Repeat the previous steps for each new controller to be installed in the server.

Management Agents

IPF servers that use a supported Windows operating system can install the Management Agents from the DVD that is supplied in the controller kit.

1. Power up the server.
2. When the operating system is running, insert the DVD into the DVD-ROM drive.
3. The Resource Mode Utility (RMU) opens.
4. Select the server, and then click **Software and Drivers**.
5. Click **HP Server Agents**.
6. Double-click the `setup.exe` file.
7. Follow the on-screen prompts and instructions to install or update the Management Agents.
8. If SNMP is not installed on the system, install it from the **HP Server Agents** screen. (Alternatively, you can install it from the Windows distribution CD.)

IMPORTANT: The Management Agents cannot function if the server does not have SNMP installed.

Upgrading and Replacing Options

Array Accelerator

To remove the existing array accelerator board:

1. Squeeze the ends of the heat sink clip inwards (1), and then rotate the clip out of the heat sink (2).

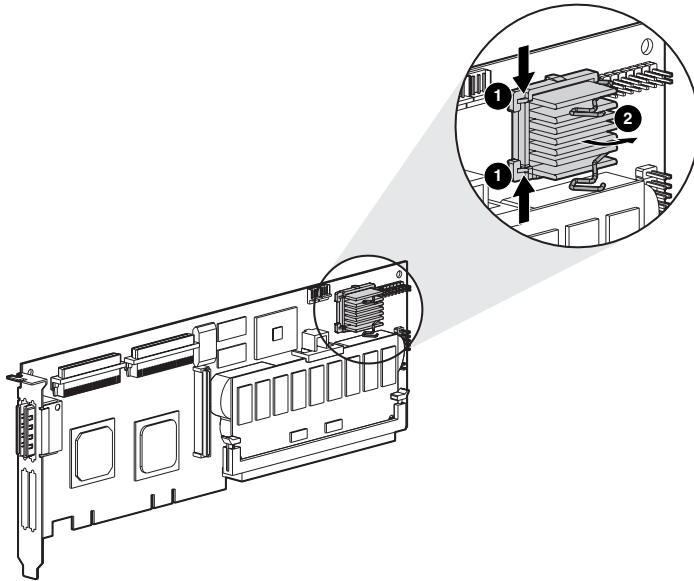


Figure 8-1: Removing the heatsink

2. Lift the heatsink out of the frame.

3. Rotate the clip back towards the controller board to allow room for the array accelerator board to be removed.
4. Remove the plastic retainer (1) by detaching it from the array accelerator and unhooking it from the controller board.

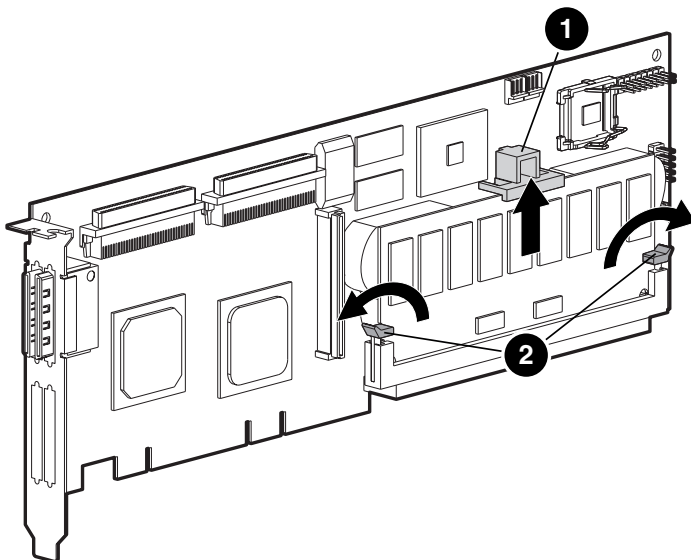


Figure 8-2: Releasing the array accelerator board

5. Swing out the DIMM ejectors (2) on each side of the array accelerator.
6. Tilt the array accelerator slightly away from the controller board (angle exaggerated in the figure for clarity), and then unplug the array accelerator from the DIMM socket on the controller board.

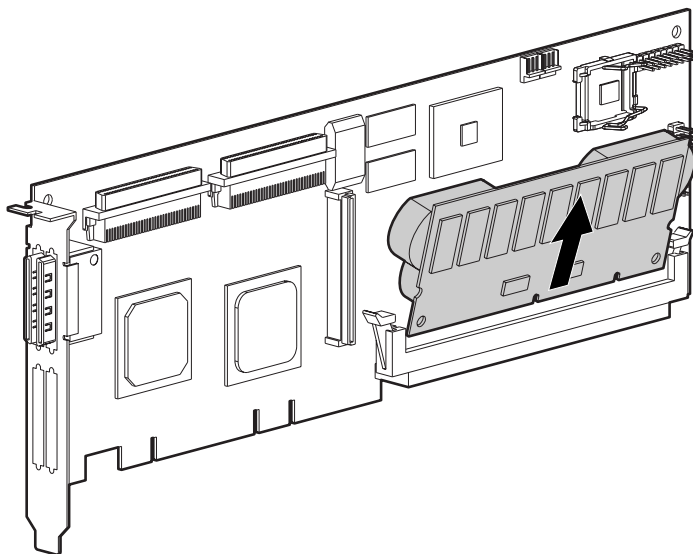


Figure 8-3: Unplugging the array accelerator board

To install the new array accelerator board:

1. Push the array accelerator board firmly into the DIMM connector socket.
2. Close the DIMM ejector levers to lock the array accelerator into place.
3. Reinstall the plastic retainer.
4. Reattach the heatsink.

Installation of the new array accelerator board is complete.

Battery Pack



WARNING: There is a risk of explosion, fire, or personal injury if the battery pack is replaced incorrectly or mistreated. To reduce the risk:

- Do not attempt to recharge the battery outside of the controller.
- Do not expose to water, or to temperatures higher than 60°C (140°F).
- Do not abuse, disassemble, crush, puncture, short external contacts, or dispose of in fire or water.
- Replace only with the spare designated for this product.

Battery or array accelerator disposal should comply with local regulations. Alternatively, return these parts by established parts return methods to HP, your authorized HP Partners, or their agents for disposal.

To remove the old NiMH battery pack:

1. Push down on the battery pack clip, located near the lower corner of the array accelerator.

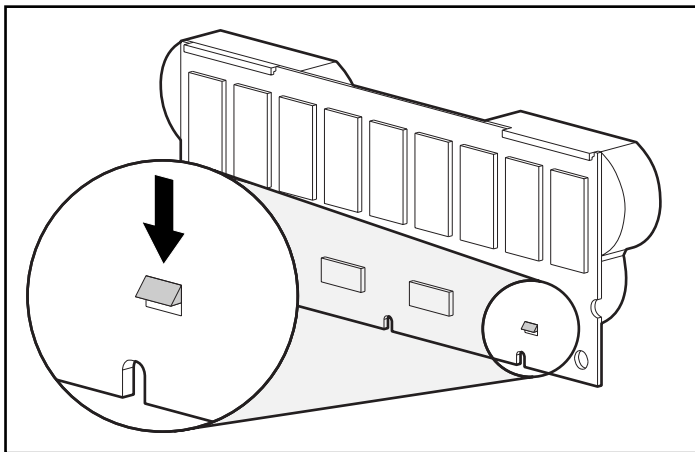


Figure 8-4: Clip on battery pack

2. Rotate the battery pack away from the array accelerator board by an angle of 10 degrees.

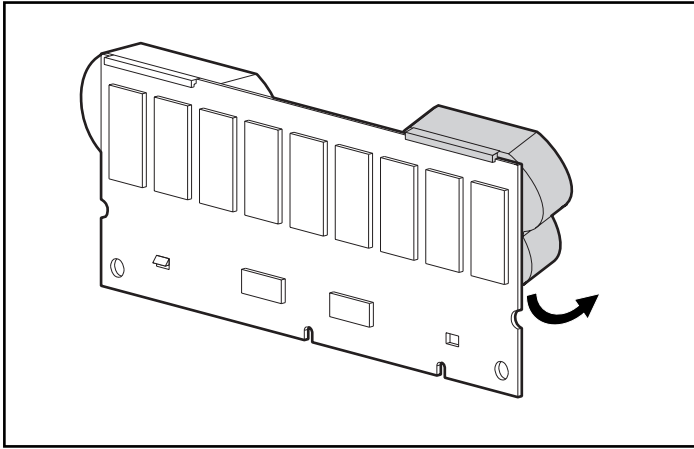


Figure 8-5: Releasing the battery pack

3. Remove the pack from the array accelerator board. If the battery pack flange grasps the board tightly, rock the pack slightly from side to side while lifting the pack upward.

