COMPAQ

Smart Array 5300 Controller

User Guide

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About This Guide

This guide is designed to be used as step-by-step instructions for installation and as a reference for operation, troubleshooting, and future upgrades for the Smart Array 5300 Controller.

Text Conventions

This document uses the following conventions to distinguish elements of text:

Keys	Keys appear in boldface. A plus sign (+) between two keys indicates that they should be pressed simultaneously.
USER INPUT	User input appears in a different typeface and in uppercase.
FILENAMES	File names appear in uppercase italics.
Menu Options, Command Names, Dialog Box Names	These elements appear in initial capital letters.
COMMANDS, DIRECTORY NAMES, and DRIVE NAMES	These elements appear in uppercase.
Type	When you are instructed to *type* information, type the information **without** pressing the **Enter** key.
Enter	When you are instructed to *enter* information, type the information and then press the **Enter** key.

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 clarifying information or specific instructions.

> **NOTE:** Text set off in this manner presents commentary, sidelights, or interesting points of information.

Symbols on Equipment

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

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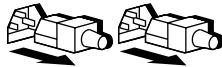
These symbols on power supplies or systems indicate the equipment is supplied by multiple sources of power.

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

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

Weight in kg
Weight in lb

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.

⚠ Important Safety Information

Before installing this product, read the *Important Safety Information* document provided.

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.

Compaq Technical Support

In North America, call the Compaq Technical Phone Support Center at 1-800-OK-COMPAQ. 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 Compaq Technical Support Phone Center. Telephone numbers for world wide Technical Support Centers are listed on the Compaq website. Access the Compaq website at www.compaq.com.

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

■ 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

Compaq Website

The Compaq website has information on this product as well as the latest drivers and Flash ROM images. You can access the Compaq website at www.compaq.com.

Compaq Authorized Reseller

For the name of your nearest Compaq authorized reseller:

■ In the United States, call 1-800-345-1518.

■ In Canada, call 1-800-263-5868.

■ Elsewhere, see the Compaq website for locations and telephone numbers.

Chapter 1

Board Components and Features

There are two models in the Compaq Smart Array 5300 Series of controllers:

■ The Smart Array 5302 is a two-channel Wide Ultra3 SCSI hard drive array controller with 32-MB or 64-MB Array Accelerator cache.

■ The Smart Array 5304 is a four-channel Wide Ultra3 SCSI hard drive array controller with 128-MB Array Accelerator cache.

A cache option kit and a two- to four-channel Wide Ultra3 adapter option kit allow the Smart Array 5302 to be upgraded to either 128-MB cache, four Ultra3 SCSI channels, or both.

The following pages show the options and the location of various important components on the controller board. Details of controller board specifications and servers supporting the SA5300 are given in Appendix C.
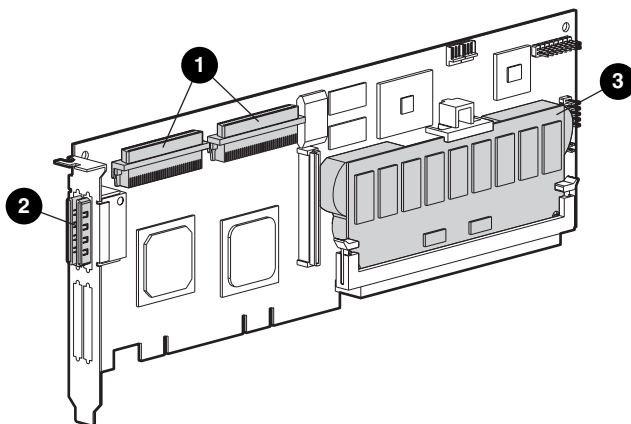
Figure 1-1. Smart Array 5302 Controller

❶ Two internal 68-pin Wide SCSI connectors (port 1 nearer the bracket, port 2 nearer the board center)

❷ Two external (VHDCI) connectors (port 1 nearer the board)

❸ Array Accelerator cache

NOTE: Ports 1 and 2 both have two connectors (one internal and one external), but only one connector can be used per port at any given time.
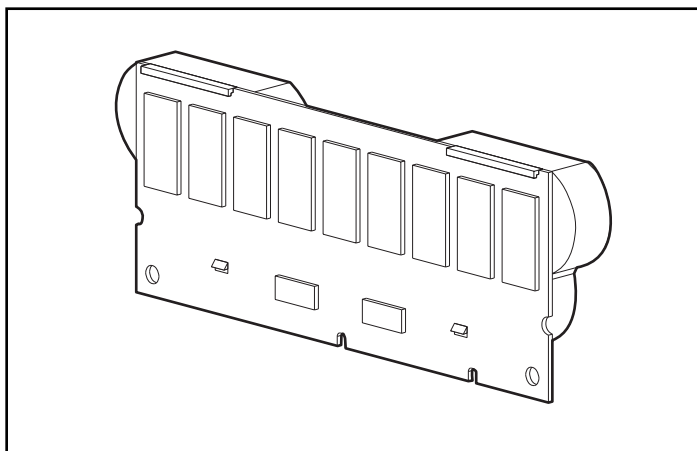
Figure 1-2. 128-MB array accelerator cache upgrade option with batteries
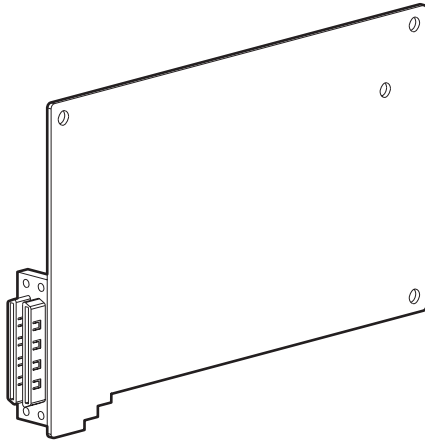
Figure 1-3. Two- to four-channel adapter upgrade option
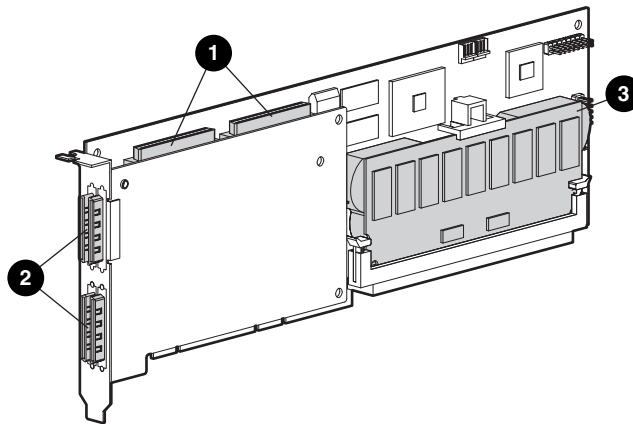
Figure 1-4. Smart Array 5304 Controller

❶   Two internal 68-pin Wide SCSI connectors (port 1 nearer the bracket, port 2 nearer the board center)

❷   Four external (VHDCI) connectors (ports 1 and 3 nearer the main board)

❸   Array Accelerator cache

> **NOTE:** Ports 1 and 2 both have two connectors (one internal and one external), but only one connector can be used per port at any given time. Ports 3 and 4 can only be used for external drives.

Overview of Controller Features

- Two or four Wide Ultra3 SCSI channels with support for up to 56 drives (4 channels, 14 drives per channel)

- Support for Wide Ultra3 SCSI devices (40-MHz bus, providing a data transfer rate of 160 MB per second per channel)

- Support for the Compaq 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 Compaq *StorageWorks*™ SAN Access Module

- Backward compatibility with Wide Ultra2 and Wide-Ultra SCSI-3 devices

- Removable Array Accelerator (see the next section for a description of the Array Accelerator features)

- 64-bit, 66-MHz PCI system interface, backward-compatible with 32-bit, 33-MHz slots

- RAID fault-tolerance support (0, 1, 0+1, 5, ADG)

- User-selectable stripe size

- Online array management features:

    - Online array capacity expansion

    - Online logical drive capacity extension

    - Online RAID migration between any level (0, 1, 0+1, 5, ADG)

    - Online stripe size migration

- Support for hot-pluggable drives

- Drive movement (in any order)

- Performance monitoring through *Compaq Insight Manager*™

- S.M.A.R.T. page support

- Drive Pre-Failure notification warranty

- Active global hot spare in the event of drive failure

- Automatic performance tuning

- Tagged command queuing

- Background initialization

- Multiple logical drives per array capability

Overview of Array Accelerator Features

The Array Accelerator is a high performance, 100-MHz SDRAM DIMM read/write cache that is particularly useful for increasing performance in database and fault-tolerant configurations. It performs both protected posted-write caching and read-ahead caching, allowing data to be accessed more than 100 times faster than from disk storage.

In protected posted-write caching, data is written to the cache memory on the Array Accelerator rather than directly to the drives. Later, when the system is idle, the controller writes the cached data to the drive array. By this method, the write cache can accept data from the server at a rate of up to 528 MB/s.

In read ahead caching, a multi-threaded algorithm predicts the next likely read operation for the array, and the required data for this operation is read into the cache from the drives. When the controller receives a read request for the cached data, the data can be burst immediately into system memory at PCI bus speeds, avoiding the latency of a disk access.

If the Smart Array 5300 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 Smart Array 5300 Controller and installed on another. Any data in the Array Accelerator that has not been written to the hard drive will be transferred to the other Smart Array 5300 Controller.

Other features of the Array Accelerator:

■   Cache capacities of 32 MB, 64 MB, or 128 MB available (smaller capacities upgradeable to 128 MB)

   NOTE: 8 MB of the 32-MB cache, and 16 MB of the 64-MB and 128-MB cache, are used for transfer buffer.

■   Mounted on a removable daughterboard (allows stored data to be moved to another controller if the original controller fails)

■   Backed up with replaceable batteries

■   Adjustable read/write ratio – usually set during array configuration (Chapter 7), but can be changed at any time

■   Single memory-chip failure protection for 64-MB and 128-MB Array Accelerators

■ 16-Bit Error Checking and Correcting (ECC) SDRAM memory. This detects and corrects all single-bit memory errors. It also detects all two-bit memory errors in any position, and most three- and four-bit memory errors in a single SDRAM. With ECC, an entire SDRAM can also fail without data loss. This provides a high level of data integrity by ensuring the correction of common memory errors without affecting system performance.

The Array Accelerator may sometimes be disabled by the Automatic Performance Tuning feature, or it can be manually disabled by using the Array Configuration Utility (ACU) (Chapter 7) .

Array Accelerator Batteries

The Array Accelerator has two rechargeable and replaceable NiMH battery packs. Under normal operating conditions, these should last for three years before replacement is necessary. They are continuously recharged via a "trickle" charging process whenever the system is powered on.

The battery packs protect data on the Array Accelerator against equipment failure or power outage for up to four continuous days. This also applies if the Array Accelerator is removed from the Smart Array 5300 Controller. When power is restored to the system, an initialization process writes the preserved data to the disk drives. This is particularly important for data that has been cached by a posted-write, but has not yet been written to the hard drives.

> **IMPORTANT:** The batteries on a new Smart Array 5300 Controller may be discharged when the board is first installed. In this case, a Power-On Self-Test (POST) message 1794 will be displayed when the server is powered on (see Appendix G), indicating that the Array Accelerator is temporarily disabled. No action is required on your part, since the internal circuitry will automatically recharge the batteries.
>
> Recharging the batteries can take up to 4 hours. The Smart Array 5300 Controller will function properly during this time, although without the performance advantage of the Array Accelerator. When the batteries are charged to 90 percent of their capacity, the Array Accelerator is automatically enabled.
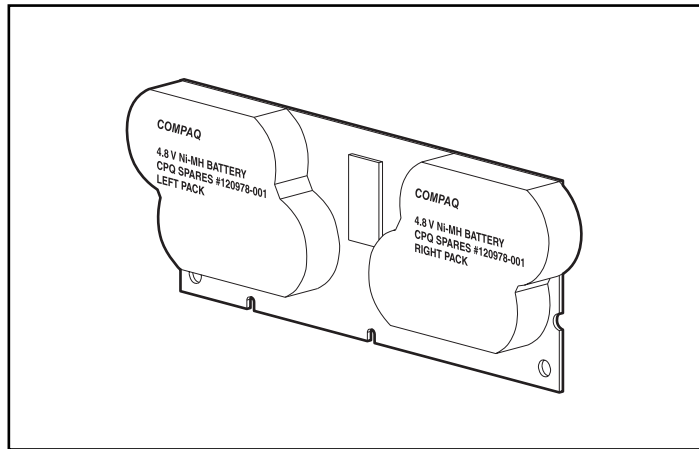
Figure 1-5. Battery packs located on the back of the Array Accelerator

For detailed battery replacement instructions, see Chapter 9.

PCI System Interface

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

■ runs at 66-MHz.

■ has a 64-bit interface.

■ has two parity protection signals.

■ provides a high-speed path (up to 528 MB/s) between the system board and the controller.

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. This allows the system processor to handle application processing or other types of tasks.

For maximum performance, Compaq 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, Wide Ultra2, and Wide-Ultra SCSI standards. Wide Ultra3 and Wide Ultra2 devices can use LVD or SE signaling on the SCSI bus, but Wide-Ultra devices can use only SE signaling.

A SCSI bus cannot carry LVD and SE signals concurrently. Attaching LVD and SE devices to the same SCSI bus will cause the LVD devices to revert to SE signaling to maintain compatibility. Hence, for maximum performance, Wide-Ultra devices should be connected to a separate bus from Wide Ultra2 and Wide Ultra3 devices.

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 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 RAID 1, RAID 5, or RAID ADG.

- **Dynamic sector repair** by the controller automatically remaps any sectors that have media faults (detected either during normal operation or by auto reliability monitoring).

- **Drive parameter tracking** monitors more than 15 drive-operational parameters and functional tests. This allows the array controller to detect drive problems and predict drive failure before they actually occur. It also makes pre-failure warranty possible on Compaq disk drives.

  Tracked parameters include read, write, and seek errors; spin-up time; cable problems; and functional tests such as track-to-track seek time, one-third stroke, and full stroke seek time.

- **Drive failure alert features** cause an alert message to be displayed on the system monitor when drive failure occurs. Different Compaq 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 (RAID 1 or higher) configurations. 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. Otherwise, if another hard drive fails before data has been rebuilt, the logical volume will fail and data will be lost. (See Appendix E for more information on recovering from drive failure.)

■ **Predictive Failure Alert** is a powerful problem-prevention feature that warns you when a drive failure is imminent. This allows you to take corrective action with minimal effect on critical business operations. Instructions for using Predictive Failure Alert can be found in the documentation for Compaq Insight Manager and Compaq Management Agents, located on the Compaq Management CD. Your system must use Compaq Insight Manager and a Compaq Smart Array controller to benefit from Predictive Failure Alert.

   NOTE: A predictive failure alert will not launch a rebuild and activate an online spare, because the degraded drive has not actually failed yet and is still online. The online spare is only activated after a drive in the array has failed.

■ **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. When you upgrade the ROM, the inactive image (the one not being used by the system) is upgraded. Thus, if one ROM image becomes corrupt (caused, for example, by power fluctuation during an upgrade of the ROM), the server still has a good copy of the ROM image to boot from. This is a background feature, and a user will not normally notice any difference in operation. When you use Recovery ROM for the first time, however, both ROM images are upgraded. This will cause a boot delay of about 20 seconds.

Other Compaq options such as Compaq Insight Manager and Compaq Server Manager/R provide additional drive failure features. See your authorized Compaq reseller for more information on these products.

Chapter **2**

Installation Overview

The exact procedure for installation of a new controller will differ from one system to another. The flow chart on the next page summarizes the steps that need to be taken for various possible scenarios, and gives reference to the relevant chapter for more detail. If a step does not apply in your specific instance, omit it and go to the next step.

In most cases, the steps must be performed in the order shown. In particular, the server firmware must be updated before the hardware is installed to ensure that the system will not hang up on boot.

| 1 | Back up data (REQUIRED if migrating from a non-array controller). | → | 2 | Upgrade the system firmware using System *ROMPaq* ™ (Chapter 3). |

| 3 | If the SA5300 will be the boot controller, install the device driver for your operating system (Chapter 4). |

| 5 | Update the controller firmware if required, using Options ROMPaq (Chapter 6). | ← | 4 | Install the controller hardware (Chapter 5). |

| 6 | Set the controller order using ORCA (Chapter 7). |

| 7 | Create logical drives using ORCA or ACU (Chapter 7). | → | 8 | If necessary, configure your system using the System Configuration Utility (Chapter 8). |

| 9 | If the SA5300 will not be the boot controller, install the device driver for your operating system (Chapter 4). |

| 10 | Reveal the logical drives to your system (Chapter 8). |

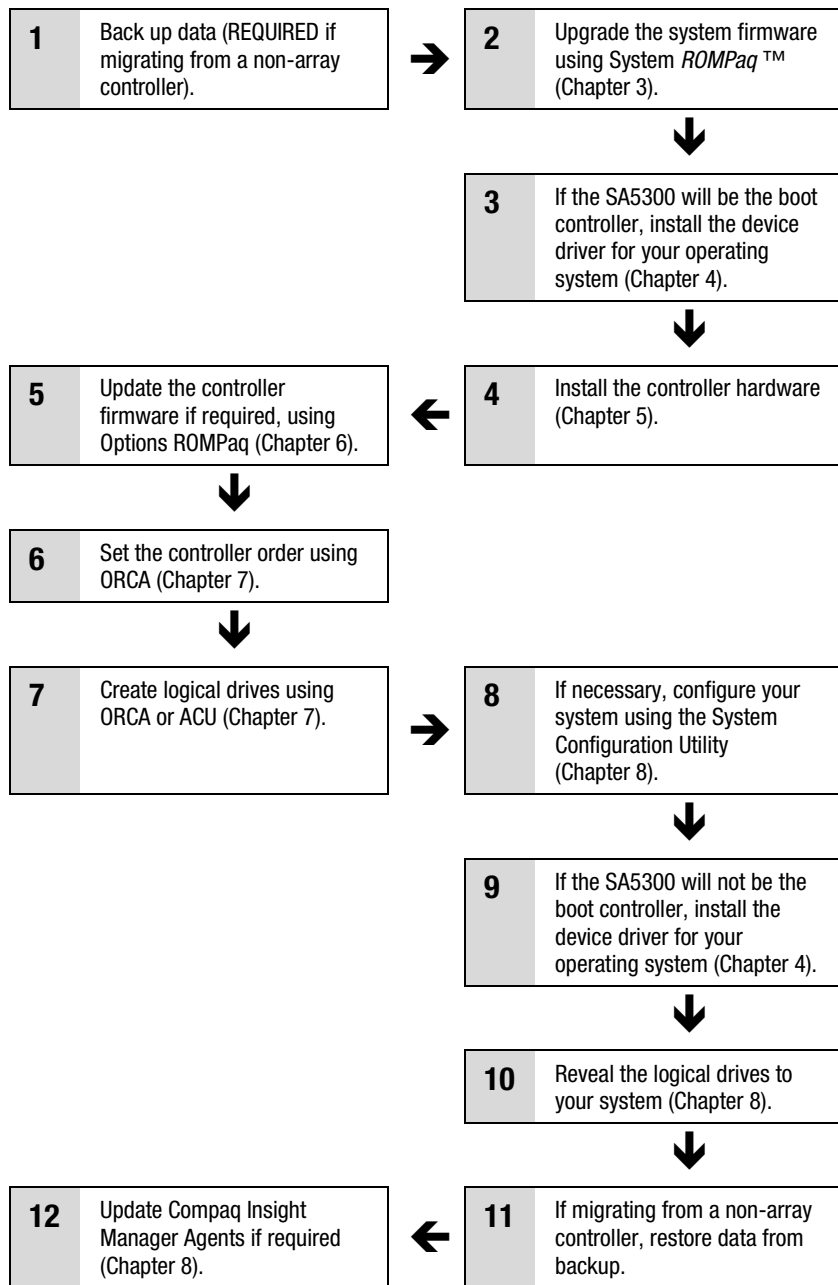| 12 | Update Compaq Insight Manager Agents if required (Chapter 8). | ← | 11 | If migrating from a non-array controller, restore data from backup. |

Figure 2-1. Flow chart for controller installation and system setup

Chapter ***3***

Updating the Server Firmware

The ROM on all Compaq servers and most Compaq options can be updated by using a Compaq utility called ROMPaq. This utility replaces the existing contents of the ROM with another version stored in a disk file.

There are two ROMPaq utilities:

■ **System ROMPaq.** This is used to update the system ROM in all Compaq servers that support Flash ROM. System ROMPaq *must* be run when installing a new array controller in a Compaq server to be sure that the server can use all the features of the array controller.

■ **Options ROMPaq.** This is used to update the onboard ROM on all Compaq options that support flashing. Use Options ROMPaq whenever new versions of the array controller firmware or SCSI drive firmware become available, to take advantage of expanded capabilities.

Both these ROMPaq utilities have two main sources:

■ The downloadable SoftPaq file on the Compaq website

■ The SmartStart and Support Software CD that is either shipped with your server or available directly from Compaq

Instructions for using these sources are given on the following pages.

Before using the CD, compare the version number of the ROMPaq on the CD against the version on the website. If the CD version is older, you should use the SoftPaq version instead.