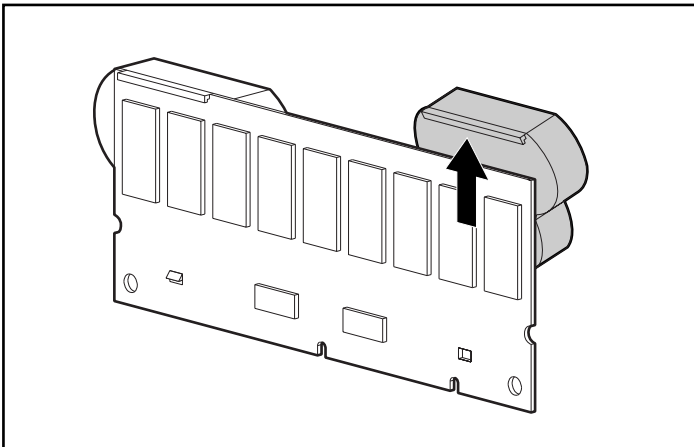


Figure 8-6: Removing the battery pack

Since both packs are likely to be discharged at a similar rate, repeat the procedure for the other battery pack.

To install a new NiMH battery pack:

1. Wait about 15 seconds after removing the old battery packs to allow the battery charge monitor to reset.
2. Hook the battery pack flange onto the top of the array accelerator board, with the pack held at a 10-degree angle to the plane of the board.

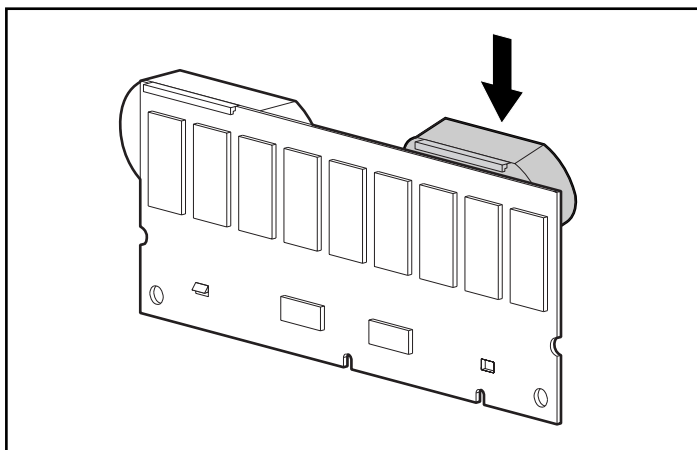


Figure 8-7: Installing the new battery pack

3. Rotate the battery pack towards the array accelerator board. Be sure that the clip and two pegs line up with the corresponding holes in the array accelerator board, and then press the battery pack firmly to lock it securely in place.
4. Confirm that the flange (1) and clip (2) are securely attached to the array accelerator board.

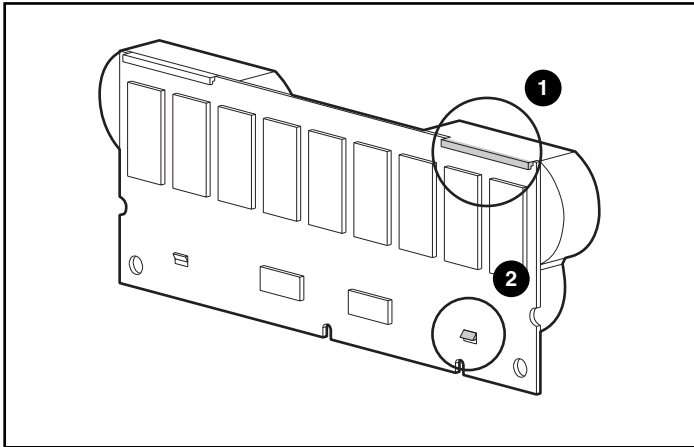


Figure 8-8: Securing the flange and clip

Installation of the new battery pack is complete. Repeat for the other battery pack.

Two- to Four-Channel Adapter Board

To remove the existing two- to four-channel adapter board:

1. Remove the screw that secures the two- to four-channel adapter board. This screw is reachable from the back of the controller board.

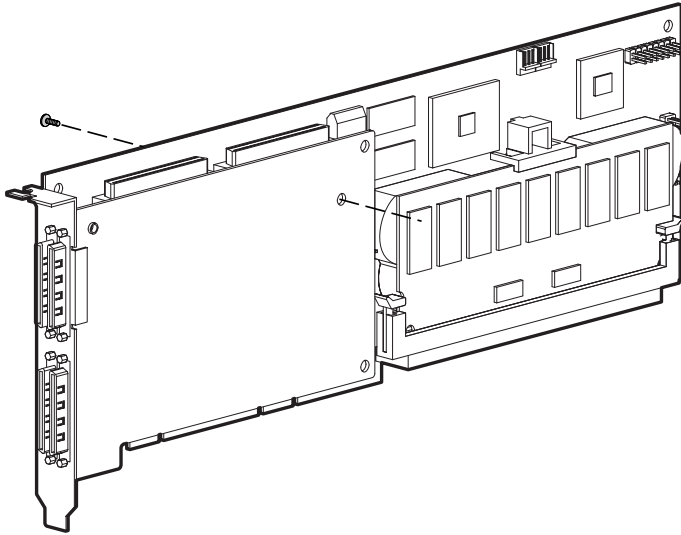


Figure 8-9: Removing the securing screw

2. Unplug the two- to four-channel adapter board from the connector on the controller board.

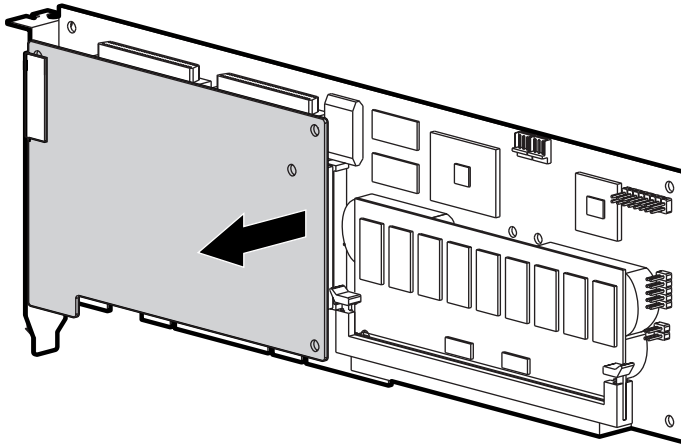


Figure 8-10: Unplugging the two- to four-channel adapter board

3. Pull the two- to four-channel adapter board out of the VHDCI socket.

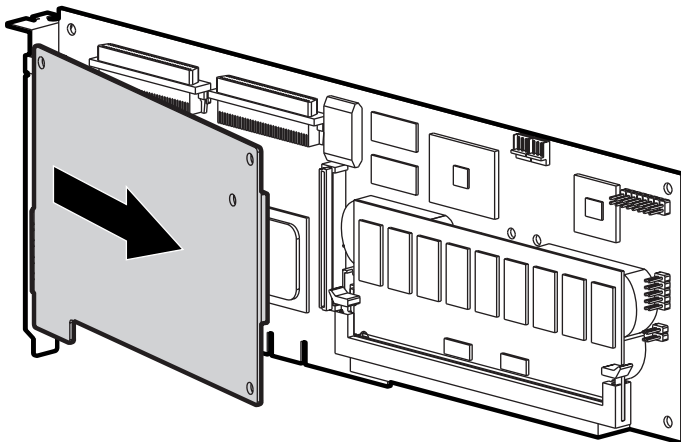


Figure 8-11: Removing the two- to four-channel adapter board

To install the new two- to four-channel adapter board:

1. Insert the VHDCI connector on the adapter board into the unoccupied VHDCI slot (1) while sliding the adapter board under the bracket lip (2) on the occupied VHDCI slot.