Using the SoftPaq

If you use the SoftPaq, or if the server that needs a firmware update does not have a bootable CD-ROM drive, you will need to run System ROMPaq from diskette. The diskette can be created directly from the SoftPaq, or it can be created from the Smart Start and Support Software CD by using another server that has a bootable CD drive.

To create the diskette directly from the SoftPaq:

1. Create a temporary directory on your hard drive.
2. Locate the page containing the ROMPaq SoftPaq on the Compaq website.
3. Click the ROMPaq SoftPaq link.
4. Click the Download button, and direct the download to the temporary directory you created.
5. Click Save**.**
6. Execute the downloaded SoftPaq and follow the on-screen instructions to create the diskette.

To run System ROMPaq from diskette:

1. With the server off, place the System ROMPaq diskette in the diskette drive.
2. Turn on the server.
3. Press **Enter** at the Welcome screen.
4. At the Select A Device screen, select the server from the list of the programmable devices. This may be the only item in the list. Press **Enter**.
5. At the Select An Image screen, you will see:

   Device to reprogram: your server
   Current ROM revision: date of existing ROM version
   Select Firmware Images: date of latest ROM version

   Press **Enter**.

6. Review the information on the Caution screen and press **Enter** to reprogram the system ROM, or press **Esc** to discontinue reprogramming and return to the Select An Image screen (previous step).

   After pressing **Enter,** you will see the following message:

   Reprogramming Firmware

DO NOT INTERRUPT the reprogramming process. You will be notified when reprogramming is complete.

> **CAUTION:** Interrupting the ROM reprogramming will leave the firmware in an unknown state. You may not be able to boot the server if this happens.

7. When System ROMPaq has finished reprogramming the system ROM, press **Esc** to exit the utility.

8. Remove the System ROMPaq diskette and reboot the server by cycling the power (cold boot).

Using the SmartStart and Support Software CD

To run System ROMPaq directly from the *SmartStart*™ and Support Software CD:

1. Boot the server from the SmartStart and Support Software CD.

2. On the Compaq System Utilities menu screen, select Run System ROMPaq.

3. Follow the on-screen prompts and instructions to reprogram your system ROM.

If your server does not have a bootable CD-ROM drive, you will need to copy System ROMPaq to diskette and use the diskette to upgrade your server firmware.

1. Insert the Smart Start and Support Software CD into the CD-ROM drive tray of a server with a bootable CD drive.

2. Restart the server.

3. On the System Utilities Menu screen, select Create Support Software.

4. On the Diskette Builder menu screen, scroll through the list and select System ROMPaq Firmware Upgrade Diskette, then click the Next button.

5. Click the Create Diskettes Only radio button, and click Next**.**

6. Follow the remaining instructions on the screen to create the System ROMPaq diskette.

7. Follow the instructions in the previous section to run System ROMPaq from the diskette.

Chapter **4**

Installing the Device Drivers

This chapter describes the installation procedures for the Smart Array 5300 drivers in a server running any of the following operating systems:

- Microsoft Windows 2000

- Microsoft Windows NT 4.0

- Novell NetWare 4.2 and 5.x

- SCO UnixWare 7.1.x

- SCO OpenServer 5

- Linux

The drivers for these operating systems are located on the Smart Array 5300 Support Software CD. Driver updates are posted on the Compaq website, www.compaq.com.

- If the Smart Array 5300 will be the boot controller, you will also need to install the operating system (even if it is already present).

- If the Smart Array 5300 will *not* be the boot controller, you should postpone installation of the device drivers until after you have configured logical drives (Chapter 7).

The procedure for installing the drivers also depends on whether the server is new, or has previously been used and has the operating system and user data already on it.

Microsoft Windows 2000

Installing the Drivers on a New System

> **IMPORTANT:** When extending a logical drive under Windows 2000, upgrade the disk to DYNAMIC *before* creating a partition on that disk. If the disk already has a partition when it is upgraded to DYNAMIC, Windows 2000 may not allow logical drive extension. Refer to the Windows 2000 documentation for details about DYNAMIC and BASIC disks.

1. Start installing Windows 2000 as directed by the operating system instructions.

2. Press the **F6** key when instructed by a message that briefly displays at the bottom of the screen. If you do not press **F6** during the interval that the prompt is displayed, you must restart the installation.

3. After a delay, which may last several minutes, you will see this message at the bottom of the screen:

   S = Specify Additional Device   ENTER = Continue   F3 = Exit

   Press the **S** key.

4. If a menu is displayed, use the arrow keys to scroll to the menu item Other, and then press **Enter.**

5. You will be prompted to insert your manufacturer-supplied diskette. Insert the Smart Array 5300 Controller Support Software Diskette #1 and press **Enter.**

6. Select the menu item Compaq Smart Array 53xx Controller for Windows 2000 and press **Enter.**

7. A message on-screen will ask you to specify drivers for other hardware. If you do not have any additional drivers to install, press **Enter.**

8. Follow the on-screen instructions to complete the Windows 2000 installation. Leave the diskette in the drive until instructed to remove it.

9. Reboot.

10. Insert the Smart Array 5300 Controller Support Software CD into the CD-ROM drive.

If autorun does not execute:

a. Click Start and choose Run from the menu.

b. Enter <CD-ROM drive letter>:\Win2K\cpqsetup.exe in the Open field, and then click OK.

A message will be displayed, stating that the software is installed and up-to-date.

11. Click the Install button to continue installing the CISS Array Notification driver (*CPQCISSE.SYS*) and follow the on-screen instructions.

Results of the installation are logged to the file *<BOOT DRIVE LETTER>:\CPQSYSTEM\LOG\CPQSETUP.LOG*.

Installing the Drivers on an Existing System

NOTE: If installing the driver for the first time, the PNP Device Manager displays a Found New Hardware wizard dialog box. Click the **Cancel** button.

1. Insert the Smart Array 5300 Controller Support Software CD into the CD-ROM drive.

2. If autorun does not execute:

a. Click Start and choose Run from the menu.

b. Enter <CD-ROM drive letter>:\Win2K\cpqsetup.exe in the Open field, and then click OK.

3. Click the Install Windows 2000 Drivers button.

4. Confirm your choices on the following screens by clicking the appropriate buttons, and reboot the system if prompted when installation is complete.

Results of the installation are logged to the file *<BOOT DRIVE LETTER>:\CPQSYSTEM\LOG\CPQSETUP.LOG*.

Microsoft Windows NT 4.0

Installing the Drivers on a New System

1. Start the Windows NT installation directly from the Operating System CD, or from boot diskettes built from the CD.

2. Follow the Operating System instructions. When the Windows NT Setup screen is displayed, press **Enter** to begin driver installation.

3. If one of the entries at the bottom of the screen prompts you to press S to skip detection, press the **S** key.

4. When prompted to Specify Additional Device by a message at the bottom of the screen, press the **S** key.

5. Use the arrow keys to scroll to the menu item Other, then press **Enter**.

6. You will be prompted to insert your manufacturer-supplied diskette. Insert the Smart Array 5300 Controller Support Software Diskette #1 and press **Enter**.

7. Scroll to Compaq Smart Array 53xx Controller for Windows NT 4.0, then press **Enter.**

8. A message on-screen will ask you to specify drivers for other hardware. If you do not have any additional drivers to install, press **Enter.**

9. Continue the installation by following the on-screen instructions.

10. When Windows NT has rebooted, log in.

11. Insert the Smart Array 5300 Controller Support Software CD into the CD-ROM drive to install the CISS (*CPQCISSE.SYS*) Array Notification driver.

    If autorun does not execute:

    a. Click Start and choose Run from the menu

    b. Enter <CD-ROM drive letter>:\Winnt4\cpqsetup.exe in the Open field, and then click OK.

12. Follow the on-screen instructions.

Results of the installation are logged to the file
<BOOT DRIVE LETTER>:\CPQSYSTEM\LOG\CPQSETUP.LOG.

Installing the Drivers on an Existing System

1. Insert the Smart Array 5300 Controller Support Software CD into the CD-ROM drive.

   If autorun does not execute:

   a. Click Start and choose Run from the menu.

   b. Enter <CD-ROM drive letter>:\Winnt4\cpqsetup.exe into the Open field, and then click OK.

2. Follow the on-screen instructions.

   Results of the installation are logged to the file *<BOOT DRIVE LETTER>:\CPQSYSTEM\LOG\CPQSETUP.LOG.*

Novell NetWare 5.x

NOTE: NetWare 4.2 has a separate entry.

Installing the Drivers on a New System

1. Start NetWare 5.x installation as directed by the Operating System instructions.

2. The following message is displayed:

   The following drivers were detected for this server. Add change or delete device drivers as needed

   On the Options menu, use the arrow keys to choose Modify, then press **Enter.**

3. On the Device Type menu, choose Storage Adapters, then press **Enter.**

4. When the next screen is displayed, press the **Insert** key to add drivers. Press the **Insert** key again to add unlisted drivers.

5. Text at the top of the screen will prompt you to select a driver for each storage adapter. Insert the Smart Array 5300 Controller Support Software Diskette #1 into the diskette drive, then press **F3** to continue.

6. In the pop-up box, type a:\NetWare **a**nd press **Enter.**

7. Verify that *CPQRAID.HAM* (Compaq Smart Array 5300 Controller) is added to the list of storage drivers. Press **Escape,** then press **Enter** to return to Driver Summary.

8. On the Options menu, use the arrow keys to choose Continue, and press **Enter.**

9. At the next screen, on the Options menu, choose Modify and press **Enter.**

10. On the Device Type menu, choose Storage Devices and press **Enter.**

11. If *CPQSHD.CDM* (Compaq SCSI Hard Disk Driver) is listed, select it and press **Delete.**

12. Press the **Insert** key to add drivers. Press the **Insert** key again to add unlisted drivers.

13. Text at the top of the screen will prompt you to select a driver. Insert the Smart Array 5300 Controller Support Software Diskette #1 into the diskette drive, then press **F3** to continue.

14. In the popup box, type a:\NetWare and press **Enter.**

15. Verify that *CPQSHD.CDM* (Compaq SCSI Hard Disk Driver) is added to the list of storage devices. Press **Escape,** then press **Enter** to return to Driver Summary.

16. On the Options menu, choose Continue, then press **Enter.**

17. Follow the on-screen instructions to finish installation of the operating system.

Installing the Drivers on an Existing System

1. Insert the Smart Array 5300 Controller Support Software CD into the CD-ROM drive.

2. At the system console, type load CDROM and press **Enter.**

3. At the system console, type load <CD-volume name>:\NW5x\cpqsetup.nlm and press **Enter.**

4. Follow the on-screen instructions to complete the driver installation. Results are logged in the *SYS:\SYSTEM\CPQSETUP.LOG* file.

5. To install online ACU support, view <CD-volume name>:\Readme.txt for instructions.

6. After running *CPQSETUP*, enter restart server.

Novell NetWare 4.2

Installing the Drivers on a New System

1. Within the DOS partition where NetWare 4.2 will be installed, create a directory called NWUPDATE under <BOOT DRIVE LETTER>.

2. Insert Smart Array 5300 Controller Support Software Diskette #1 into the diskette drive.

3. Enter copy a:\NetWare\CPQSHD.* <boot drive letter>:\nwupdate.

4. Start the NetWare installation as directed by the Operating System instructions.

5. When a popup message confirms that a new PCI device has been detected, press **Enter.**

6. From the Driver Actions menu, choose Select Additional or Modify Selected Disk/LAN Drivers and press **Enter.** Press **Enter** again.

7. When prompted to choose the server drivers, choose Select Additional Driver and press **Enter.**

8. Select the option Use Only Previously Installed Drivers, then press the **Insert** key to add unlisted drivers.

9. Press **F3** to continue.

10. In the popup box, type a:\NetWare and press **Enter.** Select the *CPQRAID.HAM* driver**.**

11. On the Driver CPQRAID Parameter Actions menu, use the arrow keys to choose Save Parameters and Load Driver, then press **Enter.**

12. A popup window displays the message:

    Do you wish to select an additional Disk Driver [Y/N]

    Choose the option that matches your requirement and complete the installation of the Operating System as directed.

Installing the Drivers on an Existing System

1. Insert the Smart Array 5300 Controller Support Software CD into the CD-ROM drive.

2. At the system console, type load CDROM, then press **Enter.**

3. Type CD mount all, then press **Enter.**

4. Type load <CD-volume name>:\NW4x\cpqsetup.nlm and press **Enter.**

5. Follow the on-screen instructions to complete the driver installation. Results are logged in the *SYS:\SYSTEM\CPQSETUP.LOG* file.

6. Instructions for copying online ACU support are available at *<CD-VOLUME NAME>:\README.TXT.*

7. When finished, enter down at the NetWare console, then enter restart server.

SCO UnixWare 7.x

Installing the Drivers on a New System

The most recent drivers and support files for SCO UnixWare 7.x are located at www.compaq.com/support/files/server/us/index.html.

1. Start the UnixWare 7.x installation as directed by the operating system instructions.

2. When prompted for an hba diskette, insert the Smart Array 5300 Controller Support Software Diskette #2 into the diskette drive.

3. After the hba drivers are loaded, insert additional hba diskettes if required.

4. Continue the installation using the operating system instructions. Leave the diskette in the diskette drive until you are instructed to remove it.

Installing the Drivers on an Existing System

1. Log on to the server as root.

2. Insert the Smart Array 5300 Controller Support Software Diskette #2.

3. Type pkgadd-d diskette1 ciss.

4. Continue the installation using the operating system instructions. Leave the diskette in the diskette drive until you are instructed to remove it.

SCO OpenServer 5.0.x

Installing the Drivers on a New System

The most recent drivers and support files for SCO Open Server 5.0.x are available at www.compaq.com/support/files/server/us/index.html.

1. Run ORCA (Chapter 7) and verify that the Compaq Smart Array 5300 Controller is set to Controller Order First.

2. Boot the system from the OpenServer 5.0.x boot diskette or CD provided by SCO.

   The following boot message (or one similar) will be displayed:

   SCO OPENSERVER ™ RELEASE 5
   BOOT:

3. At the boot prompt, enter the following text:

   defbootstr link=ciss hd=sdsk

4. After the system finishes reading the information on the boot diskette or CD, the following message (or one similar) will be displayed, prompting you to insert the Compaq boot-time loadable drivers for SCO OpenServer Release 5:

   LOADING KERNEL FD (64) UNIX .TEXT
   ....
   ....
   ....
   ....
   LOADING KERNEL FD (64) UNIX .BSS
   LOADING KERNEL SYMBOL TABLE, THIS MAY TAKE A FEW MINUTES
   PLEASE INSERT THE FD (65) CISS VOLUME AND PRESS <RETURN>, OR 'Q' TO QUIT:

   Insert the provided Smart Array 5300 Support Software Diskette #3 and press **Enter**.

5. Proceed through the remainder of the installation as directed by the messages on the screen.

Installing the Drivers on an Existing System

1. Insert the Smart Array 5300 Controller Support Software Diskette #3 into the diskette drive.

2. Login as root and run the following commands at the prompt:

   MKDIR/5300BTLD
   MOUNT –ORO /DEV/FD0 /5300BTLD
   BTLDINSTALL /5300BTLD

3. You will be prompted to enter the package that has to be installed. Enter ciss and follow the instructions on the screen.

4. Run the following commands at the prompt:

   UMOUNT /5300BTLD
   RMDIR /5300BTLD

5. Run MKDEV CPQCISS and follow the instructions on the screen.

Linux

The latest Linux drivers, support files, and installation instructions are available for download at

   ftp:\\ftp.compaq.com\pub\linux

The Linux Smart Array driver is also present in Linux kernels 2.2.11 and newer, available at www.kernel.org.

Driver installation procedures vary between the different Linux distributions. For instructions relevant to your distribution, check the README file in the downloaded support files.

Consult your Linux user documentation for additional installation guidelines.

Chapter **5**

Controller Installation and Cabling

Preparing the Server

You may need a Torx T-15 screwdriver and a 3/16-in flat-bladed screwdriver.

⚠️ **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.

To prepare the server for Smart Array 5300 installation:

1. Back up all data. This is *mandatory* if you are moving non-arrayed SCSI drives to the Smart Array 5300, since data is not preserved during a move between array controllers and non-array controllers.

2. Shut down all applications.

3. Turn OFF the server.

⚠️ **CAUTION:** In systems using external data storage, be sure the server is the first unit powered down and the last to be powered back up. This will ensure that the system will not erroneously mark the drives as "failed."

4. Turn OFF any peripheral devices attached to the server.

5. Unplug the AC power cord from the outlet, then from the server.

> **IMPORTANT:** If you will be replacing a Smart Controller with a Smart Array 5300, see the "External Cabling Instructions" section later in this chapter to determine the external cabling requirements.

6. 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.

7. Remove or open the access panel.

Installing the Smart Array 5300

> **CAUTION:** Electrostatic discharge (ESD) can damage electronic components. Be sure you are properly grounded before beginning this procedure. See Appendix B for ESD information.

If you will be using Advanced Data Guarding (RAID ADG), install the RAID ADG Enabler Module on the Smart Array 5300 Controller before installing the controller in the server. The enabler module must be present for RAID ADG to be available as a fault-tolerance option. Also, the Array Accelerator cache must be no smaller than 64 MB when using RAID ADG. See Chapter 9 for installation instructions for the enabler module or cache.

To install a Smart Array 5300 in a Compaq server:

1. Select an available PCI slot. Slots that use a 64-bit interface, or operate at 66 MHz (or both), may provide higher performance. However, do not mix 66-MHz devices and 33-MHz devices on the same PCI bus; this will cause all devices on the bus to run at only 33 MHz.

2. Remove the slot cover or open the hot-plug latch. Save the retaining screw, if it is present.

3. Press the Smart Array 5300 firmly into the slot so that the contacts on the board edge are properly seated in the system board connector.
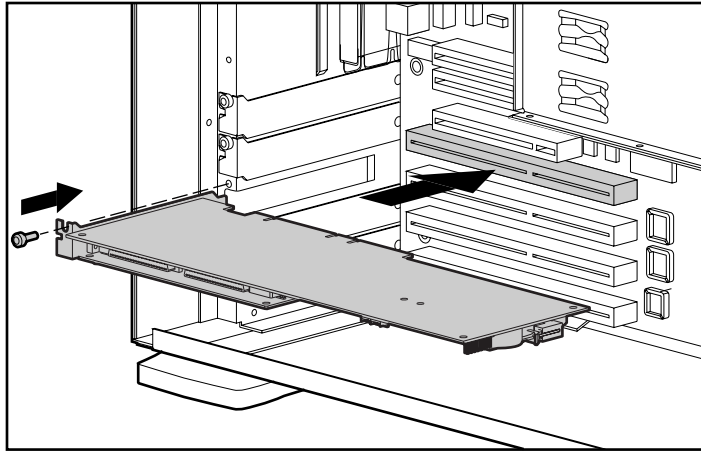
Figure 5-1. Installing a Smart Array 5300 Controller in a Compaq server

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

4. Secure the board in place with the hot-plug latch or retaining screw.

5. Connect all necessary cables to internal and external storage, as described in the following section.

Cabling Information

Ports 1 and 2 on the Smart Array 5300 each have two SCSI connectors, one for external storage units and one for internal hard drives in the server. The two connectors on a 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.

Each port on the Smart Array 5300 supports up to 14 drives. Peripherals attached to any of the connectors must have a unique SCSI ID value in the range 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 Compaq products that support hot-pluggable drives, the SCSI IDs for peripherals are automatically set. The IDs can also be set manually by using switches or jumpers on the device itself; this will be *required* for non-hot-pluggable devices.

> **IMPORTANT:** When replacing an existing Smart controller with the Smart Array 5300 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 Compaq servers and storage systems, however, the controller, SCSI cable, or backplane already provides this termination.

Internal Cabling for Compaq Servers

The exact procedure depends upon whether the device is hot-pluggable.

1. Power off the system, if the device is not hot-pluggable.

2. Install the Wide Ultra3, Wide Ultra2 or Wide-Ultra SCSI-3 drives into the server's removable media bays.

   ❑ For maximum performance, do not mix LVD (Wide Ultra3, Wide Ultra2) and SE (Wide-Ultra) drives on the same bus.

   ❑ Drives that are to be grouped in the same array should have the same capacity.

   For additional drive installation instructions, consult the original installation information that accompanied your drives.

3. Continue following the cabling instructions with whichever procedure is relevant for your system.

   For hot-pluggable drives:

   Use the internal point-to-point SCSI cable provided with your server. Attach this cable from internal port 1 or port 2 of the Smart Array 5300 Controller to the hot-plug drive cage.

   NOTE: For Duplex Drive Cage options, use both internal ports.

   For non-hot-pluggable drives:

   a. Manually set the SCSI ID on each drive to a unique value in the range of 0 to 15 for each SCSI bus; SCSI ID 7 is reserved for controller use. (For detailed instructions, consult the documentation that came with the drive.)

   b. Attach the multi-device SCSI cable from the internal port 1 or port 2 of the Smart Array 5300 to the non-hot-pluggable hard drives.

   ❑ If the drives are Wide-Ultra SCSI-3, use the multi-device SCSI cable that was provided with your server.

❑ If the drives are Wide Ultra3 SCSI or Wide Ultra2 SCSI, the multi-device cable may have been provided with your server. If additional cables are needed, order cable option kit, part number 166389-B21. This cable is equipped to terminate either Wide Ultra3, Wide Ultra2, or Wide-Ultra SCSI-3 drives.

> ⚠ **CAUTION:** Cable assembly 148785-001 is included in option kit 166389-B21 and is REQUIRED with Wide Ultra3 drives. Not using this cable may result in reduced performance and/or data loss.

See Appendix E, "Hard Drive Installation and Replacement," for additional information.

External Cabling for Compaq Servers

All Compaq Storage Enclosure models include external SCSI cables. Check the connector type on your storage device to identify the cable type needed. See Figure 5-2 and Table 5-1 for details.
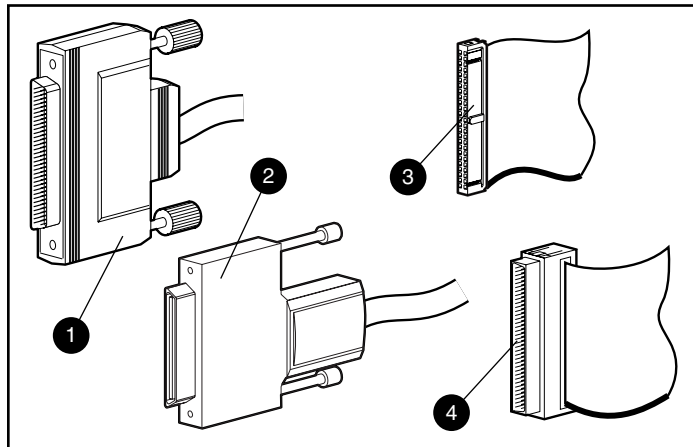
Figure 5-2. Identifying SCSI cable connectors

❶ External 68-pin Wide

❷ External offset VHDCI

❸ Internal 68-pin Wide

❹ Internal 50-pin narrow

Table 5-1
External SCSI Cables for Compaq Enclosures

Cable Type	Length	Option Kit Number	Cable Assembly Number
Offset VHDCI to Wide	6 ft / 1.8 m	341176-B21	313375-001
Offset VHDCI to Wide	12 ft / 3.6 m	341177-B21	313375-002
Offset VHDCI to Offset VHDCI	6 ft / 1.8 m	341174-B21	313374-001
Offset VHDCI to Offset VHDCI	12 ft / 3.6 m	341175-B21	313374-002
Offset VHDCI to Offset VHDCI	24 ft / 7.2 m	164604-B21	313374-004
Offset VHDCI to Offset VHDCI	39 ft / 11.7 m	150214-B21	313374-005

Note: If additional cables are required, order by the option kit number.

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 Smart Array 5300.

1. On the rear of the server, connect the cable to the VHDCI connector on the Smart Array 5300.

   IMPORTANT: Offset VHDCI cables *must* be used with the Smart Array 5300. Early versions of the VHDCI cables do not accommodate side-by-side connection of the cables to the Smart Array 5300. If your storage enclosure did not include the Offset VHDCI cables, you may need to order these. See Table 5-1 for Compaq part numbers.

   NOTE: Port 1 (or port 2) cannot be used externally if it is already being used internally.

2. Tighten the lock screws on the cable connector.

3. Attach the other end of the cable to the Compaq storage enclosure.

4. Tighten the lock screws on the cable connector.

5. Replace the access panel and secure it with the thumbscrews as required.

   NOTE: The server will not operate with the access panel removed. This precaution protects thermally sensitive components by ensuring the proper airflow through the server, and prevents contact with hazardous energy during servicing.
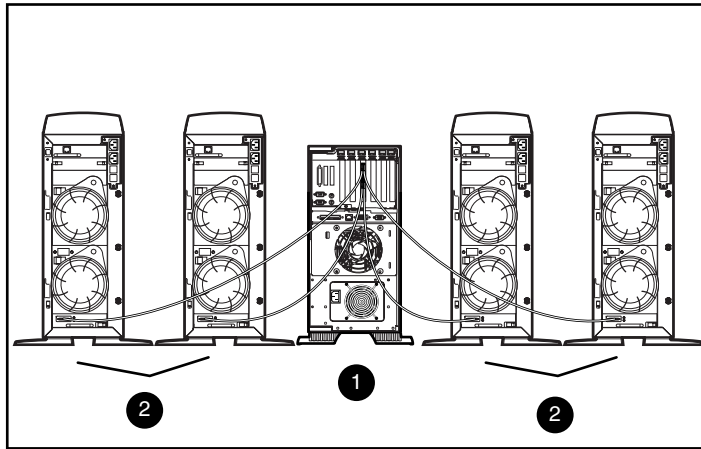
Figure 5-3. An example of external cabling between a Smart Array 5304 and
            four Compaq storage tower enclosures

❶   Smart Array 5304 Controller installed in server

❷   Compaq storage systems

> **NOTE:** The configuration of your system may differ from that shown above.

Chapter **6**

Options ROMPaq

Options ROMPaq updates the firmware on Compaq options. Compaq recommends that you run the latest Options ROMPaq on all Compaq array controllers whenever new versions of Options ROMPaq are released.

If you purchased your server with an array controller already installed, you do not need to run Options ROMPaq during server installation. However, if you have older Smart Array controllers or other Compaq options (such as drives), run Options ROMPaq to make sure that these devices have the latest firmware.

You can run Options ROMPaq either directly from the Controller Support Software CD, or from diskettes that you created from the CD. You will need to use diskettes if your server does not have a bootable CD-ROM drive. Instructions for both methods are given on the following pages.

To run Options ROMPaq directly from the CD:

1. Ensure that the server is off.

2. Place the Support Software CD in the server CD drive.

3. Boot the server by turning on the power.

4. The System Utilities Menu screen will be displayed. Press the **6** key on the keyboard, or use the arrow keys to select option 6 on the menu (Run Options ROMPaq) and press **Enter.**

5. Press **Enter** at the Welcome screen.

6. At the Select A Device screen, select ALL COMPAQ Smart Array 5300 Controller(s) from the list of programmable devices, then press **Enter**.

7. You should see one of two possible screens.

   ❑ If the screen reads:

   The ROM image files found for the device selected are not newer than the current ROM image

   press **Enter,** then go to step 9 of these instructions.

   ❑ If the screen reads:

Device to reprogram:	ALL COMPAQ Smart Array 5300 Controller(s)
Controller(s) Current ROM revision:	COMPAQ Smart Array 5300 Controller x.xx
Select Firmware Images:	COMPAQ Smart Array 5300 Controller y.yy

   this indicates that the ROM firmware currently on the Smart Array 5300 is older than that on the Options ROMPaq diskette.

   Press **Enter** to update the ROM.

8. Review the information on the Caution screen, then press **Enter** to reprogram the Smart Array 5300 ROM. (Alternatively, you may press **Esc** to discontinue the reprogramming and return to the Select an Image screen described in the previous step).

   After pressing **Enter,** you will see the following message:

   Reprogramming Firmware

   DO NOT INTERRUPT the reprogramming process. You will be notified when reprogramming is complete.

   > ⚠ **CAUTION:** Interrupting the ROM reprogramming may leave the firmware in an unknown state. If this happens, you may not be able to reprogram the ROM and the Smart Array 5300 ROM may have to be replaced.

9. When Options ROMPaq finishes reprogramming the array controller ROM, you can reprogram more options or exit Options ROMPaq.

   ❑ To reprogram another Compaq option, press **Enter**, and then repeat steps 6 through 8.

   ❑ If you have finished reprogramming Compaq options, press **Esc** to exit Options ROMPaq.

10. Remove the Controller Support Software CD and reboot the server by cycling the power (cold boot).

The Smart Array 5300 ROM has been updated. If there are any new or increased capabilities, they have been enabled with the new firmware.

To create Options ROMPaq diskettes:

1. Insert the Controller Support Software CD into the server CD drive tray.

2. Open the OPTRMDSK folder on the CD and execute the *QRST5.EXE* file.

3. Follow the on-screen prompts to create the set of four Options ROMPaq diskettes.

To run Options ROMPaq from the diskettes:

1. Ensure that the server is off.

2. Insert the first Options ROMPaq diskette into the diskette drive.

3. Restart the server.

4. Press **Enter** at the Welcome screen.

5. The Select a Device screen will be displayed. If the Smart Array 5300 is on the list of programmable devices, select it and press **Enter.** If it is not present, you will be prompted to insert the remaining diskettes for devices not listed on the first diskette. Locate and select the Smart Array 5300 on the device list.

6. You should see one of two possible screens.

    ❑ If the screen reads:

        The ROM image files found for the device selected are not newer than the current ROM image

        press **Enter,** then go to step 8 of these instructions.

    ❑ If the screen reads:

Device to reprogram:	ALL COMPAQ Smart Array 5300 Controller(s)
Controller(s) Current ROM revision:	COMPAQ Smart Array 5300 Controller x.xx
Select Firmware Images:	COMPAQ Smart Array 5300 Controller y.yy

        this indicates that the ROM firmware currently on the Smart Array 5300 is older than that on the Options ROMPaq diskette.

        Press **Enter** to update the ROM.

7. Review the information on the Caution screen, then press **Enter** to reprogram the Smart Array 5300 ROM. (Alternatively, you may press **Esc** to discontinue the reprogramming and return to the Select an Image screen described in the previous step).

    After pressing **Enter,** you will see the following message:

    Reprogramming Firmware

DO NOT INTERRUPT the reprogramming process. You will be notified when reprogramming is complete.

> △ **CAUTION:** Interrupting the ROM reprogramming may leave the firmware in an unknown state. If this happens, you may not be able to reprogram the ROM and the Smart Array 5300 ROM may have to be replaced.

8. When Options ROMPaq finishes reprogramming the array controller ROM, you can reprogram more options or exit Options ROMPaq.

   ❑ To reprogram another Compaq option, press **Enter**, then repeat steps 5 through 7.

   ❑ If you have finished reprogramming Compaq options, press **Esc** to exit Options ROMPaq.

9. Remove the Options ROMPaq diskette and reboot the server by cycling the power (cold boot).

The Smart Array 5300 ROM has been updated. If there are any new or increased capabilities, they have been enabled with the new firmware.

Chapter **7**

Configuring Your Array

Compaq provides three utilities for configuration of your arrays, each of which is described in detail in this chapter. The two main utilities are compared in the following table. NetWare users also have the option of using CPQONLIN, which is a menu-driven utility.

For background information about drive arrays and hardware RAID fault-tolerance methods, see Appendix D.

Table 7-1
Features of ORCA and ACU

Option ROM Configuration for Arrays (**ORCA**)	Array Configuration Utility (**ACU**)
Menu-driven interface	Graphical interface
Targeted to experienced RAID users with minimal configuration needs	Targeted to users with extensive configuration needs; also has wizards for novice users
Can be started when server is booting	Can be executed at any time; runs online with Windows 2000, Windows NT 4.0, and NetWare
Does not require diskettes or CDs to run	Runs from the SA 5300 Controller Support Software CD
Can create, configure and/or delete logical drives, specify RAID level, assign online spare, and set controller order; however, cannot set stripe size or controller settings	Full control over physical configuration; can configure any number of physical drives and arrays; suggests the optimal configuration and fault tolerance method for unconfigured controllers; provides descriptions of various configuration errors
Supports only English	Supports many languages

There are some limitations common to all three methods:

■ For the most efficient use of drive space, do not mix drives of different capacity within the same array. Each configuration utility treats all hard drives in an array as if they have the same capacity as the smallest drive in the array. Excess capacity of larger drives is wasted because it cannot be used by the array.

■ Only one online spare drive can be assigned per array. (In ORCA, there is also the restriction that only one array can use a given online spare.)

■ The probability that an array will experience a hard drive failure increases with the number of hard drives in the array (see Appendix F). To keep the probability of failure acceptably low, use no more than 14 drives in a RAID 5 array. However, an array using RAID ADG is more secure, and is limited in size only by the number of drives that can be attached to the controller.

■ An array can have no more than 32 logical drives.

Option ROM Configuration for Arrays (ORCA)

When a computer system is powered on, part of the start-up sequence is the Power-On Self-Test (POST). Any array controllers in the system will be initialized while POST is running. If the array controller supports ORCA, POST will temporarily halt and an ORCA prompt will be displayed for about 5 seconds.

If ORCA is not supported, the prompt will not be displayed and the system will continue with POST.

While the prompt is displayed, you can press **F8** to start the ORCA utility or press the **ESC** key to bypass ORCA immediately.

Compaq Smart Array 5300 Controller

Press <F8> to run the Option ROM Configuration for Arrays utility

Press <Esc> to skip configuration and continue

Figure 7-1. POST prompt message for ORCA

After **F8** has been pressed, you will see the main ORCA menu. This will allow you to select the boot controller for the system, or create, view, or delete a logical drive.

To create a logical drive:

1. Choose the Create a Logical Drive menu option.

   The screen now displays a list of all available (unconfigured) physical drives and the valid RAID options, and allows you to configure a spare drive for the array.

   NOTE: You can only create one logical drive at a time.

2. Use the arrow keys, space bar, and tab key to navigate around the screen and set up your logical drive.

3. Press **Enter** to accept the settings.

4. At the next screen, press **F8** to confirm your settings and save the new configuration.

5. After several seconds, the Configuration Saved screen is displayed. Press **Enter** to continue.

   You can now create another logical drive on any remaining hard drives by repeating the previous steps.

Array Configuration Utility (ACU)

The ACU is located on the Smart Array 5300 Controller Support Software CD. You can either run the ACU directly from the CD, or – if the server you are configuring is running Windows NT, Windows 2000, or NetWare – you can download the ACU onto your server and run it online.

When you start the ACU, it checks the configuration of every controller and drive array.

If an array is not configured optimally, a configuration wizard will open and guide you through the configuration process. The ACU wizard will also help you configure any new controllers, assign unused physical drives to existing arrays (without destroying data), and configure any unused space present on an array into another logical drive.

If a problem is found, an error or warning message will be displayed describing the problem. These messages include instructions to correct configurations. If a warning message indicates that an "Internal Error Has Occurred" and cites an error code number, the problem requires assistance from Compaq technical support. See the "About This Guide" section at the beginning of this guide for technical support phone numbers.

Context-sensitive online help for each screen can be reached by pressing the **F1** key or clicking the Help button. The status bar at the bottom of the screen will also display messages describing the current selection.

To run the ACU from the CD:

1. Insert the CD into the CD-ROM drive and reboot the server.

2. On the CD menu, double-click the ACU icon.

3. Configure your array (see the following sections for detailed procedures).

4. When finished, remove the CD and restart the server.

To run the ACU online:

■ **Windows NT and Windows 2000 –** Insert the CD and follow the on-screen instructions to download the utility. When installation is complete, click Start, select Compaq System Tools, and then double-click the ACU icon.

■ **NetWare –** If your systems is running NetWare, you have two choices:

❑ If you prefer a menu-driven interface, use the NetWare Online Array Configuration Utility (described later in this chapter). Load *CPQRAID.HAM* and *CPQONLIN.NLM* from the CD. Open *CPQONLIN.NLM* and follow the on-screen instructions.

❑ If you prefer a graphical interface, follow the previous instructions to run the ACU from CD.

ACU Screen Descriptions

The main ACU screen and the various secondary screens are described on the following pages.

Main Configuration screen

The Main Configuration screen is the first to be displayed after the configuration wizard has finished or been bypassed.
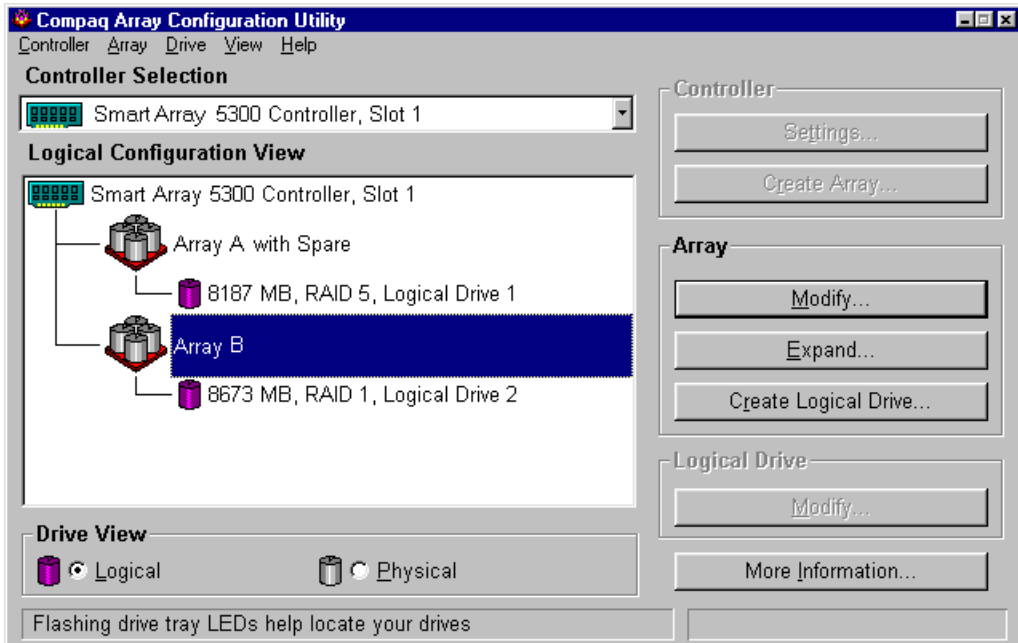
Figure 7-2. Main Configuration screen

The Main Configuration screen contains these regions:

■ Menu bar

■ Controller Selection box

■ Configuration View window

■ Drive View box

■ Controller box

■ Array box

■ Logical Drive box

■ More Information button

Some buttons will be grayed out. You cannot select grayed-out buttons until you select an item in the configuration view window that provides that option.

Menu Bar

The menu bar at the top of the Main Configuration screen contains the following drop-down menus:

■ Controller—Allows you to select a controller, refresh the screen, save or clear a configuration, create an array, and to exit the program. Also gives access to settings, advanced features, information, and the configuration wizard.

■ Array—Allows you to delete, modify, or expand the capacity of an array, create logical drives, and view array information.

■ Drive—Allows you to delete or change logical drives and to view drive information.

■ View—Allows you to switch between Physical Configuration View and Logical Configuration View.

■ Help—Allows you to access online help.

Controller Selection box

This box provides a drop-down menu of the controllers installed in the system. When a listed controller is selected, details of the drives and arrays that are connected to the controller are shown in the Configuration View window.

Controller Selection

Smart Array 5300 Controller, Slot 1

Figure 7-3. Controller Selection box

Physical/Logical Configuration View window

The Physical/Logical Configuration View window shows all the drives and arrays configured for the controller that was selected from the Controller Selection box menu.

Use the Drive View radio buttons below the Configuration View window to show the physical or logical view.

Figure 7-4 shows the physical configuration view of a Smart Array 5300 in slot 1. Two unassigned drives and two arrays are shown connected to the controller. The physical drives within each array are also shown, including a spare drive.
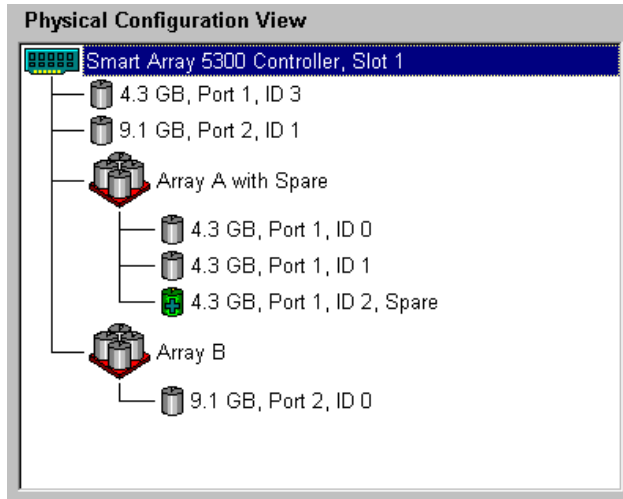
Figure 7-4. Physical Configuration View window

> **NOTE:** Selecting any item in the configuration view window will cause the corresponding hard drive tray LEDs to blink. This feature is useful for identifying all physical drives in an array or logical drive, all drives on a controller, or a specific physical drive.

Drive View box

Use the radio buttons in this box to display a logical or physical configuration view in the Configuration View window.

Figure 7-5. Drive View box

Controller box

The buttons in the Controller box are activated when you select a controller in the Controller Selection box.
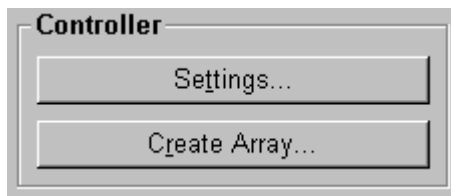
Figure 7-6. Controller box

Click one of these buttons to display the Controller Settings screen or the Create Drive Array screen. These screens are described later in this section.

Array box

The buttons in the Array box are activated when you select an array in the Configuration View window.
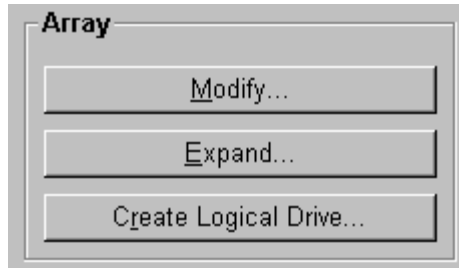
Figure 7-7. Array box

Click one of these buttons to display the Modify Array screen, the Expand Array screen, or the Create Logical Drive screen. These screens are described later in this section.