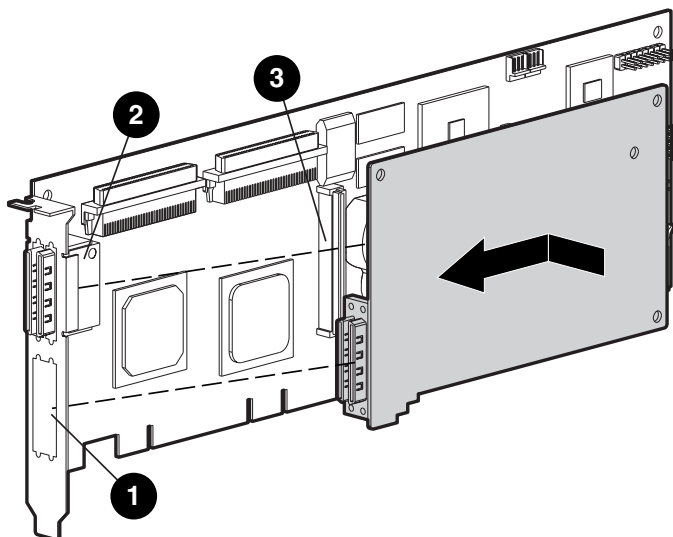


Figure 8-12: Installing the adapter board

2. Plug the adapter board into the connector (3) on the controller board.
3. Secure the adapter board to the controller board by inserting and tightening the appropriate screw (included in the kit) in the back of the controller board.

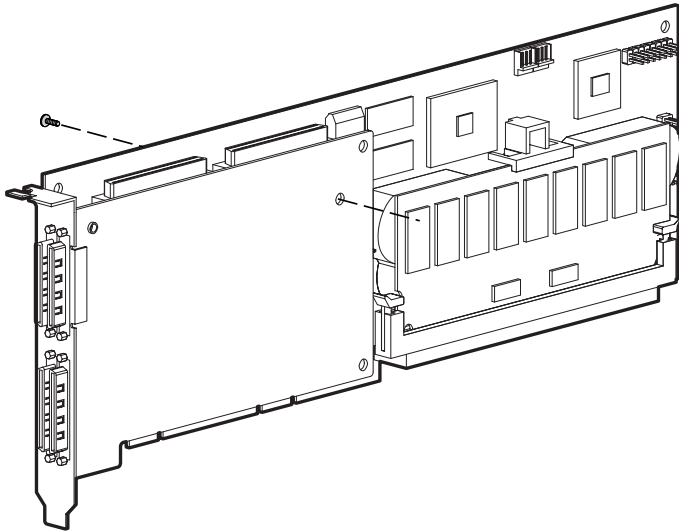


Figure 8-13: Securing the adapter board to the array controller board

Installation of the new adapter board is complete.

Enabling RAID ADG

You can enable RAID ADG on a Smart Array 5300 Controller by installing a software key. Alternatively, if you have an older version of the controller, you can install a hardware enabler module on the controller board.

Using the Software Key

1. Confirm that the array accelerator has a capacity of at least 64 MB.
2. Close all applications and utilities on the server containing the controller.
3. Insert the CD from the RAID ADG option software kit into the CD-ROM drive.
4. Reboot the server.
5. If necessary, upgrade the controller firmware to the version provided on the CD, and then reboot the server. (This step is required, for example, if the controller is a Smart Array 5300 with a current firmware version less than 2.72.)

NOTE: If the firmware on the controller is newer than that on the CD, the flash utility does not replace it with the earlier firmware from the CD.

6. Select **Array Configuration Utility 6.0** from the CD menu.

This action opens ACU 6.0, the browser-based version of the Array Configuration Utility (ACU).

IMPORTANT: Use the version of ACU 6.0 that is provided on the CD. The software key cannot be installed using versions of ACU 6.0 earlier than 1.40, nor can it be installed using ACU.

7. When the utility has loaded, select the controller that is to be used to configure RAID ADG.
8. Select **License Key Management**.
9. Select **Enter License Key**.
10. Enter the 25-character license key (provided on the CD sleeve) and click **Submit**.
If you wish, you can now configure the controller using ACU 6.0.
11. Exit ACU 6.0, remove the CD, and reboot the server.

For further instructions or clarifications regarding the software key installation procedure, refer to the ACU 6.0 online help.

Using the Enabler Module

The connector for the RAID ADG Enabler Module is located at the corner of the controller board near the array accelerator connector socket, as shown in Figure 8-14. The module attaches to the controller board with the narrow tab (circled in Figure 8-15) nearest to the corner of the controller board. This tab can be pressed outwards during installation to allow the module to be more readily inserted into the board. The clips at each end of the module fit into the slots on the board.

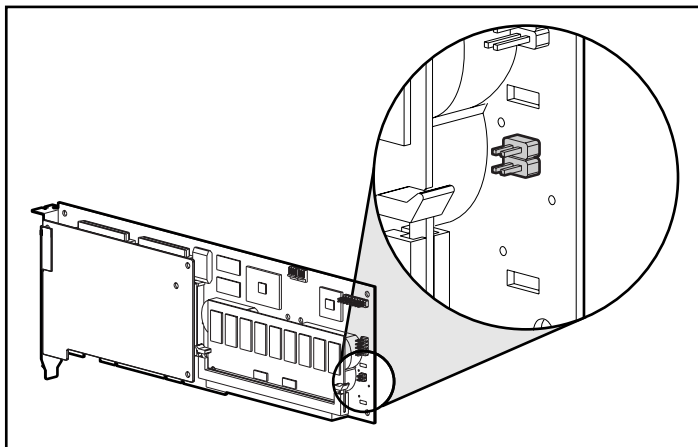


Figure 8-14: Location of the RAID ADG Enabler Module connector on the Smart Array 5300 Controller board

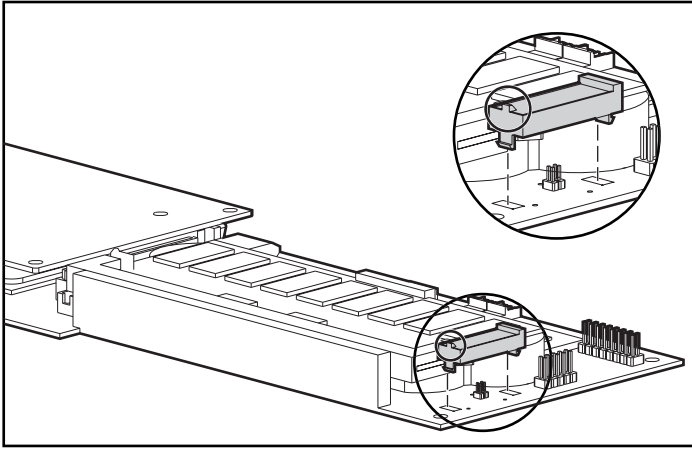


Figure 8-15: Aligning the module on the controller board

When replacing a Smart Array 5300 Controller, you may want to remove the RAID ADG Enabler Module from the old controller and install it onto the new controller.

To remove the RAID ADG Enabler Module:

Press the innermost plastic clip under the controller board towards the other clip (1), and push the module out of the board (2).