Logical Drive box

The buttons in the Logical Drive box are activated when you select a logical drive in the Configuration View window.
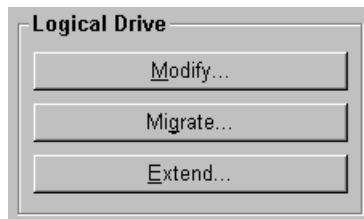
Figure 7-8. Logical Drive box

Click one of these buttons to display the Modify Logical Drive screen, the Migrate Logical Drive screen, or the Extend Logical Drive screen. These screens are described later in this section.

More Information button

Click the More Information button in the bottom right of the Main Configuration screen to get details of the item that is selected in the Configuration View window.

Secondary Screens

Controller Settings screen

This screen is reached by clicking the Settings button in the Controller box (Figure 7-6) on the Main Configuration screen. It allows the rebuild priority, expand priority, and accelerator read/write ratio to be set.
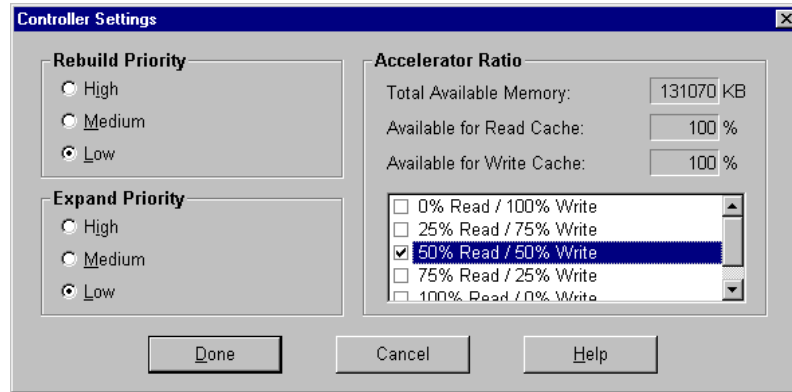
Figure 7-9. Controller Settings screen

The settings for Rebuild Priority and Expand Priority will not affect the performance of an idle system. However, they will affect performance on a busy system. On the Low settings, the controller will rebuild or expand only when the controller is idle, whereas on High settings the controller will give precedence to the rebuild or expansion. However, Low settings leave the array vulnerable to drive failure for a longer time.

The Accelerator Ratio setting determines the amount of memory allocated to the read and write caches. Some applications may perform better with a larger write cache; others may perform better with a larger read cache.

> **NOTE:** If you optimize the Accelerator Ratio setting, you may also want to change the Stripe Size setting. See Tables 7-2 and 7-3 for details.

Create Drive Array screen

This screen is reached by clicking the Create Array button in the Controller box (Figure 7-6) on the Main Configuration screen. The left window of the Create Drive Array screen shows all drives that are attached to the controller previously selected on the Main Configuration screen.
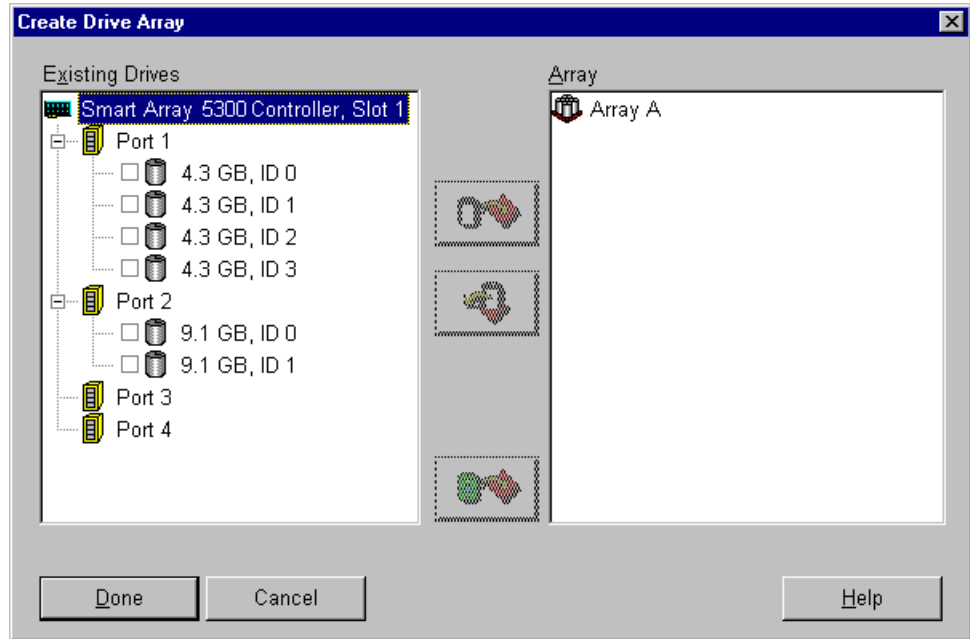
Figure 7-10. Create Drive Array screen

The three buttons in the middle of this screen are:

■ Assign Drive To Array

■ Remove Drive From Array

■ Assign Spare To Array

When creating an array, use physical drives that all have the same capacity. If you mix drives that have different capacities, the ACU treats the drives as if they all have the same capacity as the smallest drive in the array. This wastes storage space on the larger drives.

Performance improves when drives in an array are distributed across several SCSI ports on the controller rather than being connected to only one port.

> **NOTE:** The probability that an array will experience a drive failure increases with the number of drives in the array. Compaq recommends that no more than 14 drives be used per array in RAID 5 configurations. (If RAID ADG is used, however, the number of drives in the array is only restricted by the number of drives that can be attached to the controller).

Fault-tolerant configurations (RAID 1, 5, or ADG) allow an online spare to be assigned to an array. This spare acts as an immediate replacement for a failed drive. The Automatic Data Recovery process (see Appendix E) reconstructs the failed drive data from fault tolerance information on the remaining drives in the logical volume. This reconstructed data is written to the spare drive. Once data recovery is complete, the logical volume can again run at full fault tolerance.

However, if another drive fails before the data has been completely recovered, the entire logical volume will fail. Also, non-correctable disk errors can prevent completion of the Automatic Data Recovery process.

Modify Logical Drive screen

This screen is reached by clicking the Modify button in the Array box on the Main Configuration screen. It brings up a screen similar to the Create Drive Array screen, which allows you to change the configuration of logical drives on your array.

Expand Array screen

This screen is reached by clicking the Expand button in the Array box on the Main Configuration screen. It resembles the Create Drive Array screen (Figure 7-10).

The Expand Array screen allows you to add more hard drives to an array that has already been configured. The extra capacity can be used to build another logical drive on the array, or to extend the logical drive that already exists on the array (see "Extending Logical Drive Capacity" later in this chapter).

Create Logical Drive screen

This screen is reached by clicking the Create Logical Drive button in the Array box (Figure 7-7) on the Main Configuration screen. It allows you to select the fault tolerance method, enable the array accelerator, and set the stripe size and logical drive size.
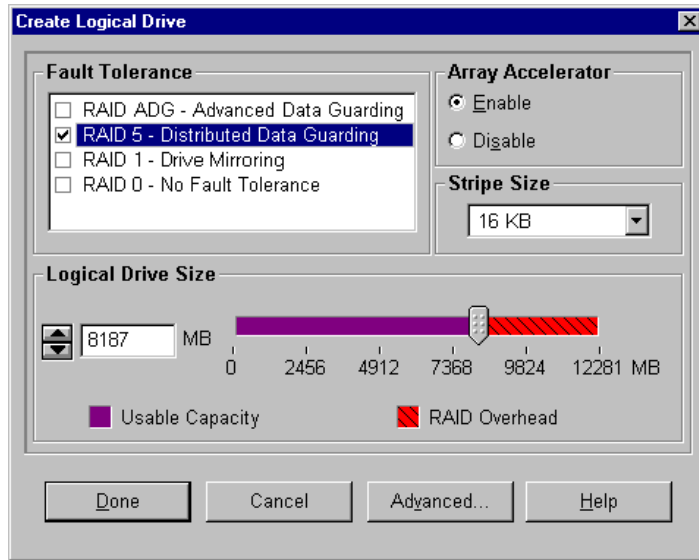
Figure 7-11. Create Logical Drive screen

Three features on this screen merit further description:

■ Stripe Size box

■ Logical Drive Size box

■ Advanced button

The **Stripe Size box** has a drop-down menu that lets you select the width of a data stripe *on a new logical drive*. (This width corresponds to the size of a data block on each hard drive in the logical volume, as described in Appendix D).

> **CAUTION:** This method does NOT preserve user data. Instead, to change the RAID level and stripe size on a logical drive that *already contains user data*, click the Migrate button to reach the Migrate RAID/Stripe Size screen.

Each RAID level supports several stripe widths (Table 7-2). The default stripe size initially displayed by the ACU is chosen for optimum performance under the commonest operating conditions. Table 7-3 suggests how to optimize the stripe width for different types of application.

Table 7-2
Available Stripe Sizes for a Given RAID Level

Fault Tolerance Level	Default (KB)	Available Stripe Sizes (KB)
RAID 0	128	8, 16, 32, 64, 128, 256
RAID 1 or 0+1	128	8, 16, 32, 64, 128, 256
RAID 5, RAID ADG	16	8, 16, 32, 64

Table 7-3
Optimum Stripe Size

Type of Server Application	Suggested Stripe Size Change
Mixed read/write	Accept the default value
Mainly sequential read (such as audio/video applications)	Larger stripe sizes work best
Mainly write (such as image manipulation applications)	Smaller stripes for RAID 5, RAID ADG
	Larger stripes for RAID 0, RAID 0+1, RAID 1

The **Logical Drive Size box** shows how much drive capacity is available on the selected logical drive when using the chosen RAID level. The left side of the slider scale shows how much drive capacity is available to store data, while the right side indicates how much capacity is required for storing parity or mirrored information. (RAID overhead is not needed for RAID 0.)

The default logical drive size first shown in this box is the maximum available for your drive array. To create more than one logical drive on the array, reduce the logical drive size by typing a smaller number in the scroll box.

Clicking the **Advanced button** causes the Advanced Features screen to be displayed. This screen allows you to enable or disable the maximum boot size for a logical drive. The default boot size is 32 sectors (16kB) per track, and the maximum boot size is 63 sectors per track.
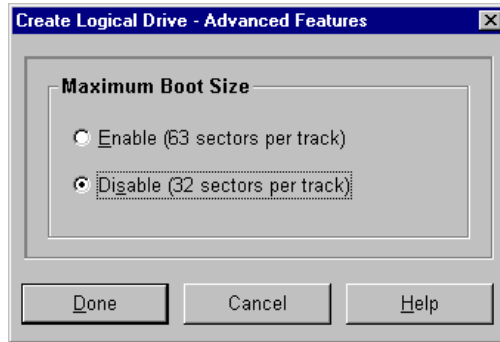
Figure 7-12. Advanced Features screen

Some operating systems need to use the maximum boot size to be able to create large boot partitions. For example, enabling the maximum boot size on a logical drive in Windows NT 4.0 allows you to create a bootable partition with a maximum size of 8 GB.

> **NOTE:** Enabling the maximum boot size may decrease performance of the logical drive.

Migrate RAID/Stripe Size screen

This screen is reached by clicking the Migrate button in the Logical Drive box (Figure 7-8) on the Main Configuration screen. It allows you to change the stripe width (block size) or RAID level of an existing logical drive while online, without causing data loss.
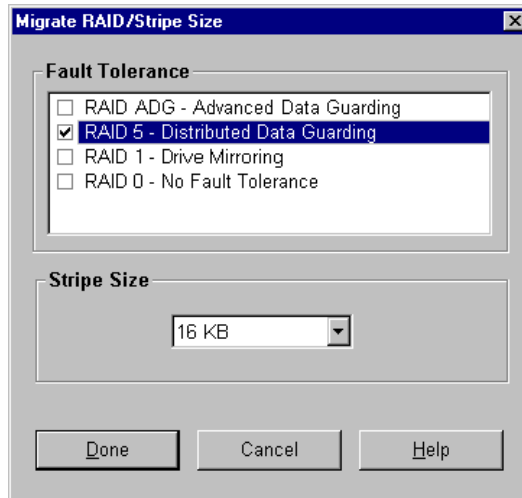
Figure 7-13. Migrate RAID/Stripe Size screen

Extend Logical Drive screen

This screen is reached by clicking the Extend button in the Logical Drive box (Figure 7-8) on the Main Configuration screen. It allows you to increase the capacity of a logical drive while online without disruption of data.

> **IMPORTANT:** Not all operating systems support online capacity extension. Read the procedure in the following section to determine whether your system is supported.
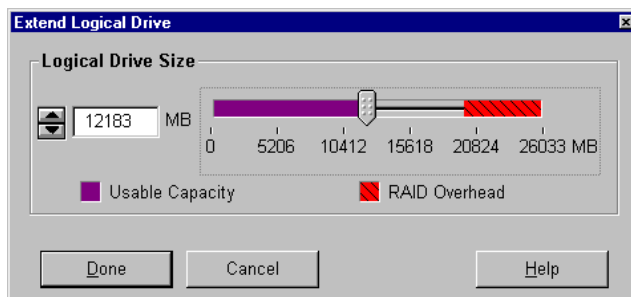
Figure 7-14. Extend Logical Drive screen

Typical Configuration Procedures

When you start the ACU to configure a new array, the configuration wizard will open to lead you through the process. However, you can bypass the wizard and manually:

■ Create a new array.

■ Expand the capacity of an array.

■ Extend the capacity of a logical drive.

■ Migrate to a different RAID level or stripe size.

Creating a New Array

There are three stages in the procedure for manually creating a new array:

1. Choose a controller for the array.

2. Group physical drives of the same size into an array.

3. Divide the array into one or more logical drives.

For this example, assume that you have four 4.3-GB drives and two 9.1-GB drives connected to a Smart Array 5300 Controller. You want to make two arrays:

■ Array A: three 4.3-GB drives with the fourth 4.3-GB drive used as a spare. This array is to be configured with RAID 5 fault tolerance.

■ Array B: two 9.1-GB drives in a RAID 1 fault-tolerance configuration.

Stage 1: Choose a controller for the array

1. On the ACU Main Configuration screen, select one of the controllers from the drop-down list in the Controller Selection box. (Alternatively, click Controller on the menu bar, then click Select.)

2. Click the Controller Settings button.

   The Controller Settings screen is displayed.

3. Select the rebuild priority, expand priority, and accelerator ratio.

4. Click the Done button to return to the Main Configuration screen.

Stage 2: Group physical drives of the same size into an array

1. Click the Create Array button in the Controller box.

   The Create Drive Array screen is displayed.

2. Select the drives you want to make up the array from the drives shown in the left window.

   IMPORTANT: Only group physical drives in an array if they are of similar capacity. If the drives have different capacities, the excess capacity of the larger drives cannot be used by the array and will be wasted.

   For this example, select the three drives on Port 1 with SCSI IDs 0, 1, and 2.

3. Click the Assign Drive(s) to Array button in the middle of the screen.

   NOTE: The probability that an array will experience a drive failure increases with the number of drives in the array. Compaq recommends that no more than 14 drives be used per array in RAID 5 configurations. (If RAID ADG is used, however, the number of drives in the array is only restricted by the number of drives that can be attached to the controller).

4. Select the drive at Port 1: SCSI ID 3 and click the Assign Spare to Array button in the middle of the screen.

NOTE: The same spare drive may be assigned to multiple arrays. However, spare drives must have a capacity greater than or equal to that of the other drives in the array.

The Create Drive Array screen should resemble the following figure.
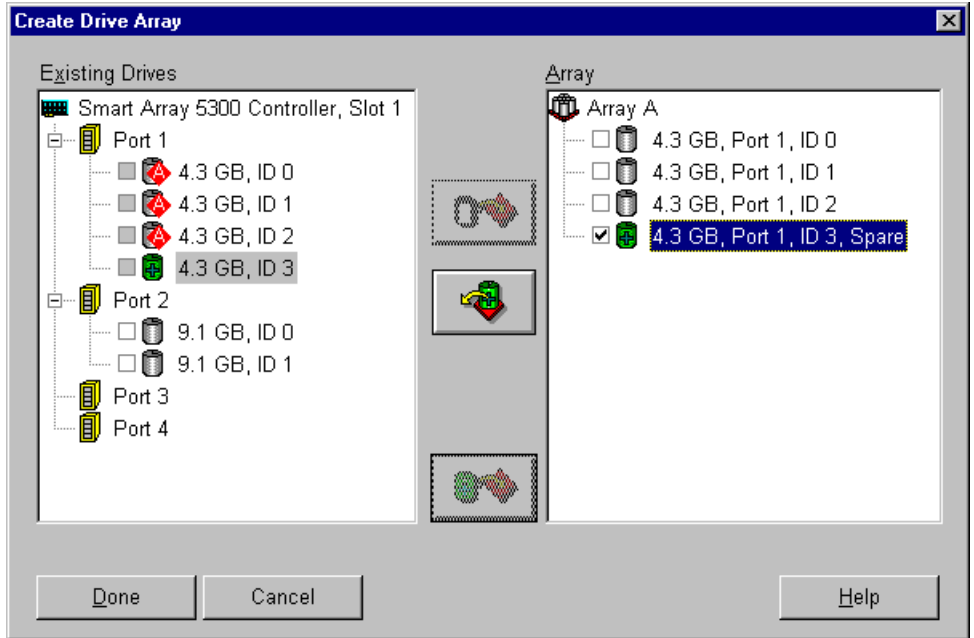
Figure 7-15. Example Array A

5. Click the Done button to return to the Main Configuration screen.

The Logical Configuration view should now resemble the following figure.
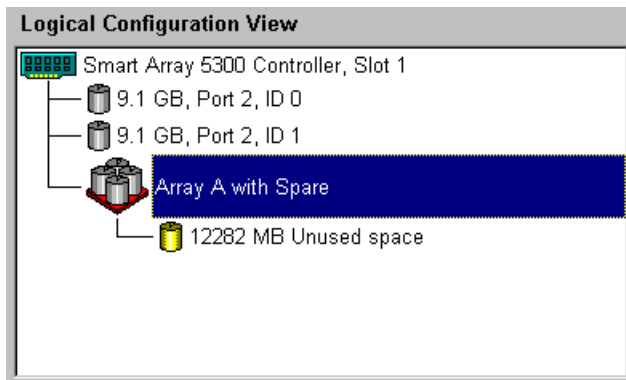
Figure 7-16. Example array - Logical Configuration View with one array

6. Select the controller icon, then click the Create Array button to create Array B.

7. Repeat the previous steps to assign both 9.1-GB drives to array B.

8. Click the Done button to return to the Main Configuration screen.

In this example, each array was created using drives from the same SCSI Port. Better performance can be achieved by selecting drives from more than one port, if you installed the correct drives in the ports before you ran the ACU.

Stage 3: Create logical drives across the physical drives in the array

1. Select the Array A icon or the Unused Space icon under Array A in the Logical Configuration View window.

2. Click the Create Logical Drive button in the Array box.

3. Select the RAID 5 checkbox.

4. Click the Enable Array Accelerator radio button.

5. Change the stripe size, if desired.

6. The default values in the Logical Drive Size box will create a single logical drive on the array. For this example, accept the default values.

7. Click the Done button to return to the Main Configuration screen.

8. To save the new settings, click Controller on the menu bar and select the Save Configuration option.

9. To create a logical drive on Array B, select the Array B icon or the Unused Space icon under Array B in the Logical Configuration View and follow the previous steps. This time, select RAID 1 as the fault tolerance method. Save the configuration as before.

   The Main Configuration screen should now resemble the following figure.
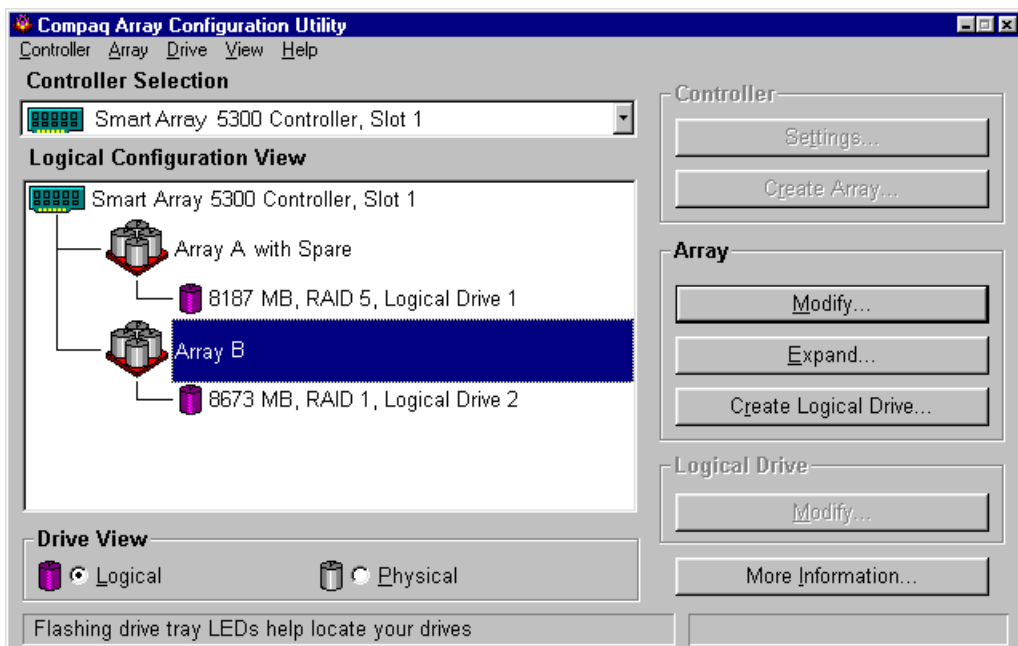
Figure 7-17. Example array – Logical Configuration View screen, two arrays

> **NOTE:** The capacity shown for each logical drive is the free capacity available for data storage. This value excludes the amount used for fault tolerance.

Expanding Array Capacity

Array capacity expansion is the addition of storage capacity to an array that has already been configured. The capacity of logical drives on the array does not change, and existing data is not disturbed.

During capacity expansion, the ACU automatically redistributes existing logical drives across all physical drives in the expanded array. If the array being expanded has more than one logical drive, data will be redistributed one logical drive at a time. Newly created logical drives will not be available until capacity expansion has finished.

> **CAUTION:** Do not exchange the Smart Array 5300 or Array Accelerator board during array capacity expansion. This will cause irretrievable data loss.

> **NOTE:** The expansion process takes about 15 minutes per GB. A logical drive will be unavailable for any other process while it is undergoing an expansion, and no other logical drive in the system can be expanded, extended, or migrated during this time.

There are three stages in the procedure for expanding an array:

1. Back up data on the array. Although data loss is not expected during normal operation, backing up data will give peace of mind. The backup data can also be used to return the array to the original configuration, if necessary.

2. Install the new physical drives.

> **IMPORTANT:** Only group physical drives in an array if they are of similar capacity. If the drives have different capacities, the excess capacity of the larger drives cannot be used by the array and will be wasted.

3. Use the ACU to assign the new physical drives to an existing array. When the expansion process is complete, the extra capacity can be used to increase the size of an existing logical drive (see "Extending Logical Drive Capacity" later in this chapter) or to create a new logical drive.

For example, assume that you start with two arrays on a controller, neither with a spare:

■ Array A has three 4.3-GB drives in a RAID 5 configuration.

■ Array B has two 9.1-GB drives in a RAID 1 configuration.

Now you install a 4.3-GB drive, and want to expand Array A to include this new drive. This scenario is represented in the following figure.
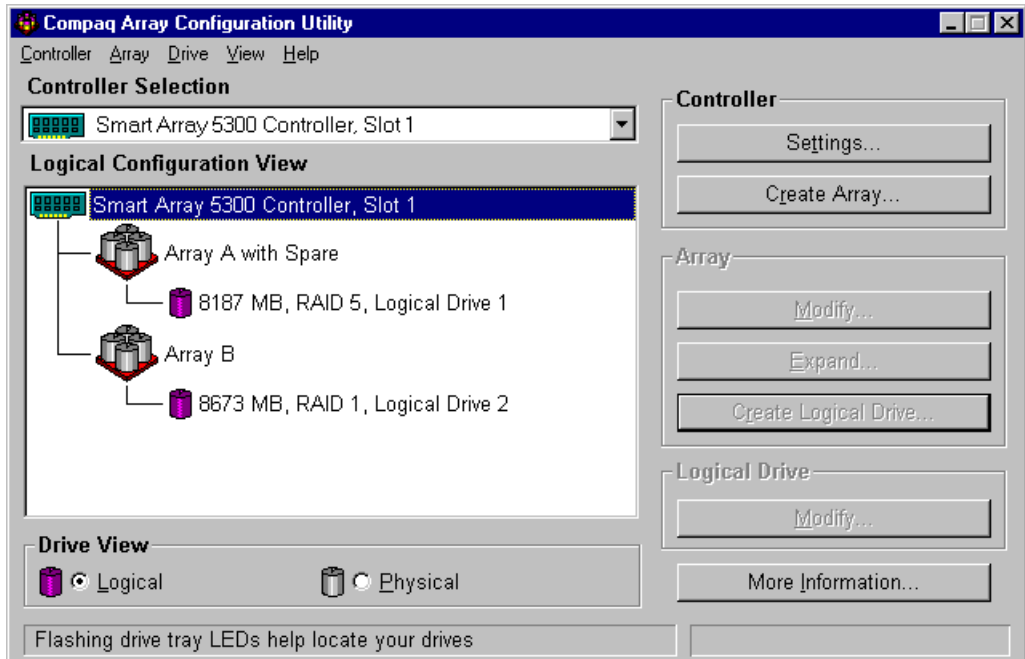
Figure 7-18. Array expansion example – Logical Configuration View screen

To expand Array A and create a second logical drive on this array:

1. Select Array A in the Logical Configuration View window.

2. Click the Expand button in the Array box.

3. In the left-hand window of the Expand Array A dialog box, select the unassigned 4.3-GB drive.

4. Click the Assign Drive to Array button.

Figure 7-19. Assign Drive to Array button

5. Click the Next button at the bottom of the screen. The screen that is now displayed should resemble the following figure.
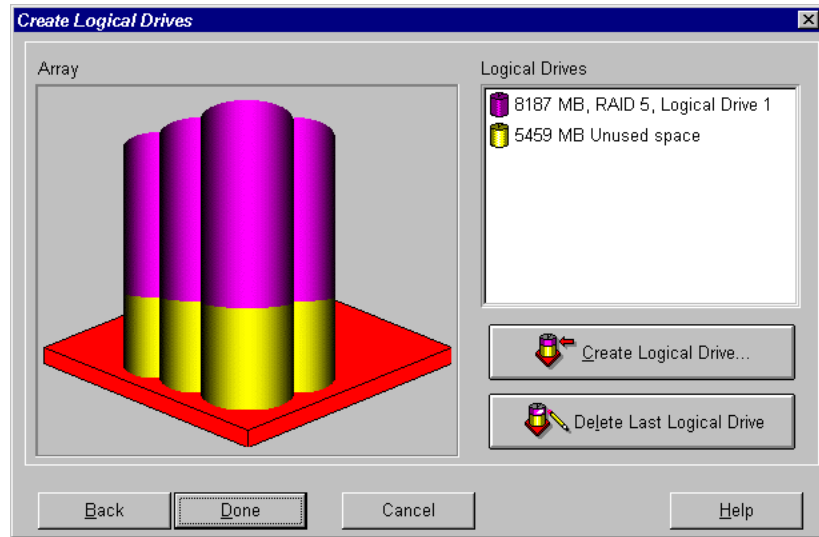
Figure 7-20. Expansion Wizard – Create Logical Drives screen

6. Click the Create Logical Drive button.

7. Set the fault tolerance, stripe size, array accelerator, and size for the second logical drive that you want to create on array A.

8. Click the Done button to return to the Create Logical Drives screen.

9. Click the Done button again to return to the Main Configuration screen.

10. On the menu bar, select Controller, Save Configuration. This saves the settings for the second logical drive and starts the capacity expansion process.

   NOTE: The second logical drive will not be accessible until the capacity expansion process on Logical Drive 1 is complete. Also, Logical Drive 1 will be unavailable for any other process while it is undergoing an expansion, and no other logical drive in the system can be expanded, extended or migrated during this time.

Extending Logical Drive Capacity

Logical drive capacity extension is the enlargement of an existing logical drive, usually after the array has been expanded. There must be enough free capacity on the array for the logical drive to be extended. If necessary,

increase the free capacity by adding hard drives to the array and expanding the array capacity (previous section) before extending logical drive capacity.

These operating systems support *online* logical drive capacity extension:

> **NOTE:** Logical drive capacity can be extended *offline* by backing up all data, reconfiguring the array, and restoring the data.

- Windows 2000

- Windows NT 4.0

- NetWare 4.2, 5.x

- IBM OS/2 Warp Server for eBusiness

- OpenServer 5.0.4, 5.0.5

- UnixWare 7.1.x

If your operating system is not listed, check the operating system documentation or contact your operating system vendor before extending logical drives.

> **IMPORTANT:** When extending a logical drive under Windows 2000, upgrade the disk to DYNAMIC *before* creating a partition on that disk. If the disk already has a partition when it is upgraded to DYNAMIC, Windows 2000 may not allow logical drive extension. Refer to the Windows 2000 documentation for details about DYNAMIC and BASIC disks.

To extend the capacity of a logical drive using ACU:

1. Select the logical drive in the Logical Configuration View window.

2. Click the Extend button in the Logical Drive box.

   The Extend Logical Drive screen displays the current capacity and overhead of the selected logical drive. The unshaded region on the slider scale shows the free capacity on the array that is available for extension.

3. Move the slider control to increase the size of the logical drive.

   NOTE: You cannot reduce the size of the logical drive from this screen.

4. Click the Done button to return to the Main Configuration screen.

5. To save the logical drive settings, click the Controller item on the menu bar and select the Save Configuration option.

   A progress bar at the lower right of the screen shows the status of the expansion process.

6. Make the extra capacity of the logical drive available to the operating system by one of the following methods:

   ❑ Create a new partition in the logical drive by using the operating system partitioning software (see Chapter 8).

   ❑ Increase the size of an existing partition by using the operating system partitioning software or third-party partitioning tools.

Migrating RAID Level or Stripe Size

NOTE: Before migrating stripe size, check that the available memory in the Array Accelerator is no smaller than the lowest common multiple of the total stripe sizes of the two different configurations.

For example, consider the change from an 11-drive RAID 5 logical volume to a 14-drive RAID 1 logical volume. If each configuration uses the corresponding default stripe width, this will be a change in block size from 16 kB per stripe to 128 kB per stripe.

■ A full stripe in the RAID 5 configuration contains 160 kB (ten of the drives contain user data; one drive contains parity data).

■ A full stripe in the RAID 1 configuration contains 896 kB.

The lowest common multiple of the two stripe sizes is 4480 kB, and this is the minimum amount of memory that must be available in the Array Accelerator.

To migrate to a different RAID level or stripe size using ACU:

1. Back up the data on the logical drive. Although data loss is unlikely, the backup data may be used to return to the original configuration, if necessary. The backup data may also be needed if the number of sectors needs to be increased (this will be determined in step 8).

2. Ensure that the Array Accelerator batteries are fully charged.

   NOTE: The migration process takes about 15 minutes per GB. A logical drive will be unavailable for any other process while it is undergoing migration, and no other logical drive in the system can be expanded, extended, or migrated during this time.

3. Check that the write cache is enabled (look on the Controller Settings screen).

4. Select the logical drive in the Logical Configuration View window.

5. Click the Migrate button in the Logical Drive box.

6. Change the RAID level by clicking the appropriate checkbox.

7. Change the stripe size. (Table 7-3 gives the optimum stripe size for specific situations.)

8. Click the Done button to return to the Main Configuration screen.

   If you get a message stating that the number of sectors needs to be increased:

   a. Delete the old logical volume.

   b. Reconfigure the array as a new logical volume with the new fault-tolerance method and stripe size that you had selected.

   c. Copy the backed-up data (from step 1) into the new logical volume.

9. To save the new settings, click the Controller item on the menu bar and select the Save Configuration option.

NetWare Online Array Configuration Utility (CPQONLIN)

The NetWare Online Array Configuration Utility (CPQONLIN) is an NLM for configuring your drive arrays without shutting down your server. CPQONLIN also indicates when a drive attached to the array controller has failed, is undergoing expansion, or is waiting (queued) for expansion or rebuild.

You must load the appropriate device driver (*CPQRAID.HAM)* before loading *CPQONLIN.NLM*. Both *CPQRAID.HAM* and *CPQONLIN.NLM* are located on the Smart Array 5300 Controller Support Software CD and diskettes. See the NetWare section of Chapter 4 for information about installing *CPQRAID.HAM*.

Before creating NetWare volumes or partitions, remember these tips to optimize system performance:

■ If you want to use hardware-based RAID, do not select mirroring while using *INSTALL.NLM* or *NWCONFIG.NLM*.

■ Novell recommends that you create volumes with a 64-KB block size to decrease the amount of RAM required to mount the volume.

■ Novell also recommends that you use the Block Sub-Allocation feature to allow disk space to be allocated more efficiently.

■ Linear memory provides the best system performance in the NetWare environment. If you previously used the System Configuration Utility to configure your server, this would be the default setting. To check that linear memory is being used, run the System Configuration Utility and view the Compaq Memory settings. Make sure that a linear option has been selected under the Base Memory option.

Running CPQONLIN

If no logical drives are configured when CPQONLIN is started, an auto-configuration wizard (Figure 7-21) will be displayed. You can select a fault tolerance level for the array shown, and CPQONLIN will then optimize the configuration for that array.

```
┌─────────────────────────────────────────────────────────────────────────┐
│ ░RCONSOLE.EXE                                                    _ □ ✕    │
├───────────────────────────────────────────────────────────────────────┤
│                                                                           │
│   Compaq Online Configuration  v2.42            NetWare Loadable Module  │
│                                                                           │
│                                                                           │
│      ┌───────────────────────────────────┐    ┌──────────────────────┐  │
│      │     Proposed Logical Configuration│    │  Select Fault Tolerance│ │
│      │ ┌───────────────────────────────┐ │    │┌────────────────────┐ │  │
│      │ │Smart Array 5300 Controller -- slot 10│ ││RAID 5 (Dist Data Guard)││
│      │ │   └─ Array A with Spare       │ │    ││RAID 1 (Drive Mirroring)││
│      │ │        └─ 26029 MB, RAID 5 -- Log Drive 1│││RAID 0 (No Fault)  │ │
│      │ └───────────────────────────────┘ │    ││Custom Configuration│ │  │
│      └───────────────────────────────────┘    │└────────────────────┘ │  │
│                                                └──────────────────────┘  │
│                                                                           │
│                                                                           │
│ Enter=Select Configuration    Tab=Physical View    Del=Remove Spare   F1=Help│
└─────────────────────────────────────────────────────────────────────────┘
```

Figure 7-21. CPQONLIN auto-configuration wizard with RAID 5 fault tolerance selected

Alternatively, you can select Custom Configuration. This will allow you to manually create arrays and to assign fault tolerance to one array at a time.

When you select Custom Configuration, the Main Configuration View screen (Figure 7-22) will be displayed. Highlight the controller, array, or logical drive you want to configure, then make a selection from the Options menu on the right side of the screen. Press **F1** for online help at any time.

```
RCONSOLE.EXE                                                        _ □ ×

 Compaq Online Configuration  v2.42              NetWare Loadable Module


      ┌──────────────────────────────────────┐    ┌──────────────────────┐
      │       Logical Configuration View      │    │   Controller Options │
      │                                        │    ├──────────────────────┤
      │ Smart Array 5300 Controller -- slot 10 │    │ Controller Settings  │
      │    └  Array A with Spare               │    └──────────────────────┘
      │         └ 26029 MB, RAID 5 -- Log Drive 1 │
      └──────────────────────────────────────┘




 Enter=Select      Esc=Previous Menu      Tab=Physical View      F3=Info      F1=Help
```
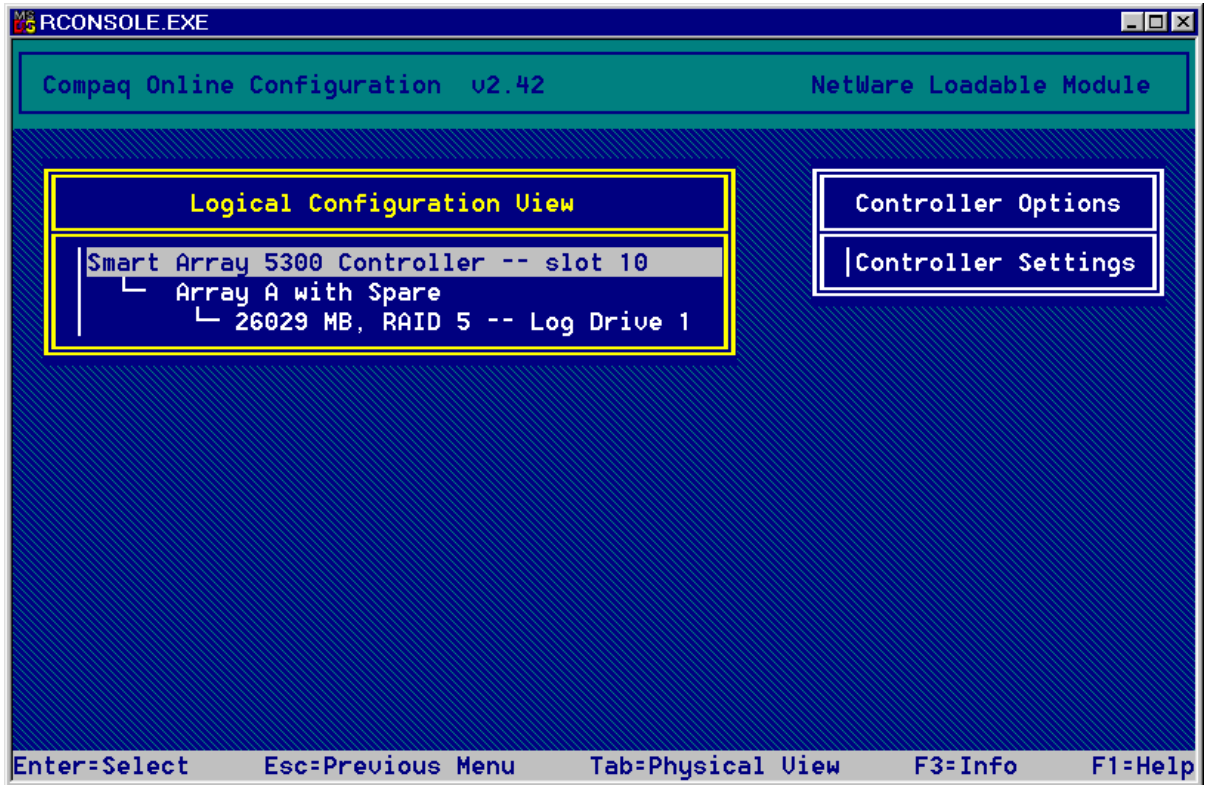
Figure 7-22. Main Configuration View screen

CPQONLIN allows you to:

■ Set the Drive Rebuild Priority, Expand Priority, and Accelerator Ratio.

■ Expand an array.

■ Add and configure spare drives.

■ Migrate RAID level and stripe size.

To set the drive rebuild priority, expand priority, or accelerator ratio:

1. Highlight the controller on the Main Configuration View screen.

2. Select the Controller Settings option on the right-hand side of the
   screen. The Controller Settings screen will be displayed (Figure 7-23).

3. Alter the default settings on this screen to suit your needs.

```
RCONSOLE.EXE                                                              _ □ ✕

  Compaq Online Configuration  v2.42                   NetWare Loadable Module




      Compaq Smart Array 5300 controller in PCI  slot 10


          Rebuild Priority : High
           Expand Priority : Low

          Accelerator Ratio : Read  50% - Write  50%




Press Esc to save changes or exit                                       F1=Help
```
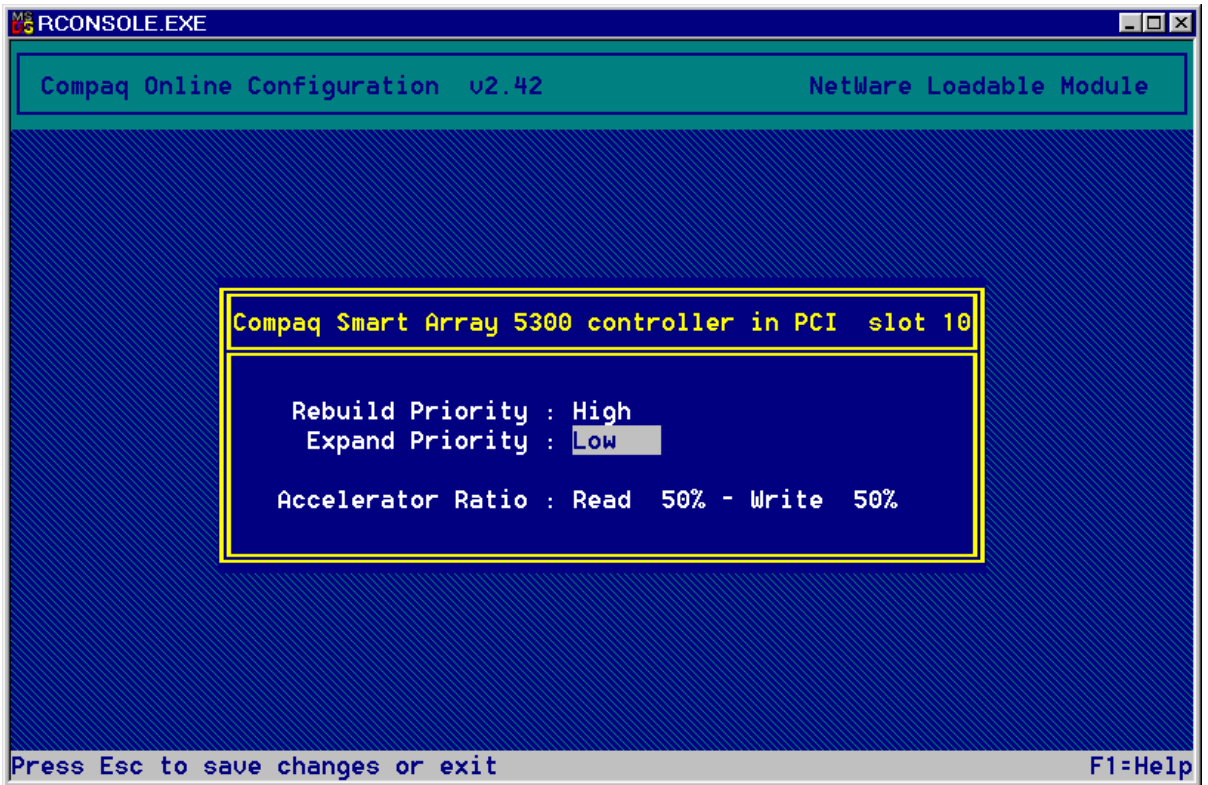
Figure 7-23. Controller Settings screen

Logical drives can only be rebuilt if they are configured for fault tolerance (RAID 1, 5, or ADG). Drive rebuild will occur after a failed physical drive in the array has been replaced.