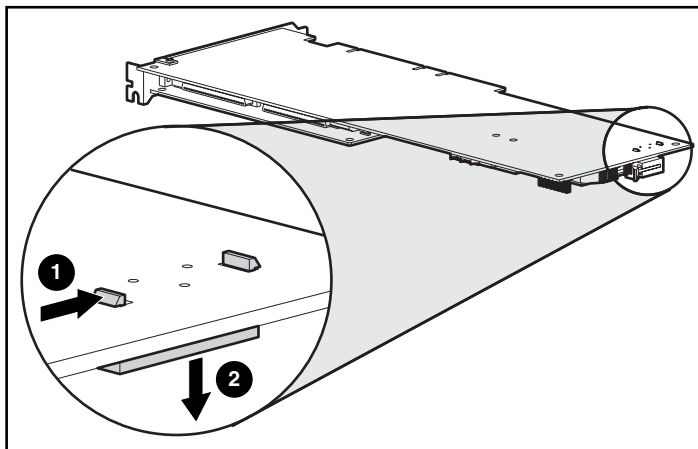


Figure 8-16: Removing the RAID ADG Enabler Module

To install the module on the new controller board:

1. Check that the array accelerator on the new controller board has at least 64 MB of read/write cache.
2. Hold the module at an angle and insert the rear end of the module into the appropriate slot (1).

3. Use one thumb to press the tab at the top of the rear end outward (2a), while using the other thumb to **gently** press the other end of the module (2b) into the connector and slot on the controller board.

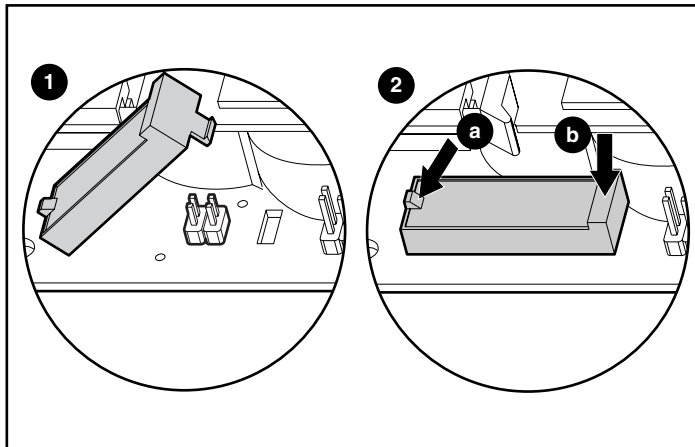


Figure 8-17: Installing the module

Installation of the RAID ADG Enabler Module is complete.

Regulatory Compliance Notices

Regulatory Compliance Identification Numbers

For the purpose of regulatory compliance certifications and identification, your product has been assigned a unique series number. The series number can be found on the product nameplate label, along with all required approval markings and information. When requesting compliance information for this product, always refer to this series number. The series number should not be confused with the marketing name or model number of the product.

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.

The rating label on the device shows the classification (A or B) of the equipment. Class B devices have an FCC logo or FCC ID on the label. Class A devices do not have an FCC logo or FCC ID on the label. After the Class of the device is determined, refer to the corresponding statement in the following sections.

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 your product, contact us by mail or telephone:

- Hewlett-Packard Company
P. O. Box 692000, Mail Stop 530113
Houston, Texas 77269-2000
- 1-800-652-6672 (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.

Mouse Compliance Statement

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.

European Union Notice

Products with the CE Marking comply with both the EMC Directive (89/336/EEC) and the Low Voltage Directive (73/23/EEC) issued by the Commission of the European Community.

Compliance with these directives implies conformity to the following European Norms (the equivalent international standards are in parenthesis):

- EN55022 (CISPR 22) – Electromagnetic Interference
- EN55024 (IEC61000-4-2, 3, 4, 5, 6, 8, 11) – Electromagnetic Immunity
- EN61000-3-2 (IEC61000-3-2) – Power Line Harmonics
- EN61000-3-3 (IEC61000-3-3) – Power Line Flicker
- EN60950 (IEC950) – Product Safety

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。

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BSMI Notice

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。

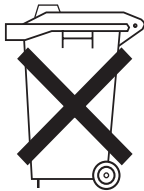
Battery Replacement Notice

The array accelerator on the controller is equipped with a nickel metal hydride (NiMH) battery pack. Replacement is to be performed by an authorized service provider using the spare designated for this product.



WARNING: There is a risk of explosion, fire, or personal injury if the battery pack is not properly handled. To reduce the risk:

- Do not attempt to recharge the battery outside of the controller.
 - Do not expose to water, or to temperatures higher than 60°C.
 - Do not abuse, disassemble, crush, puncture, short external contacts, or dispose of in fire or water.
 - Replace only with the spare designated for this product.
-



Batteries, battery packs, and accumulators should not be disposed of together with the general household waste. To forward them to recycling or proper disposal, please use the public collection system or return them to HP, your authorized HP Partners, or their agents.

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

Electrostatic Discharge

To prevent damage to 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, observe the following precautions:

- 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.

There are several methods 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 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.

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

Controller Specifications

Table C-1: Controller Specifications

Dimensions	31.5 cm × 10.8 cm × 1.5 cm (12.4 in × 4.3 in × 0.6 in)
Power required	21.2 W for 5302 (16.3 W at 3.3 V, 4.8 W at 5 V) 24.9 W for 5304 (19.0 W at 3.3 V, 5.9 W at 5 V)
PCI Bus transfer rate	Up to 528 MB/s
SCSI Bus	
Number of channels	4 (5304), or 2 upgradeable to 4 (5302)
Number of drives per channel	Up to 14
Connector type	68-pin Wide internal, VHDCI external
Termination	Required, but provided on HP and Compaq branded systems
Transfer rate	Up to 160 MB/s (40 MHz) per channel
Temperature Range	
Operating	10° to 35°C (50° to 95°F)
Shipping	-30° to 60°C (-22° to 140°F)
Relative Humidity (Non-condensing)	
Operating	20% to 80%
Non-operating	5% to 90%

Drive Arrays and Fault Tolerance

What Is a Drive Array?

The capacity and performance of a single physical (hard) drive is adequate for home users. However, business users demand higher storage capacities, higher data transfer rates, and greater protection against data loss when drives fail.

Connecting extra physical drives to a system increases the total storage capacity (refer to Figure D-1), but has no effect on the efficiency of read/write (R/W) operations. Data can still be transferred to only one physical drive at a time.

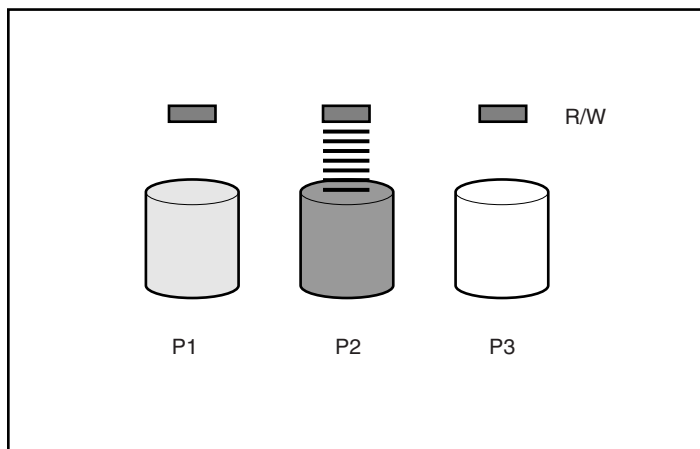


Figure D-1: Physical drives added to system

With an array controller installed in the system, the capacity of several physical drives can be combined into one or more virtual units called **logical drives** (also called logical volumes). Then, the read/write heads of all the constituent physical drives are active simultaneously, reducing the total time required for data transfer.

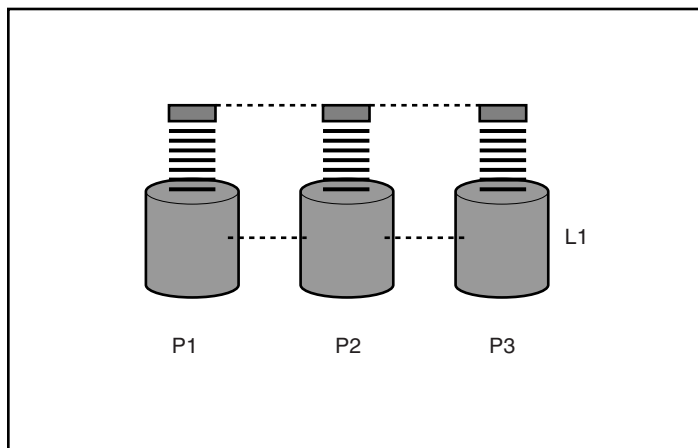


Figure D-2: Physical drives configured into a logical drive (L1)

Because the read/write heads are active simultaneously, the same amount of data is written to each drive during any given time interval. Each unit of data is called a **block**, and over all the physical drives in a logical drive the blocks form a set of data **stripes** (refer to Figure D-3).

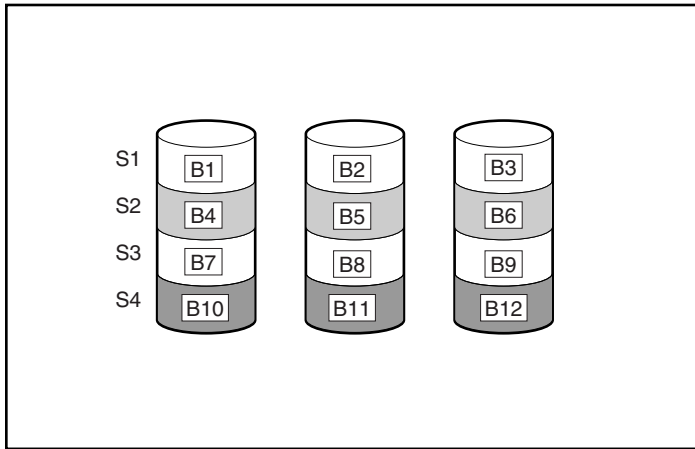


Figure D-3: Data striping (S1-S4) of data blocks B1-B12

For data in the logical drive to be readable, the data block sequence must be the same in every stripe. This sequencing process is performed by the array controller, which sends the data blocks to the drive write heads in the correct order.

A natural consequence of the striping process is that each physical drive in a given logical drive will contain the same amount of data. If one physical drive has a larger capacity than other physical drives in the same logical drive, the extra capacity is wasted because it cannot be used by the logical drive.

The group of physical drives containing the logical drive is called a **drive array** (or just **array**). Because all the physical drives in an array are commonly configured into just one logical drive, the term array is also often used as a synonym for logical drive. However, an array can contain several logical drives, each of a different size (refer to Figure D-4).

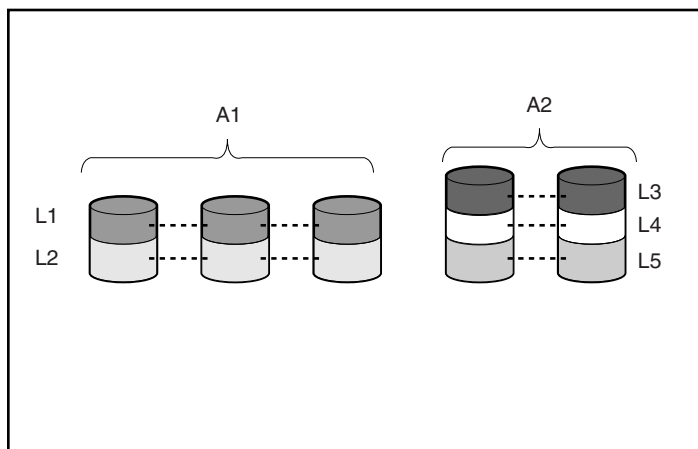


Figure D-4: Two arrays (A1, A2) containing five logical drives spread over five physical drives

Each logical drive in an array is distributed over all of the physical drives within the array. A logical drive can also extend over more than one port on the same controller, but it cannot extend over more than one controller.

Drive failure, although rare, is potentially catastrophic. In Figure D-4, for example, failure of **any** physical drive causes **all** logical drives in the same array to fail, and all data on the drives is lost.

To protect against data loss due to physical drive failure, logical drives are configured with **fault tolerance**. There are several fault-tolerance methods; those supported by current HP and Compaq branded controllers (and described in the following section) are:

- RAID 0—Data Striping only (no fault tolerance)
- RAID 1+0—Drive Mirroring
- RAID 5—Distributed Data Guarding
- RAID ADG—Advanced Data Guarding

For any configuration except RAID 0, further protection against data loss can be achieved by assigning a drive as an **online spare** (or **hot spare**). This drive contains no data and is connected to the same controller as the array. When any other physical drive in the array fails, the controller automatically rebuilds information that was originally on the failed drive onto the online spare. The system is quickly restored to full RAID-level data protection. (However, in the unlikely event that another drive in the array fails while data is being rewritten to the spare, the logical drive will still fail.)

When you configure an online spare, it is automatically assigned to all logical drives in the same array. Additionally, you do not need to assign a separate online spare to each array; you can configure one hard drive to be the online spare for several arrays, as long as the arrays are all on the same controller.

Fault-Tolerance Methods

RAID 0—No Fault Tolerance

This configuration (refer to Figure D-3) provides no protection against data loss when a drive fails. However, it is useful for rapid storage of large amounts of noncritical data (for printing or image editing, for example), or when cost is the most important consideration.

Advantages

- Highest performance method for writes
- Lowest cost per unit of data stored
- Maximum drive capacity for data storage (none needed for fault tolerance)

Disadvantages

- Loss of data on the logical drive if a physical drive fails
- Cannot use an online spare
- Can only preserve data by backing it up to external drives

RAID 1+0—Drive Mirroring

In this configuration, data is duplicated onto a second drive.

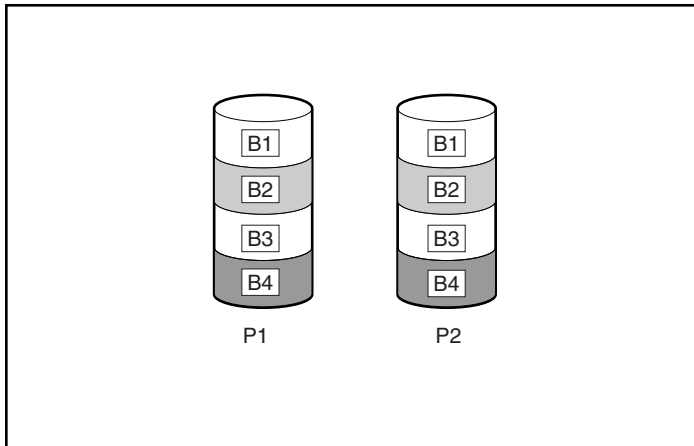


Figure D-5: Drive mirroring of P1 onto P2

When the array has more than two physical drives, drives are mirrored in pairs.

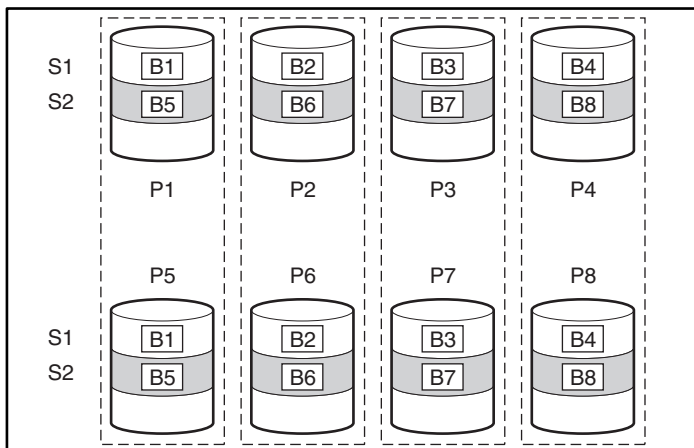


Figure D-6: Mirroring with more than two physical drives in the array

In each mirrored pair, the physical drive that is not busy answering other requests answers any read request sent to the array. (This behavior is called **load balancing**.) If a physical drive fails, the remaining drive in the mirrored pair can still provide all the necessary data. Several drives in the array can fail without incurring data loss, as long as no two failed drives belong to the same mirrored pair.

This fault-tolerance method is useful when high performance and data protection are more important than the cost of physical drives.

NOTE: When there are only two physical drives in the array, this fault-tolerance method is often referred to as RAID 1.