If drive rebuild or expansion is set to low priority (the default setting), a rebuild (or expansion) will take place only when the array controller is not busy handling normal I/O requests. This setting has minimal effect on normal I/O operations.

When the rebuild or expansion is set to high priority, normal I/O operations are suspended. Although performance is affected, this setting provides better data protection because the array is vulnerable to additional drive failures while a drive is being rebuilt or expanded.

Accelerator ratio

The accelerator read/write ratio determines the amount of memory allocated to the read and write caches on the array accelerator. Different applications have different optimum settings. Table 7-3 gives the optimum stripe size for specific situations.

Expanding an Array

Performance may be slightly degraded during array expansion, depending on the Expand Priority setting described in the previous section. To minimize this, expand the array during periods of low server use if possible.

> **IMPORTANT:** Only group physical drives in an array if they are of similar capacity. If the drives have different capacities, the excess capacity of the larger drives cannot be used by the array and will be wasted.

Adding and configuring a spare drive

To add a spare drive to an array, the array controller must have a drive that is either unassigned, or assigned as a spare to another array. You can assign a spare to as many arrays as you want, or assign a separate spare to each array. When you select Assign Spare Drive, only drives that qualify will be listed (for example, drives with too small a capacity will not be listed). If a drive that you expect to see is not listed, press the **TAB** key to switch to the physical drive view and check the capacity of the drive.

Online RAID and Stripe Size Migration

You can modify both the RAID level and stripe size of an existing logical drive while online. Select the Drive Settings option under the logical drive menu for the drive you wish to modify. Select the new RAID level and/or stripe size from the choices presented to you. If the new settings are valid, the migration will begin when you save your changes.

Chapter 8

Completing System Configuration

System Configuration Utility

The System Configuration Utility (SCU) can be used to set controller order, and to create, populate, and update a system partition. It is provided on the Smart Start and Support Software CD, and on the Smart Array 5300 Controller Support Software CD. Compare the SCU version numbers from these two sources and use the most recent version.

> **NOTE:** If your server uses a ROM-based configuration utility, you will not need to run the System Configuration Utility.

1. While the server is rebooting, insert the CD into the CD-ROM drive.

2. From the *<CD-ROM drive>:\SYSCFDSK\US* directory, run the file *QRST5.EXE* and follow the on-screen instructions to create four SCU diskettes.

3. Insert diskette #1 into the server diskette drive.

4. Boot the system.

5. Select the System Configuration Utility option from the menu (or list of icons) that is displayed.

6. Follow the on-screen instructions to create and populate (or update) a system partition.

7. If the Smart Array 5300 will not be the boot controller, exit from the SCU. Otherwise, continue with the remaining steps.

8. SCU will announce that new hardware has been detected. Press **Enter** to start configuring the hardware.

9. When the SCU main screen is displayed again, select Review or Modify Hardware Settings from the menu.

10. At the next screen, select View or Edit Details from the menu.

11. Scroll down the list and select the Smart Array 5300 Controller from the menu.

12. Set the Controller Order to First and press **F10**, then press **F10** again.

13. On the menu, select Save and Exit.

14. Press **Enter** to confirm your choice.

    If the server does not reboot or a CD error message is displayed, press **Ctrl+Alt+Del** to continue and reboot the server.

Making the Logical Drive Accessible

Raw logical drives created using ACU, ORCA, or CPQONLIN are invisible to the operating system. To make the new logical drives visible to your system and available for data storage, you will need to format the logical drive. Follow the instructions given in your operating system documentation.

Updating the Compaq Insight Manager Agents

The latest versions of the Compaq Insight Manager and Management Agents for the Smart Array 5300 are available for download at www.compaq.com/manage.

You may also obtain the agents from your local Compaq Reseller or Authorized Compaq Service Provider. Refer to the documentation included with Compaq Insight Manager for the correct procedure to update the agents.

Chapter **9**

Upgrading and Replacing Options

Array Accelerator

To remove the existing Array Accelerator:

1. Squeeze the ends of the heat sink clip inwards ❶, then rotate the clip out of the heat sink ❷.
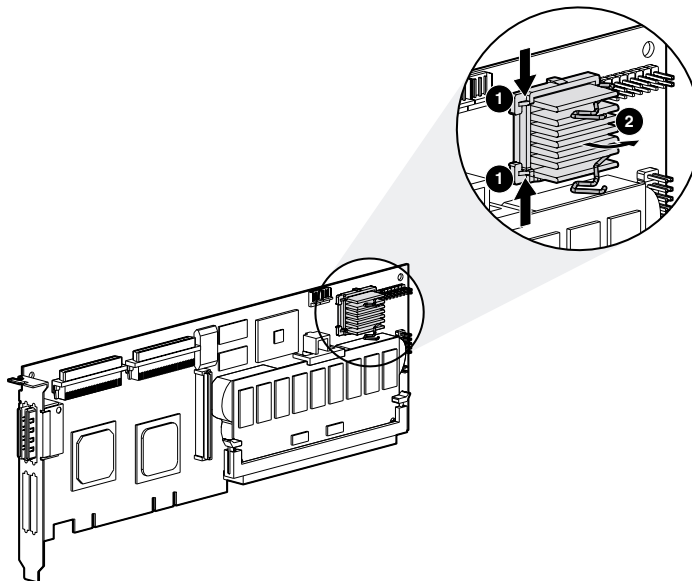
Figure 9-1. Remove the heatsink

2. Lift the heatsink out of the frame.

3. Rotate the clip back towards the board to allow room for the Array Accelerator board to be removed.

4. Remove the plastic retainer ❶ by detaching it from the Array Accelerator and unhooking it from the Smart Array 5300 board.
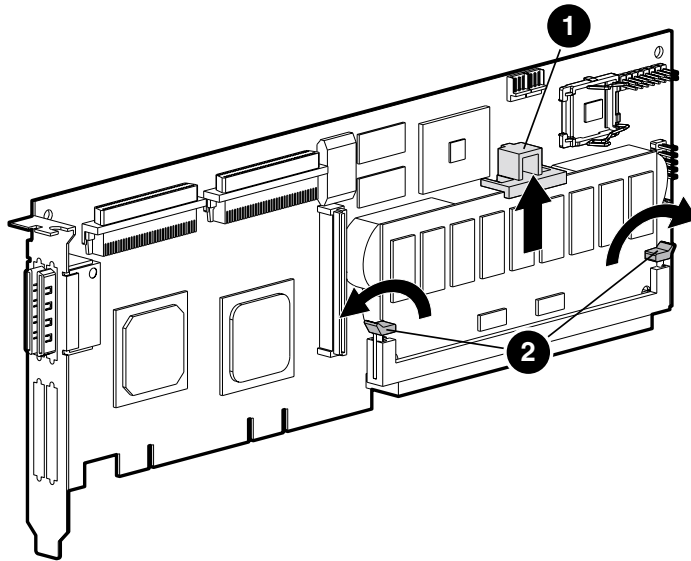
Figure 9-2. Release the Array Accelerator board

5. Swing out the DIMM ejectors ❷ on each side of the Array Accelerator.

6. Tilt the Array Accelerator slightly away from the Smart Array 5300 board (angle exaggerated in the figure for clarity), and unplug the Array Accelerator from the Smart Array 5300 DIMM socket.

> **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.
>
> ■ Do not abuse, disassemble, crush, puncture, short external contacts, or dispose of in fire or water.
>
> ■ Replace only with the Compaq spare designated for this product.
>
> Battery or Array Accelerator disposal should comply with local regulations. Alternatively, return them by established parts return methods to Compaq Computer Corporation for disposal.
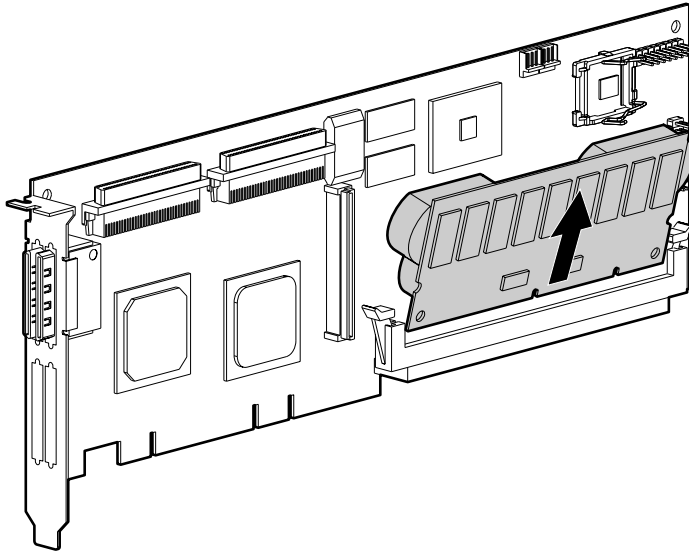
Figure 9-3. Remove the Array Accelerator from the Smart Array 5300

To install the new Array Accelerator:

1. Insert the Array Accelerator into the DIMM connector.
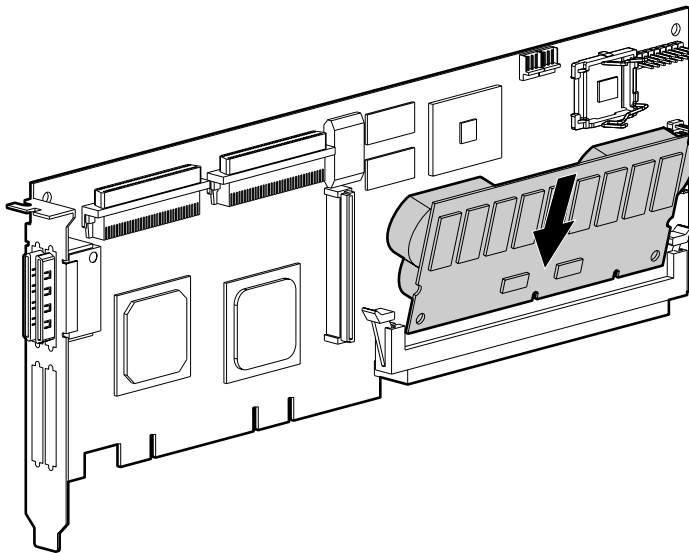
Figure 9-4. Insert the Array Accelerator into the DIMM connector

2. Close the ejectors ❶ on each side of the DIMM connector to firmly lock the Array Accelerator into place.
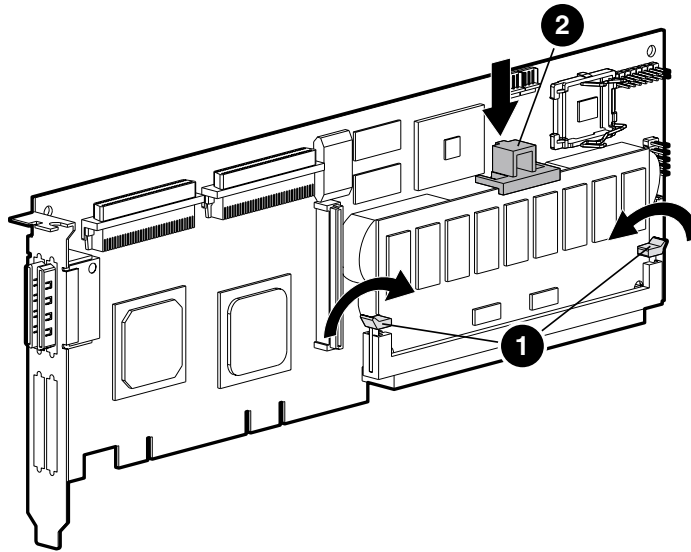
Figure 9-5. Secure the ejectors on the Array Accelerator

3. Insert the plastic retainer ❷ by hooking the back clip into the Smart Array 5300 board and rotating the retainer downwards until the two front snaps engage firmly with the Array Accelerator board.

4. Reattach the heatsink as follows:

    a. Lift up the wire clip and insert the heatsink into the frame.

    b. Rotate the clip over the heatsink ❶ and secure the ends of the clip around the prongs of the frame ❷.
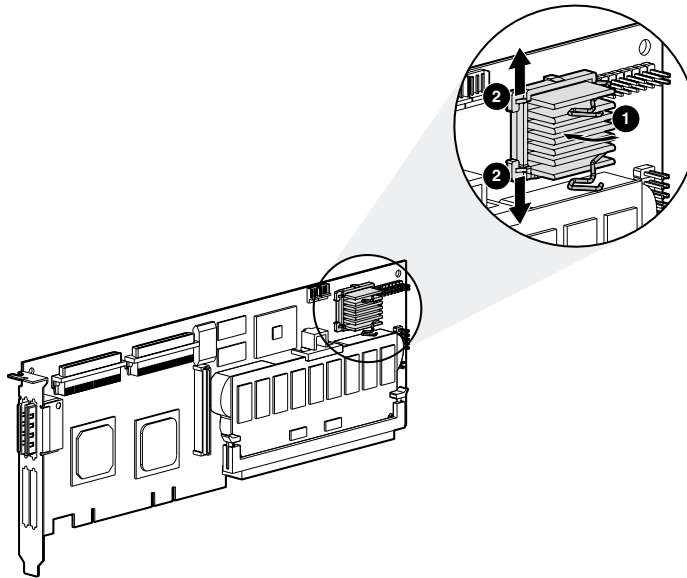
Figure 9-6. Reattach the heatsink

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.
>
> ■ Do not abuse, disassemble, crush, puncture, short external contacts, or dispose of in fire or water.
>
> ■ Replace only with the Compaq spare designated for this product.
>
> Battery or Array Accelerator disposal should comply with local regulations. Alternatively, return them by established parts return methods to Compaq Computer Corporation for disposal.

To remove the old NiMH battery pack:

1. Push down on the bottom clip of the battery pack, attached near the lower corner of the Array Accelerator.
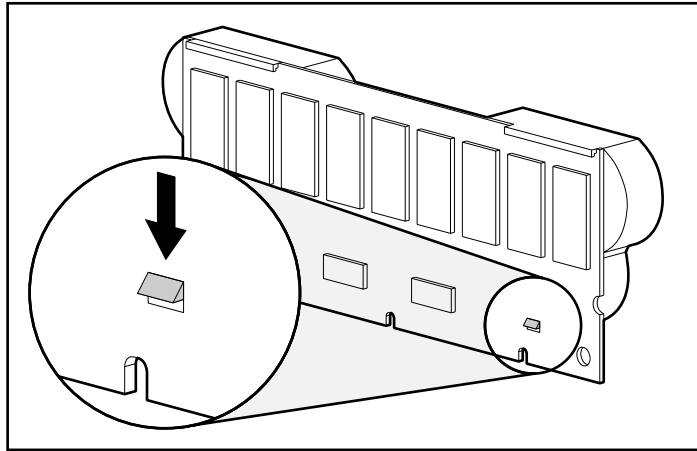
Figure 9-7. Bottom clip on battery pack

2. Swing the battery pack away from the Array Accelerator to about a 30-degree angle.
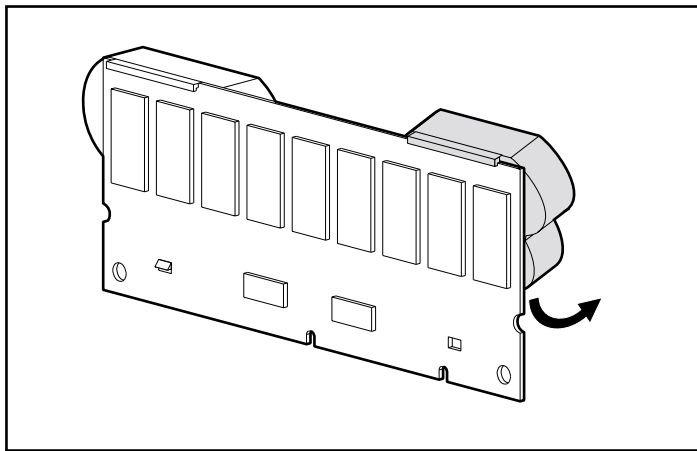
Figure 9-8. Swing the battery pack away from the Array Accelerator board

3. Lift the pack upward to unhook the top of the battery pack.
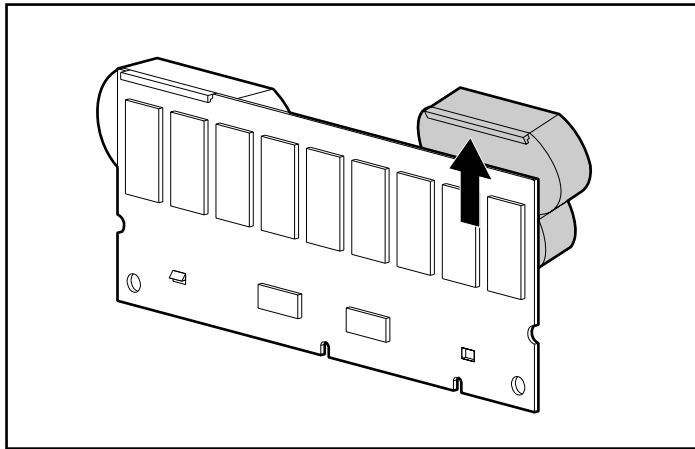
Figure 9-9. Lift the battery pack upward and away from the Array Accelerator

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

Removal of the old battery packs is complete.

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 top of the battery pack to the top of the Array Accelerator with the pack held at a 30-degree angle to the plane of the Array Accelerator board.
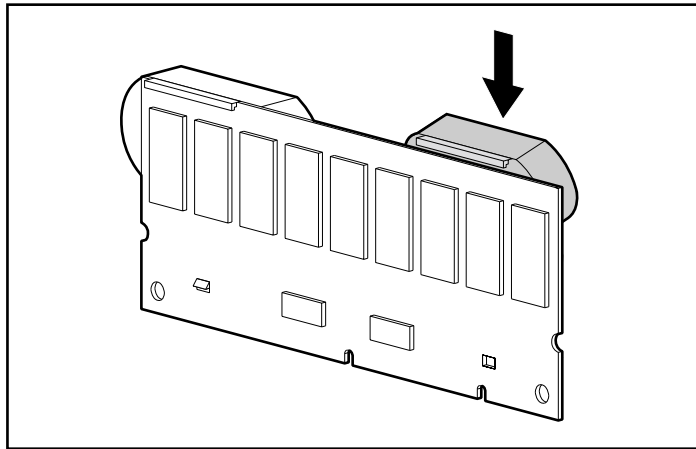
Figure 9-10. Hook the top of the battery pack to the Array Accelerator board

3. After the pack is hooked in position, swing the pack downward making sure the bottom clip and two pegs line up with the holes in the Array Accelerator.