Advantages

- Highest read and write performance of any fault-tolerant configuration
- No loss of data as long as none of the failed drives are mirrored to another failed drive (up to half of the physical drives in the array can fail)

Disadvantages

- Expensive (many drives needed for fault tolerance)
- Only 50% of total drive capacity useable for data storage

RAID 5—Distributed Data Guarding

By this method, a block of **parity data** is calculated for each stripe from the data that is in all other blocks within that stripe. The blocks of parity data are distributed over every physical drive within the logical drive (refer to Figure D-7). When a physical drive fails, data that was on the failed drive can be calculated from the user data on the remaining drives and the parity data. This recovered data is usually written to an online spare in a process called a **rebuild**.

This configuration is useful when cost, performance, and data availability are equally important.

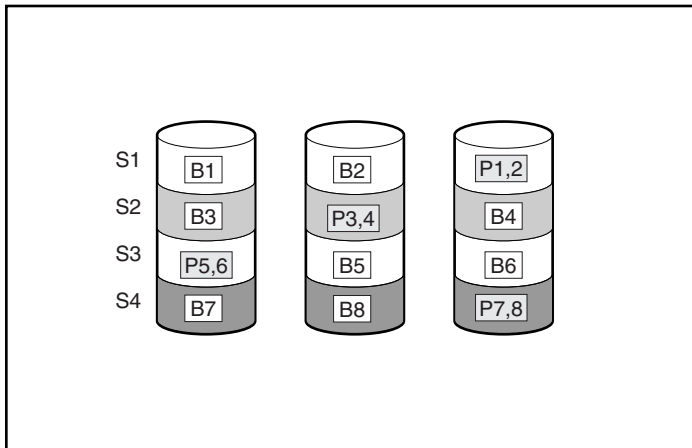


Figure D-7: Distributed data guarding, showing parity information (Px,y)

Advantages

- High read performance
- No loss of data if one physical drive fails
- More drive capacity usable than with RAID 1+0—parity information requires only the storage space equivalent to one physical drive

Disadvantages

- Relatively low write performance
- Loss of data if a second drive fails before data from the first failed drive is rebuilt

RAID ADG—Advanced Data Guarding

RAID ADG is similar to RAID 5 in that parity information is generated (and stored) to protect against data loss caused by drive failure. With RAID ADG, however, two different sets of parity data are used, allowing data to still be preserved if two drives fail. As can be seen in Figure D-8, each set of parity data uses a capacity equivalent to that of one of the constituent drives.

This method is most useful when data loss is unacceptable, but cost must also be minimized. The probability that data loss will occur when arrays are configured with RAID ADG is less than when they are configured with RAID 5 (for details, refer to Appendix F).

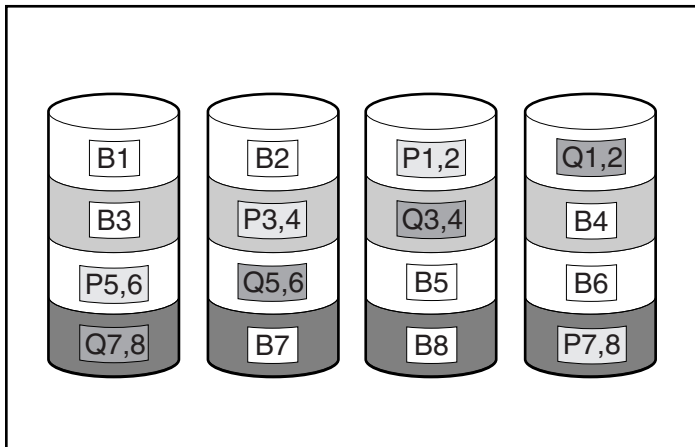


Figure D-8: Advanced data guarding (RAID ADG)

Advantages

- High read performance
- High data availability—any two drives can fail without loss of critical data
- More drive capacity usable than with RAID 1+0—parity information requires only the storage space equivalent to two physical drives

Disadvantage

The only significant disadvantage of RAID ADG is a relatively low write performance (lower than RAID 5) because of the need for two sets of parity data.

Comparing Hardware-Based RAID Methods

Table D-1 summarizes the important features of the different kinds of RAID methods described here. The decision chart in Table D-2 may help you to determine which option is best for your situation.

Table D-1: Summary of RAID Methods

	RAID 0	RAID 1+0	RAID 5	RAID ADG
Alternative name	Striping (no fault tolerance)	Mirroring	Distributed Data Guarding	Advanced Data Guarding
Usable drive space*	100%	50%	67% to 93%	50% to 96%
Usable drive space formula	n	$n/2$	$(n-1)/n$	$(n-2)/n$
Minimum number of physical drives	1	2	3	4
Tolerates failure of one physical drive?	No	Yes	Yes	Yes
Tolerates simultaneous failure of more than one physical drive?	No	Only if no two failed drives are in a mirrored pair	No	Yes
Read performance	High	High	High	High
Write performance	High	Medium	Low	Low
Relative cost	Low	High	Medium	Medium

*Values for usable drive space are calculated with these assumptions: (1) All physical drives in the array have the same capacity; (2) Online spares are not used; (3) No more than 14 physical drives are used per array for RAID 5; (4) No more than 56 drives are used with RAID ADG.

Table D-2: Choosing a RAID Method

Most Important	Also Important	Suggested RAID Level
Fault tolerance	Cost effectiveness	RAID ADG
	I/O performance	RAID 1+0
Cost effectiveness	Fault tolerance	RAID ADG
	I/O performance	RAID 5 (RAID 0 if fault tolerance is not required)
I/O performance	Cost effectiveness	RAID 5 (RAID 0 if fault tolerance is not required)
	Fault tolerance	RAID 1+0

Other Fault-Tolerance Options

Your operating system may also support software-based RAID or controller duplexing.

- **Software-based RAID** resembles hardware-based RAID, except that the operating system works with logical drives as if they were physical drives. To protect against data loss caused by physical drive failure, each logical drive must be in a different array from the others.
- **Controller duplexing** uses two identical controllers with independent, identical sets of drives containing identical data. In the unlikely event of a controller failure, the remaining controller and drives will service all requests.

However, the hardware-based RAID methods described in this appendix provide a much more robust and controlled fault-tolerant environment. Additionally, controller duplexing and software-based RAID do not support online spares, auto-reliability monitoring, interim data recovery, or automatic data recovery.

If you decide to use one of these alternative fault-tolerance options, configure your arrays with RAID 0 for maximum storage capacity and refer to your operating system documentation for further implementation details.

Hard Drive Installation and Replacement

Each SCSI channel on the controller supports up to 14 drives. Drives can be of the Wide Ultra3 or Wide Ultra2 type.

Each drive on a SCSI bus must have a unique ID value in the range 0 to 15 (except ID 7, which is reserved for controller use). This value is set automatically on hot-pluggable drives in ProLiant servers and storage systems, but values for other drives must be set manually.

- Do **not** terminate the drives. HP and Compaq branded servers and internal cabling provide the required termination of the SCSI bus.
- Do **not** use drives of different capacity in the same array. The excess capacity of larger drives cannot be used by the array and is wasted.
- Do **not** use hot-pluggable drives on the same SCSI bus as non-hot-pluggable drives.

Hard drives that are currently supported by Smart Array controllers are listed at www.hp.com/products/smartarray.

General Information About Hard Drive Failure

When a hard drive fails, all logical drives that are in the same array will be 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.

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 will be rejected with unrecoverable errors. The “Compromised Fault Tolerance” section discusses possible ways to recover from this situation.

Recognizing Drive Failure

The LEDs on the front of each hard drive are visible through the front of the server or external storage unit. When a drive is configured as a part of an array and attached to a powered-up controller, the status of the drive can be determined from the illumination pattern of these LEDs.

Table E-1 describes the meaning of the various LED combinations.

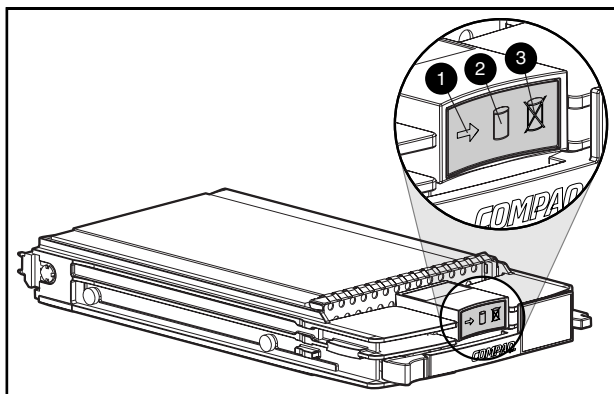


Figure E-1: Hard drive status LED indicators

Table E-1: Hard Drive Status from LED Illumination Pattern

(1) Activity	(2) Online	(3) Fault	Meaning
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	OK to replace the drive online if the array is configured for fault tolerance and all other drives in the array are online. The drive is online and configured as part of an array.
On	Flashing	Off	Do not remove the drive. Removing a drive during this process 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. Removing a drive during this process may cause data loss. 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 POST.
Flashing	Flashing	Flashing	Do not remove the drive. Removing a drive during this process can cause data loss in non-fault-tolerant configurations. Either (1) the drive is part of an array being selected by the Array Configuration Utility; (2) the Options ROMPaq utility is upgrading the drive firmware; or (3) Drive Identification has been selected in Insight Manager.
Off	Off	On	OK to replace the drive online. The drive has failed and has been placed offline.
Off	Off	Off	OK to replace the drive online if the array is configured for fault tolerance and all other drives in the array are online. Either (1) the drive is not configured as part of an array; (2) the drive is configured as part of an array, but a powered-up controller is not accessing the drive; or (3) the drive is configured as an online spare.

There are several other ways to recognize that a hard drive has failed:

- The amber LED lights up on the front of a storage system if failed drives are inside. (Other problems such as fan failure, redundant power supply failure, or over-temperature conditions will also cause this LED to light up.)
- A Power-On Self-Test (POST) message lists failed drives whenever the system is restarted, as long as the controller detects one or more good drives. For troubleshooting information, refer to Appendix G, “Diagnosing Array Problems.”
- The Array Diagnostic Utility (ADU) lists all failed drives.

Also, Insight Manager can detect failed drives remotely across a network.

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

Compromised Fault Tolerance

Compromised fault tolerance commonly occurs when more physical drives have failed than the fault-tolerance method can endure. In this case, the logical volume is failed and unrecoverable disk error messages are returned to the host. Data loss is likely to occur.

An example of this situation is where one drive on an array fails while another drive in the same array is still being rebuilt. If the array has no online spare, any logical drives on the array that are configured with RAID 5 fault tolerance will fail.

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

Procedure to Attempt Recovery

When fault tolerance has been compromised, inserting replacement drives does not improve the condition of the logical volume. Instead, if your screen displays unrecoverable error messages, try 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 allow you to make copies of important files.
2. 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.
3. Make copies of important data, if possible.
4. Replace any failed drives.
5. After the failed drives have been replaced, the fault tolerance may again be compromised. If so, cycle the power again. If the 1779 POST message is displayed, press the **F2** key to re-enable the logical drives, recreate your partitions, and restore all data from backup.

To minimize the risk of data loss due to compromised fault tolerance, make frequent backups of all logical volumes.

Automatic Data Recovery

Automatic data recovery is an automatic background process that rebuilds data onto a spare or replacement drive when another drive in the array fails. This process is also called **rebuild**.

If a drive in a fault-tolerant configuration is replaced while the system power is off, a Power-On Self-Test (POST) message is displayed during the next system startup. This message prompts you to press the **F1** key to start automatic data recovery. If automatic data recovery is not enabled, the logical volume remains in a ready-to-recover condition and the same POST message is displayed whenever the system is restarted.

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

In general, approximately 15 minutes is required to rebuild each gigabyte. The actual rebuild time depends upon:

- The level of rebuild priority that has been set for the logical drive. For details, refer to Chapter 6, “Configuring an Array.”
- The amount of I/O activity occurring during the rebuild operation
- The disk drive speed
- The number of drives in the array (for RAID 5 and RAID ADG)

For example, the rebuild time when using 9-GB Wide-Ultra hard drives in a RAID 5 configuration varies from ten minutes per gigabyte (for three drives) to 20 minutes per gigabyte (for 14 drives).

Failure of Automatic Data Recovery

If the Online LED of the replacement drive stops blinking during automatic data recovery, there are three possible causes:

- If the Online LED is glowing continuously, automatic data recovery was successful and has finished.
- If the amber failure LED is illuminated or other LEDs go out, the replacement drive has failed and is producing unrecoverable disk errors.

Remove and replace the failed replacement drive.

- If the automatic data recovery process has abnormally terminated, one possible cause is a non-correctable read error on another physical drive. The system may temporarily become operational if rebooted. In any case, locate the faulty drive, replace it, and restore data from backup.

General Aspects of Drive Replacement

Before replacing a degraded drive, use Insight Manager to examine the error counters recorded for each physical drive in the array to confirm that such errors are not presently occurring. Refer to the Insight Manager documentation on the Management CD for details.



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.

There are several other factors to remember when replacing a hard drive:

- Non-hot-pluggable drives should only be replaced while the system is powered down.
- Hot-pluggable drives can be removed and replaced at any time, whether the host or storage system power is on or off.

When a hot-pluggable drive is inserted, all disk activity on the array pauses while the new drive is spinning up (usually 20 seconds or so). If the drive is inserted while power is on, in a fault-tolerant configuration, data recovery onto the replacement drive begins automatically (indicated by the blinking Online LED).

- Replacement drives must have a capacity no less than that of the smallest drive in the array. Drives of insufficient capacity will be failed immediately by the controller before automatic data recovery can begin.
 - When you set the SCSI ID jumpers manually, check the ID value to be sure that the correct physical drive is being replaced. Set the same ID value on the replacement drive to prevent SCSI ID conflicts.
-



CAUTION: In systems using external data storage, take care that the server is the first unit to be powered down and the last to be powered back up. Doing this ensures that the system will not erroneously mark the drives as failed.

The rebuild operation takes several hours, even if the system is not busy while the rebuild is in progress. System performance and fault tolerance are both affected until the rebuild has finished. Therefore, replace drives during low activity periods whenever possible. In addition, be sure that all logical volumes on the same array as the drive being replaced have a current, valid backup.

Drive Failure During Rebuild

If another drive in the array fails while fault tolerance is unavailable during rebuild, a fatal system error may occur. If this happens, all data on the array is 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

Minimizing Fatal System Errors During Rebuild

When a hard drive is replaced, the controller gathers fault-tolerance data from the remaining drives in the array. This data is then used to rebuild the missing data (originally on the failed drive) onto the replacement drive. If more than one drive is removed at a time, the fault-tolerance data is incomplete. The missing data cannot then be reconstructed and is likely to be permanently lost.

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

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

There are some 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 an online spare has an unlit Online LED (it is offline), the degraded drive can still 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. (When the rebuild is complete, the Online LED on the front of the drive stops blinking.)

There are some 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.

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). However, if you combine arrays that were on different controllers into one larger array on a single controller, the data on the arrays is lost.

Before moving drives, these conditions must be met:

- The move will not result in more than 14 physical drives per channel.
- No more than 32 logical volumes will be configured for a controller.
- No drives are failed or missing.
- The array is in its original configuration with no active spare drives.
- Capacity expansion is not running.
- Controller firmware is the latest version (recommended).

If moving an array, all drives in the array must be moved at the same time.

IMPORTANT: There are some restrictions on moving an array:

- A drive array that has been moved from a battery-backed array controller to one that is not battery-backed can no longer undergo RAID/stripe size migration, array capacity expansion, or logical drive capacity extension.
- Do not move an array that is configured with RAID ADG to a controller that does not support RAID ADG. Only controllers that support RAID ADG can recognize a drive array that has this configuration.

When 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 is not battery backed.
2. Power down the system.
3. Move the drives.
4. Power up the system.