4. Ensure that the top hook ❶ and bottom clip ❷ on the battery pack are securely attached to the Array Accelerator.
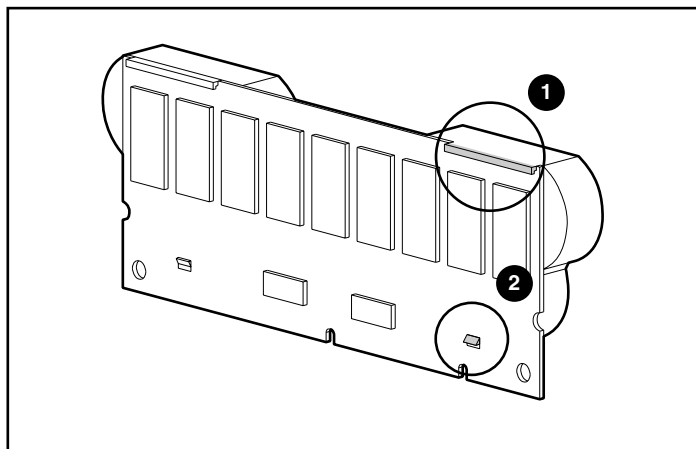
Figure 9-11. Secure the top hook and bottom clip of battery pack

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

2- to 4-Channel Adapter Board

To remove the existing 2- to 4-channel adapter board:

1. Remove the screw located on the back of the Smart Array 5300 board that secures the 2- to 4-channel adapter board.
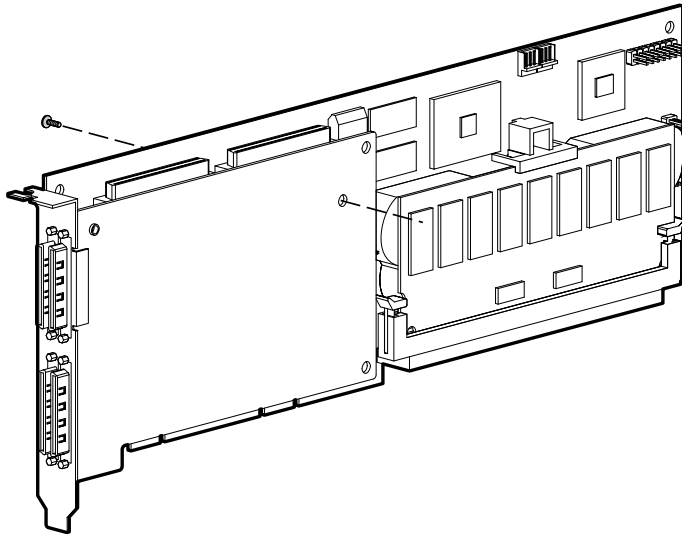
Figure 9-12. Remove the securing screw

2. Unplug the 2- to 4-channel adapter board from the connector on the Smart Array 5300 board.
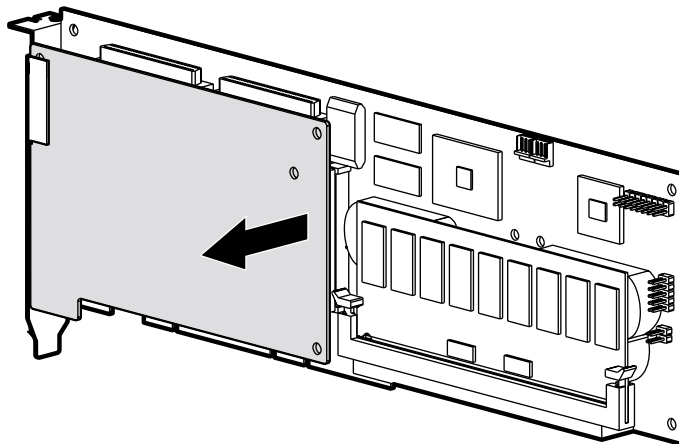
Figure 9-13. Unplug the 2- to 4-channel adapter board

3. Pull the 2- to 4-channel adapter board out of the VHDCI socket.
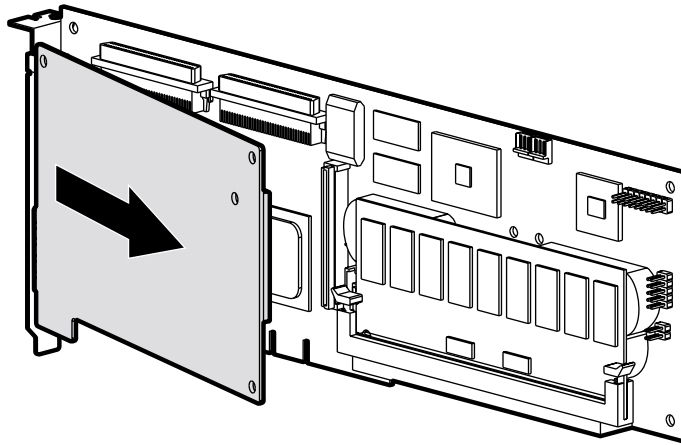
Figure 9-14. Remove the 2- to 4-channel adapter board

To install the new 2- to 4-channel adapter board:

1. Insert the VHDCI connector on the adapter board into the unoccupied VHDCI slot ❶ while sliding the adapter board under the bracket lip ❷ on the occupied VHDCI slot.
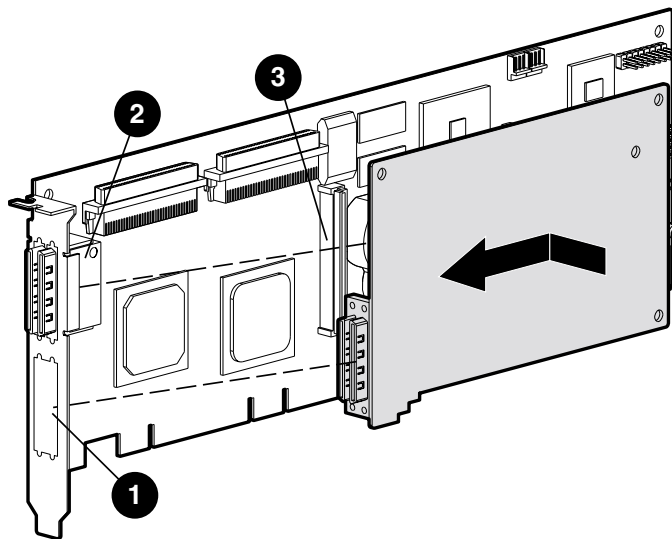
Figure 9-15. Installing the adapter board

2. Plug the adapter board into the connector ❸ on the array controller board.

3. Secure the adapter board to the array controller board by inserting and tightening the appropriate screw (included in the kit) in the back of the array controller board.
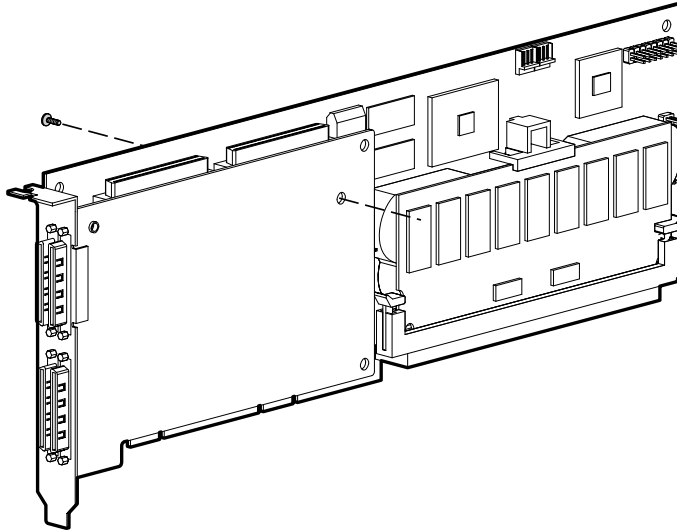
Figure 9-16. Secure the adapter board to the array controller board

Installation of the new adapter board is complete.

RAID ADG 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 (see Figure 9-17). The module attaches to the controller board with the narrow tab (circled in Figure 9-18) 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.
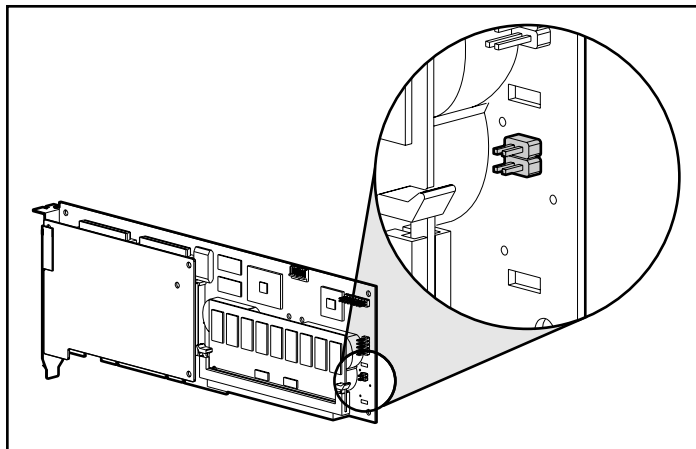
Figure 9-17. Location of the RAID ADG Enabler Module connector on the Smart Array 5300 Controller board
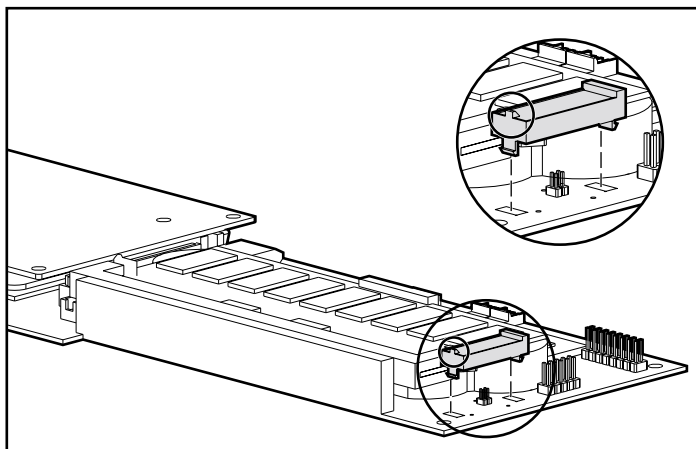
Figure 9-18. Aligning the module on the controller board

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 ❶, and push the module out of the board ❷.
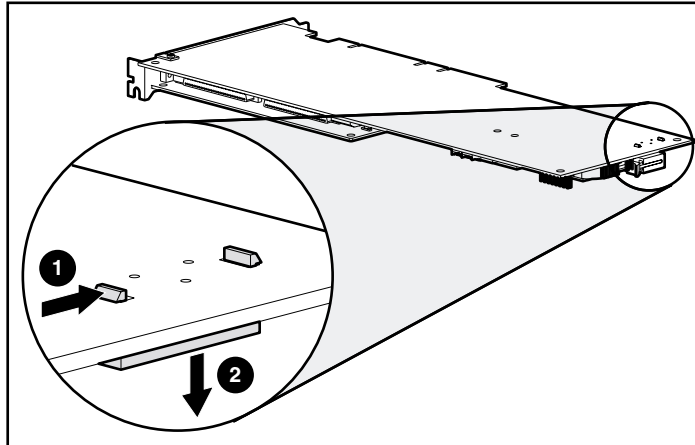
Figure 9-19. Removing the RAID ADG Enabler Module

To install the module on the new controller board:

 1. Ensure that the Array Accelerator on the new Smart Array 5300 Controller 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 ❶.
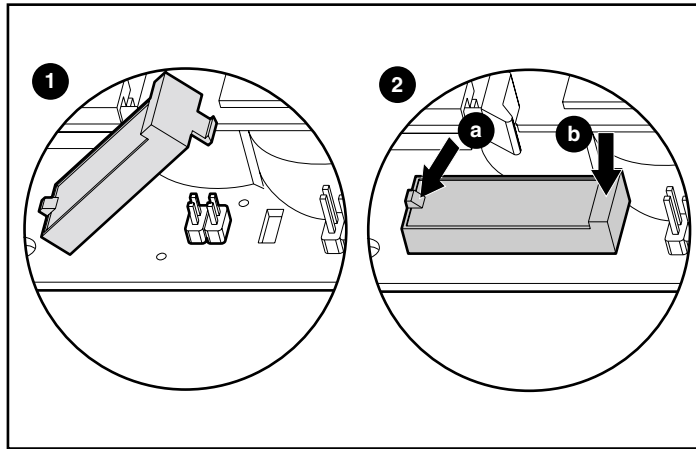
Figure 9-20. Installing the module

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

Appendix **A**

Regulatory Compliance Notices

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 (that is, 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 which class (A or B) the equipment falls into. 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. Once the class of the device is determined, refer to the following corresponding statement.

Class A Equipment

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at personal expense.

Class B Equipment

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

■ Reorient or relocate the receiving antenna.

■ Increase the separation between the equipment and receiver.

■ Connect the equipment into an outlet on a circuit 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:

Compaq Computer Corporation
P. O. Box 692000, Mail Stop 530113
Houston, Texas 77269-2000

or call 1-800- 652-6672 (1-800-OK COMPAQ). (For continuous quality improvement, calls may be recorded or monitored.)

For questions regarding this FCC declaration, contact:

Compaq Computer Corporation
P. O. Box 692000, Mail Stop 510101
Houston, Texas 77269-2000

or call (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 Compaq Computer Corporation may void the user's authority to operate the equipment.

Cables

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

Canadian Notice (Avis Canadien)

Class A Equipment

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

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

Class B Equipment

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

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

European Union 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 (in brackets are the equivalent international standards):

■ EN55022 (CISPR 22) - Electromagnetic Interference

■ EN50082-1 (IEC801-2, IEC801-3, IEC801-4) - Electromagnetic Immunity

■ 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。

VCCIマークが付いていない場合には、次の点にご注意下さい。

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

Taiwanese 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

⚠ **WARNING:** The controller may be provided with a rechargable Lithium Manganese Dioxide, Vanadium Pentoxide, or Nickel Metal Hydride battery or battery pack. There is a risk of explosion, fire, and 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.

■ Do not abuse, disassemble, crush, puncture, short external contacts, or dispose of in fire or water.

■ Replace only with the Compaq spare designated for this product.
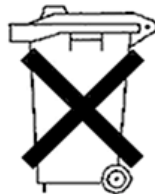
Batteries, battery packs, and accumulators should not be disposed of together with the general household waste. In order to forward them to recycling or proper disposal, please use the public collection system or return them to Compaq, your authorized Compaq Partners, or their agents.

For more information about battery replacement or proper disposal, contact your Compaq Authorized Reseller or your Authorized Service Provider.

Appendix B

Electrostatic Discharge

A discharge of static electricity from a finger or other conductor can damage printed circuit 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 parts in static-safe containers.

■ Keep electrostatic-sensitive parts in their containers until they arrive at static-free work stations.

■ Place parts on a grounded surface before removing them from their container.

■ Avoid touching pins, leads, or circuitry.

■ Always make sure you are properly grounded when touching a static-sensitive component or assembly. Use one or more of the following measures when handling or installing electrostatic-sensitive parts:

❑ Use a wrist strap connected by a ground cord to a grounded workstation or the computer chassis. Wrist straps are flexible straps with a minimum of 1 megohm +/- 10 percent resistance in the ground cords.

❑ Use heel straps, toe straps, or bootstraps 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 Compaq Service Provider install the part.

NOTE: For additional information on static electricity or assistance with the installation of this product, contact your Authorized Compaq Service Provider or refer to the Server Maintenance and Service Guide.

Appendix ***C***

Specifications and System Requirements

This appendix provides system requirements and physical, operating, and performance specifications for the Smart Array 5300 Controller.

System Compatibility

Table C-1
Servers Supporting the Smart Array 5300 Controller

Compaq ProLiant Servers (Tower)	1600, 3000, 5500, 6000, 6500, 7000, 8000, 8500, ML370, ML530, ML570, ML750
Compaq ProLiant Rack-Mountable Servers	1600R, 1850R, 3000R, 6000R, 6400R, 6500R, 7000R, 8000R, 8500R, DL360, DL380, DL580, DL750
Compaq StorageWorks Enclosure	4214R, 4214T, 4254R, 4314R, 4314T, 4354R
ProLiant Storage Systems	U2, UE
Note: To check that your server is supported, visit the Compaq website at www.compaq.com/products/servers/	

Controller Specifications

Table C-2
Smart Array 5300 Controller Specifications

Dimensions	English	International
Height	4.2 in	10.7 cm
Length	12.4 in	31.5 cm
Thickness (including Array Accelerator)	0.6 in	1.5 cm
Temperature Range		
Operating	50° to 95°F	10° to 35°C
Shipping	-22° to 140°F	-30° to 60°C
Relative Humidity (non-condensing)		
Operating	20% to 80%	20% to 80%
Non-operating	5% to 90%	5% to 90%
Power Required		
3.3V	16.33 W (5302), 19.04 W (5304)	
5V	4.83 W (5302), 5.86 W (5304)	
Total (= maximum heat dissipated)	21.2 W (5302), 24.9 W (5304)	
Data Transfer Method	64-Bit Bus Master	
SCSI Bus		
Number of channels	4 (5304), or 2 upgradeable to 4 (5302)	
Maximum number of drives per channel	14	
Connectors	68-pin internal, VHDCI external	
Termination	Required, but provided on Compaq systems	
Transfer rate (maximum)	160 MB/s (40 MHz) per channel	
PCI Bus Transfer Rate (maximum)	528 MB/s	

Appendix **D**

Drive Arrays and Fault Tolerance

This appendix explains drive array concepts and data protection methods, including fault tolerance options. This information will help you decide how to best configure your controller.

What is a Drive Array?

While the capacity and performance of a single hard drive is adequate for domestic users, business users demand higher storage capacities, higher data transfer rates, and greater security from data loss that occurs when drives fail.

Merely adding extra drives to the system increases the total storage capacity, but has little effect on the system efficiency since data can only be transferred to one hard drive at a time (Figure D-1).
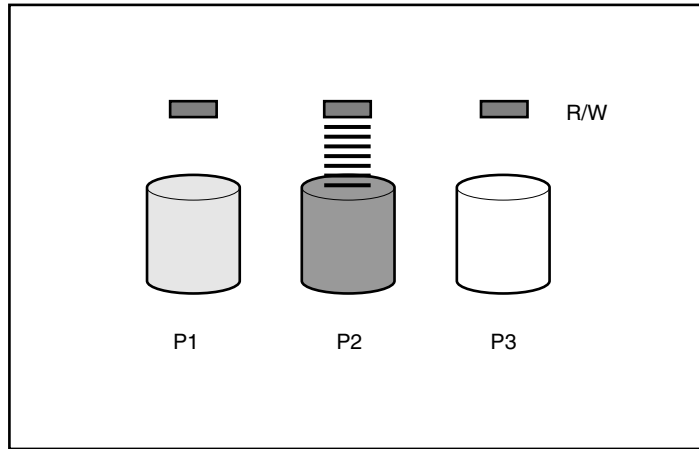
Figure D-1. Merely adding physical drives (P2, P3) has no effect on the
efficiency of read/write (R/W) operations.

With an array controller installed in the system, the capacity of several physical drives can be combined into one or more virtual units termed **logical drives** (sometimes called logical volumes). When this is done, the read/write heads of all the constituent physical drives are active simultaneously. This dramatically reduces the overall time required for data transfer (Figure D-2).
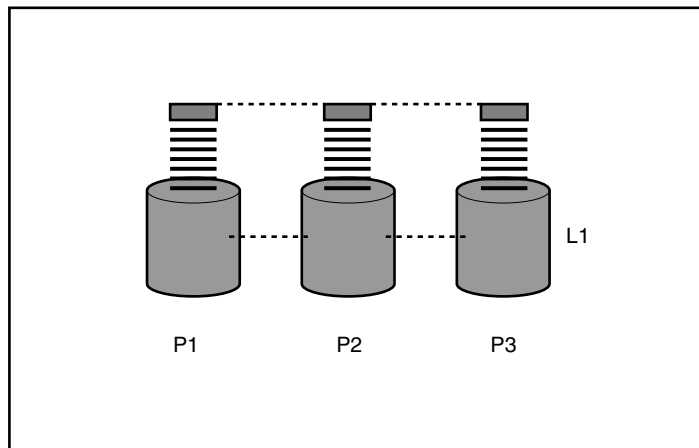
Figure D-2. Configuring the physical drives into a logical drive (L1)
dramatically improves read/write efficiency.

Since 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 termed a **block,** and over all the hard drives in a logical drive the blocks form a set of data **stripes** (Figure D-3).
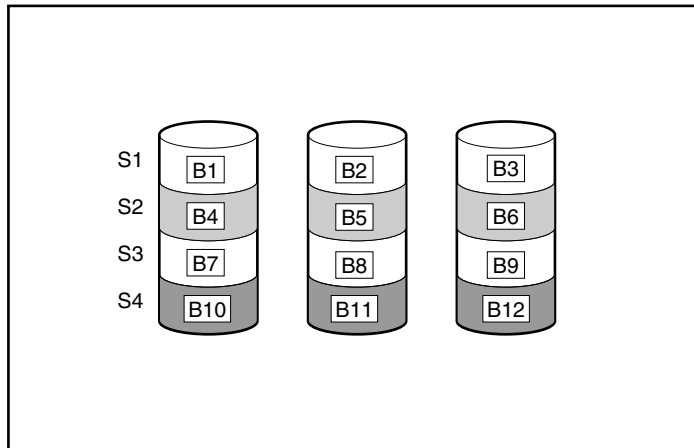
Figure D-3. Data striping (S1-S4) of data blocks B1-B12

For data in the logical drive to be readable, the data block sequence within each stripe must be the same. 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 hard drive in a given logical drive will contain the same amount of data. If one hard drive has a larger capacity than other hard 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 termed a **drive array,** often abbreviated to just **array.** Since all hard 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.

An array may contain more than one logical drive (Figure D-4), and each logical drive can be of a different size. However, all logical drives on a given array use exactly the same hard drives. Also, although a logical drive may extend over (span) more than one port on the same controller, it may not span more than one controller.
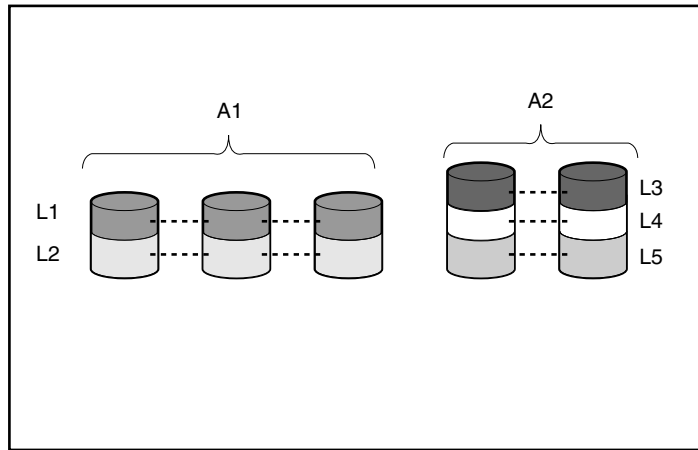
Figure D-4. Two arrays (A1, A2) containing five logical drives spread over five
physical drives

Drive failure, although rare, is potentially catastrophic. In Figure D-4, for
example, failure of *any* hard drive will lead to failure of *all* logical drives in
the same array, and hence to data loss.