A POST message is displayed, indicating that drive positions were changed and the configuration was updated.



CAUTION: If a “Not Configured” POST message is displayed, power the system down immediately to avoid data loss, and then return the drives to their original locations.

5. Restore the data from backup if necessary.

You can now check the new drive configuration by running ORCA or the Array Configuration Utility. For details, refer to Chapter 6, “Configuring an Array.”

Upgrading Hard Drive Capacity

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



CAUTION: Because a data rebuild takes about 15 minutes per gigabyte, your system is unprotected against drive failure for many hours, or even days, while the rebuild is in progress.

To upgrade hard drive capacity:

1. Back up all data.
2. Replace any drive. The data on the new drive is re-created 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 is no longer illuminated), repeat the previous step for the other drives in the array, one at a time.

When all drives have been replaced, you can use the extra capacity to create new logical drives or extend existing logical drives.

Expanding and Extending Capacity

Array capacity expansion is the addition of physical drives to an array and the redistribution of the pre-existing logical drives over the enlarged array.

The expansion process is illustrated in Figure E-2, where the original array (containing data) is shown with a dashed border, and the newly added drives are shown unshaded (containing no data). 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. Each logical drive keeps the same fault-tolerance method in the enlarged array that it had in the smaller array.

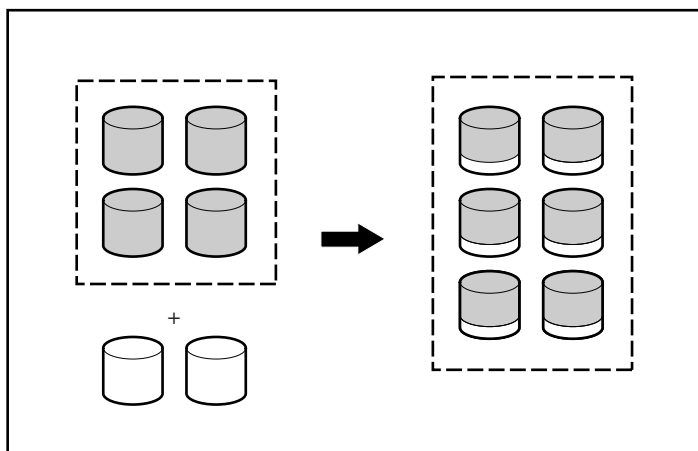


Figure E-2: Array capacity expansion

The unused capacity on the enlarged array can now be used to create an additional logical drive, with a different fault-tolerance setting if necessary.

Alternatively, the unused capacity can be used to increase the size of one of the original logical drives; this process is **logical drive capacity extension**. Another method for carrying out logical drive capacity extension is to delete an existing logical drive and then to add the freed capacity to another logical drive.

Capacity expansion is carried out using one of the utilities described in Chapter 6, “Configuring an Array”. For reconfiguration to occur online (that is, without shutting down the operating system), the configuration utility must be running in the same environment as the normal server applications. Also, online expansion is possible only in systems that are using hot-pluggable drives.

Only ACU and ACU 6.0 support capacity extension. Also, not all operating systems allow extension to be carried out while the system is online. For details, refer to Chapter 6, “Configuring an Array.”

Probability of Logical Drive Failure

The probability that a logical drive will fail depends on the RAID level setting.

- A RAID 0 logical drive fails if only one physical drive fails.
- For a RAID 1+0 logical drive, the failure situation is complex.
 - The **maximum** number of physical drives that can fail without causing failure of the logical drive is $n/2$, where n is the number of hard drives in the array. This maximum is reached only if no failed drive is mirrored to any other failed drive. In practice, a logical drive usually fails before this maximum is reached. As the number of failed drives increases, it becomes increasingly unlikely that a newly failed drive is not mirrored to a previously failed drive.
 - The failure of **only two** physical drives is enough to cause a logical drive to fail **if** the two drives happen to be mirrored to each other. The risk of this occurring decreases as the number of mirrored pairs in the array increases.
- A RAID 5 logical drive (with no online spare) fails if two physical drives fail.
- A RAID ADG logical drive (with no online spare) fails when three physical drives fail.

At any given RAID level, the probability of logical drive failure increases as the number of physical drives in the logical drive increases.

The graph in Figure F-1 provides more quantitative information. The data for this graph is calculated from the mean time between failures (MTBF) value for a typical physical drive, assuming that no online spares are present. If an online spare is added to any of the fault-tolerant RAID configurations, the probability of logical drive failure is further decreased.

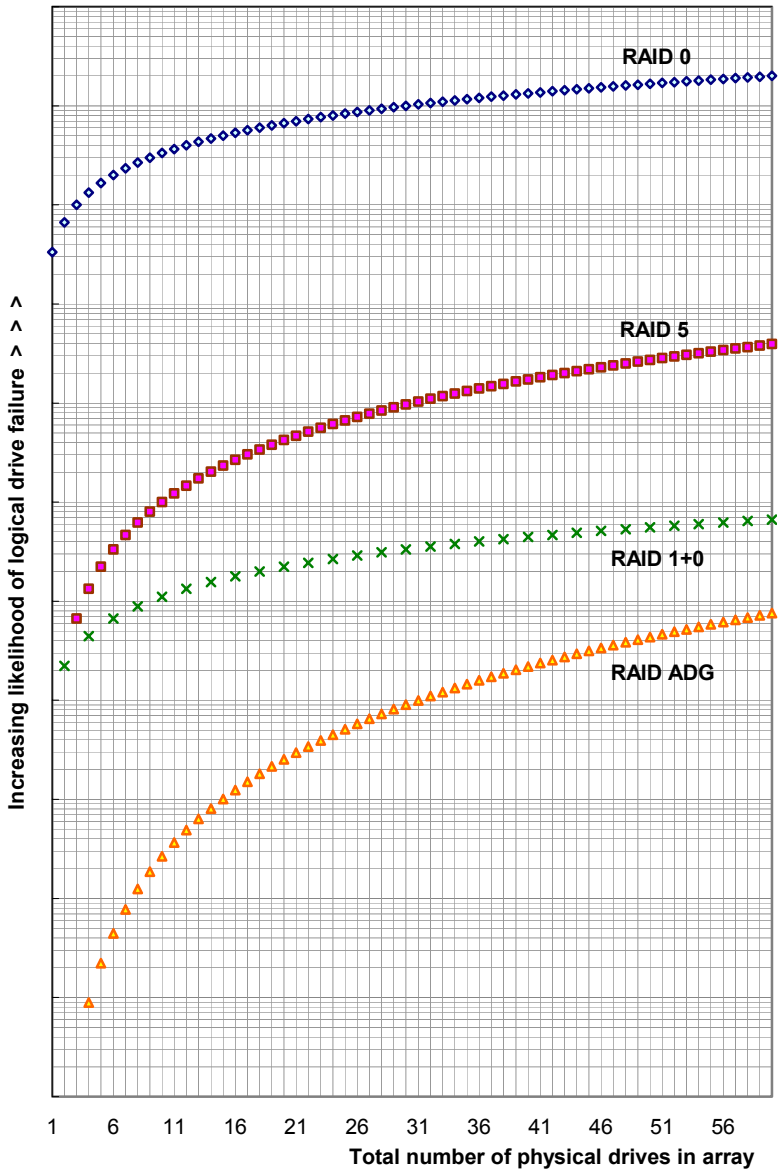


Figure F-1: Relative probability of logical drive failure

Diagnosing Array Problems

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

- **Array Diagnostics Utility (ADU)**

This utility can be downloaded from the HP website (<http://www.hp.com/support>). The meanings of the various ADU error messages are provided in the *Servers Troubleshooting Guide*.

- **Power-On Self-Test (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 *Servers Troubleshooting Guide*.

- **IPF Offline Diagnostics and Utilities**

This set of tools is available on the DVD that is supplied in the controller kit. To use one of these tools, insert the DVD into the DVD-ROM drive and follow the on-screen prompts and instructions.

- **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 then select the **Maintenance** tab.
- c. Click **Server Diagnostics**, and then follow the on-screen prompts and instructions.

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