To protect against data loss from hard drive failure, logical drives can be
configured with **fault tolerance.** Several fault tolerance methods have been
devised; those supported by the Smart Array 5300 (and described in the
following section) are:

■ RAID ADG – *Advanced Data Guarding.*

■ RAID 5 – *Distributed Data Guarding.*

■ RAID 1 and RAID 0+1 (also called RAID 10) – *Drive Mirroring.*

■ RAID 0 – *Data Striping* only (no fault tolerance).

Further protection against data loss can be achieved by assigning an **online
spare** (or **hot spare**) to any configuration except RAID 0. This is a hard drive
containing no data and connected to the same controller as the array. When a
hard drive in the array fails, the controller can then automatically rebuild
information that was originally on the failed drive onto the online spare. This
quickly restores the system to full RAID-level fault tolerance protection.
(However, in the unlikely event that another drive in the array should fail
while data is being rewritten to the spare, the logical drive will still fail.)

Each Smart Array 5300 Controller can support up to four online spares. When
an online spare is configured, it is automatically assigned to all logical drives
in the same array. A spare can also be assigned to several arrays connected to
the same controller.

Fault Tolerance Methods

RAID 0 – No Fault Tolerance

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

Advantages

■ Highest performance method for reads and writes

■ Lowest cost per unit of data stored

■ All drive capacity is used to store data – none is used for fault tolerance

Disadvantages

■ All data on logical drive is lost if a hard drive fails

■ Cannot use an online spare

■ Data can only be preserved by being backed up to external drives

RAID 1 – Drive Mirroring

In this configuration, information on one drive is duplicated onto a second drive (Figure D-5). When a logical drive with this configuration extends over more than one pair of hard drives, the method is sometimes referred to as RAID 0+1 or RAID 10.

This method is useful when high performance and data protection are more important than the cost of hard drives.
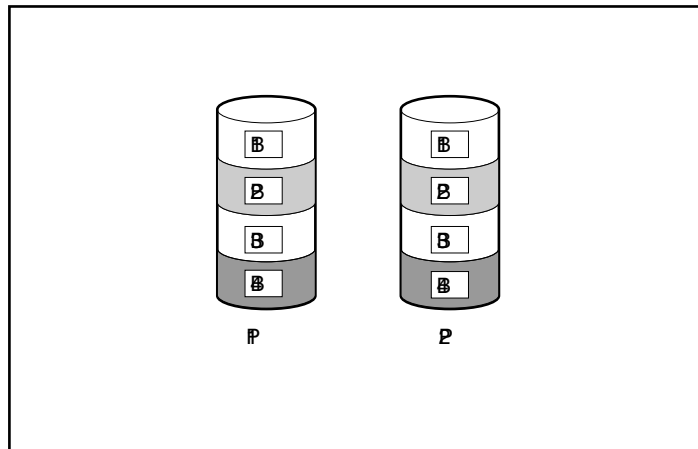
Figure D-5. Drive mirroring of P1 onto P2

Advantages

■ Highest read and write performance of any fault-tolerant configuration

■ No data is lost if one drive fails

■ In a RAID 0+1 system, data is preserved when more than one drive fails as long as none of the failed drives are mirrored to another failed drive

Disadvantages

■ Expensive, since many drives must be used for fault tolerance

■ Useable storage capacity is only 50% of the total drive capacity

■ Data will be lost if two failed drives happen to be mirrored to each other

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 hard drive within the logical drive (Figure D-6). When a hard drive fails, data on the failed drive can be rebuilt from the parity data and the user data on the remaining drives. This rebuilt data is usually written to an online spare.

This configuration is useful when cost, performance, and data availability are equally important.
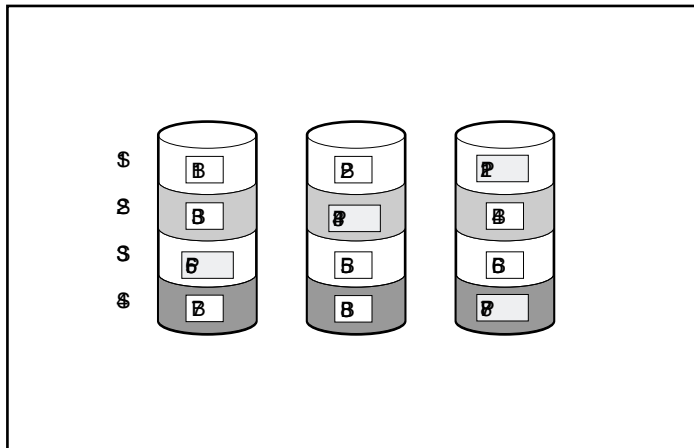
Figure D-6. Distributed data guarding, showing parity information (P)

Advantages

■ High read performance

■ No data is lost if one drive fails

■ Usable storage capacity is high, since a capacity equivalent to only one physical drive is used to store parity information

Disadvantages

■ Relatively low write performance

■ Data will be lost if a second drive fails before data from the first failed drive has been 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. This allows data to still be preserved if two drives fail. As can be seen from Figure D-7, each set of parity data uses up 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 configured with RAID ADG is less than when configured with RAID 5 (see Appendix F for statistics).
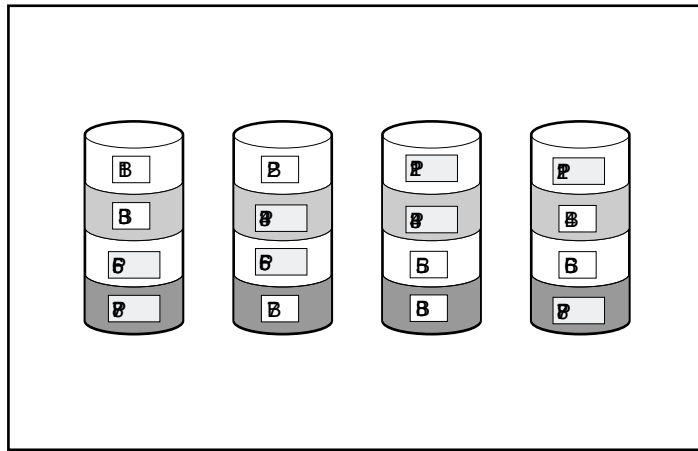
Figure D-7. Advanced data guarding (RAID ADG) with two sets of parity data

Advantages

■ High read performance

■ High data availability – any two drives can fail without loss of critical data

Disadvantage

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

Table D-1 summarizes the important features of the different kinds of RAID supported by the Smart Array 5300. The decision chart in Figure D-8 may help you determine which option is best for your situation.

Table D-1
Summary of RAID Methods

	RAID 0	RAID 1 / RAID 0+1	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 hard drives	1	2	3	4
Tolerant of single hard drive failure?	No	Yes	Yes	Yes
Tolerant of multiple simultaneous hard drive failure?	No	In RAID 0+1, only when the failed drives are not mirrored to each other	No	Yes
Read performance	High	High	High	High
Write performance	High	Medium	Low	Low
Relative cost	Low	High	Medium	Medium

*Note: The value for usable drive space is calculated assuming a maximum of 14 hard drives of the same capacity (or a maximum of 56 for RAID ADG) with no online spares. Compaq recommends that these maximum figures (excluding any allowable online spares) are not exceeded when configuring a drive array, due to the increased likelihood of logical drive failure with more hard drives.

MOST IMPORTANT	ALSO IMPORTANT	SUGGESTED RAID LEVEL
Fault tolerance	Cost effectiveness	*RAID ADG*
	I/O performance	*RAID 0+1*
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 0+1*

Figure D-8. Choosing a RAID method

Other Fault-Tolerance Options

Your operating system may also support controller duplexing or software-based RAID. However, the hardware-based RAID methods described in this Appendix (and used by the configuration utilities described in Chapter 7) provide a much more robust and controlled fault-tolerant environment. Additionally, controller duplexing and software-based RAID do not allow the use of auto-reliability monitoring, online spares, interim data recovery, and automatic data recovery.

■ **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.

■ **Software-Based RAID** resembles hardware-based RAID, except that the operating system works with logical drives as if they were physical drives. For data security, each logical drive must be in a different array.

If you decide to use one of these methods, configure the arrays with RAID 0 for maximum storage capacity. Refer to your operating system documentation for details of implementation.

Hard Drive Installation and Replacement

The Smart Array 5300 has two or four independent SCSI channels; the two-channel version is upgradeable to four using a daughterboard (see Chapter 1). Each channel supports up to 14 drives. Drives may be Wide Ultra3 SCSI, Wide Ultra2 SCSI, and Wide-Ultra SCSI-3 installed in servers and storage systems that support hot-pluggable drives.

■   For maximum I/O performance, Wide-Ultra drives should not be used on the same bus as Wide Ultra3 and Wide Ultra2 drives. Wide-Ultra drives use SE signaling, while Wide Ultra3 and Wide Ultra2 drives use LVD signaling. These two types of signaling are incompatible.

■   Drives should *not* contain termination. Compaq servers and internal cabling provide the required termination of the SCSI bus.

■   Drives that are to be grouped in the same array should be of the same capacity. The excess capacity of a larger drive cannot be used by the array and will be wasted.

■   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.

■   Hot-pluggable drives cannot be combined with non-hot-pluggable drives on the same SCSI bus.

A list of hard drives currently supported by the Smart Array 5300 is available at www.compaq.com/products/storageworks/.

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 be failed.

■ RAID 1 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 in the array.

If more hard drives are failed than the fault-tolerance method allows, fault tolerance is "compromised" and the logical drive is failed. In this case, all requests from the operating system will be rejected with "unrecoverable" errors. The section on Compromised Fault Tolerance later in this chapter 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-on 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.
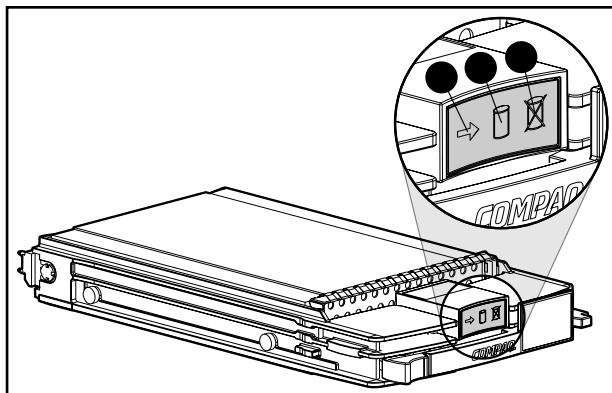
Figure E-1. Hard drive LED indicators

Table E-1
Hard Drive Status from LED Indicator Combinations

● Activity	● Online	● Fault	Meaning
On	Off	Off	**Do not remove the drive. Removing a drive during this process may cause data loss.**
			The drive is being accessed, but it is:
			■ Not configured as part of an array, *or*
			■ A replacement drive and rebuild has not yet started, *or*
			■ Spinning up during POST.
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.
Flashing	Flashing	Flashing	**Do not remove the drive. Removing a drive during this process can cause data loss in non-fault-tolerant configurations.**
			■ The drive is part of an array being selected by the Array Configuration Utility, *or*
			■ Options ROMPaq is upgrading the drive.
Off	Off	Off	OK to replace the drive online if a predictive failure alert is received and the drive is attached to an array controller.
			■ The drive is not configured as part of an array, *or*
			■ If this drive is configured as part of an array, then a powered-on controller is not accessing the drive, *or*
			■ The drive is configured as an online spare.
Off	Off	On	OK to replace the drive online.
			The drive has failed, and has been placed off-line.
Off, on or flashing	On	Off	OK to replace the drive online if a predictive failure alert is received, provided that 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.
Off, on or flashing	On or off	Flashing	A predictive failure alert has been received for this drive. Replace the drive as soon as possible.

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

■ The amber LED will light up on the front of a Compaq storage system if failed drives are inside. (Other problems such as fan failure, redundant power supply or over-temperature conditions will also cause this LED to light up.)

■ A Power-On Self-Test (POST) message will list failed drives whenever the system is restarted, as long as the controller detects one or more good drives. See Appendix G for an explanation of POST messages.

■ The Array Diagnostic Utility (ADU) will list all failed drives.

■ Compaq Insight Manager can detect failed drives remotely across a network.

Additional information on troubleshooting hard drive problems can be found in the *Compaq 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 will be failed and "unrecoverable disk" error messages will be returned to the host. Data loss is likely to occur.

An example of this situation would be 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.

Fault tolerance may also be compromised due to non-drive problems, such as a faulty cable, faulty storage system power supply, or a user accidentally turning off an external storage system while the host system power was on. In such cases, the physical drives do not need to be replaced. However, data loss may still have occurred, especially if the system was busy at the time the problem happened.

Procedure to Attempt Recovery

Inserting replacement drives when fault tolerance has been compromised will not improve the condition of the logical volume. Instead, if unrecoverable error messages display on your screen, try the following procedure to recover data.

1. Turn the entire system off and back on. 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 **F2** 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, and if the 1779 POST message is displayed, press **F2.** This will re-enable the logical drive(s), recreate your partitions, and restore all data from backup.

To minimize the risk of data loss from 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.

If a drive in a fault-tolerant configuration is replaced while the system power is off, a Power-On Self-Test (POST) message will be displayed during the next system startup. This message will prompt you to press **F1** 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 will be displayed whenever the system is restarted.

When Automatic Data Recovery is completed, the online LED of the replacement drive will stop blinking and begin to glow steadily.

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

■ The rebuild priority level (high or low) of the logical drive (see Chapter 7).

■ 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 10 minutes per GB (for three drives) to 20 minutes per GB (for 14 drives).

Failure of Automatic Data Recovery

If the online LED of the replacement drive stops blinking during Automatic Data Recovery, there are two possible causes:

■ The replacement drive is failed (amber failure LED illuminated or other LEDs go out) and is producing unrecoverable disk errors.

Remove and replace the failed replacement drive.

■ The Automatic Data Recovery process may have abnormally terminated, due to a non-correctable read error (such as a SCSI bus signal integrity problem) from another physical drive during the recovery process.

Reboot the system (a POST message should confirm the diagnosis) and retry Automatic Data Recovery. If this does not work, backup all data on the system, do a surface analysis (using User Diagnostics), and restore the data from backup.

Replacing a Drive

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.

> **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.

■ A hot-pluggable drive can be removed and replaced at any time, whether the host or storage system power is on or off. System performance and fault tolerance will both be affected until the rebuild operation is completed. This will take several hours, even if the system is not busy while the rebuild is in progress.

When a hot-pluggable drive is inserted, all disk activity on the array is paused 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 will begin automatically (indicated by the blinking online LED).

■ Non-hot-pluggable drives should only be replaced while the system power is OFF.

■ If the SCSI ID jumpers are set manually, check the ID value to ensure 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, be sure the server is the first unit powered down and the last to be powered back up. This will ensure that the system will not erroneously mark the drives as "failed."

Disk drive replacement should be performed during low activity periods whenever possible. In addition, all logical volumes on the same array as the drive being replaced should have a current valid backup.

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

If another drive in the array should fail while fault tolerance is unavailable, a fatal system error may occur. If this happens, fault tolerance has been compromised and all data on the array will be lost.

In exceptional cases, failure of another drive need not lead to a fatal system error. These exceptions include:

■ Failure after activation of a spare drive.

■ In a mirrored (RAID 1) configuration, failure of a drive that is not mirrored to any other failed drives.

■ A second drive failure in a RAID ADG configuration.

Take these precautions when removing failed drives to minimize the likelihood of fatal system errors:

■ Do not remove a degraded drive if any other member of the array is off-line (the online LED is off). In this condition, no other drive in the array can be hot-plugged without data loss.

   Exceptions:

   ❑ When RAID 0+1 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 will stop blinking.)

Exceptions:

❑ If a second drive fails while an online spare is being rebuilt, the second failed drive can still be replaced. The online LED on the spare drive will be flashing, indicating that the spare is being rebuilt from data stored on the other drives.

❑ In RAID ADG configurations, any two drives in the array can be replaced simultaneously.

❑ In RAID 0+1 configurations, any drives that are not mirrored to other removed or failed drives can be simultaneously replaced offline without data loss.

When a hard drive is replaced, the controller uses fault tolerance data on the remaining drives in the array to rebuild data (previously 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.

> **CAUTION:** In systems using external data storage, be sure the server is the first unit powered down and the last to be powered back up. This will ensure that the system will not erroneously mark the drives as "failed."

Drive Failure in NetWare

Although hard drive failures are not common, it is important to protect your critical data. To ensure a quick and transparent recovery, Compaq recommends that you configure your array controller using a hardware-based fault tolerance method (see Appendix D). These methods are more reliable than software-based fault tolerance methods or drive duplexing.

Compaq also recommends that you use good backup procedures, in case of catastrophic failure.

If a drive fails and you have hardware fault-tolerance enabled, system operation will continue. However, you should replace the drive as soon as possible to prevent failure of the array. If you do not replace the failed drive, the only option using CPQONLIN is to delete logical volumes. Do **not** delete logical volumes that contain valid data, or the data will be lost.

To monitor the status of a drive recovery, select the logical drive on the Main Configuration screen and press **F3**. The Logical Drive Information screen (Figure E-2) will show the status of the drive.
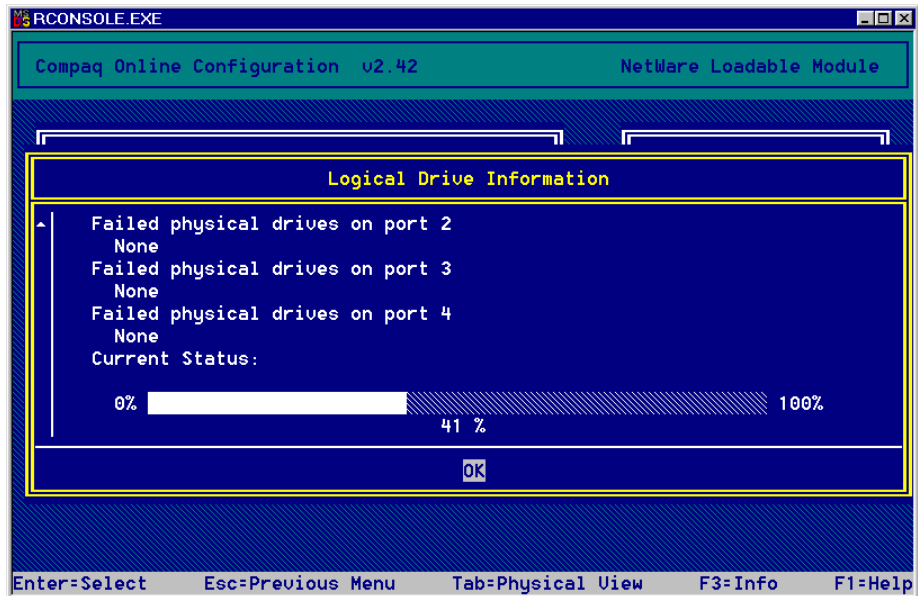
Figure E-2. Rebuilding a logical drive

- ■ **Interim Recovery:** The logical drive is operating, but a failed drive has not been replaced. Replace the drive as soon as possible.

- ■ **Ready for Recovery:** The logical drives are queued for recovery. This status is displayed when another logical drive is already rebuilding or expanding.

- ■ **Rebuilding:** The array is operating and rebuilding a replacement drive or an online spare, if one was assigned.

■ **Logical Drive Failed:** If you have one or more logical drives that are not protected by fault tolerance, the data on these logical drives will be lost; CPQONLIN will show these logical drives as failed. After hard drive replacement, any fault-tolerant logical drives will rebuild. The logical drives that were not protected (failed) will become available for data (the devices are reactivated automatically). If you have a backup of the data, restore the data now.

The following pages describe recovery procedures for systems that are using hardware-based fault tolerance, software-based (NetWare) fault tolerance, and no fault tolerance.

Hardware-Based Fault Tolerance

1. Identify and document which physical drive has failed. (On hot-pluggable drives in a ProLiant server or storage system, this is indicated by an amber drive failure LED on the drive tray.) Note the drive type and capacity.

   NOTE: Servers using hardware-based fault tolerance in NetWare cannot detect failure of a single physical drive. In this case, the data will still show as valid and accessible during the rebuilding process. However, the driver will have registered that a physical drive has failed, and a message will be displayed notifying the user that a logical drive is in a degraded state. CPQONLIN will also show the drive has failed.

2. Note which partition and volume, if any has failed. This information is provided in the error message on the server console. It is also recorded in the server error log file, which can be viewed using the NWADMIN utility.

3. If the storage unit containing the failed drive does *not* support hot-pluggable drives, perform a normal system shutdown.

4. Remove the failed drive and replace it with a drive that is of the same type and capacity. For hot-pluggable drives, after you secure the drive in the bay, the LEDs on the drive each light once in an alternating pattern to indicate that the connection was successful. The Online LED blinks, indicating that the controller recognized the drive replacement and began the recovery process.

5. Power ON the server, if it was turned off in step 3.

6. The array controller firmware rebuilds information that was on the failed hard drive onto the new drive, based on information from the remaining physical drives in the logical drive. While reconstructing the data on hot-pluggable drives, the Online LED blinks. When drive rebuild is complete, the Online LED is illuminated.

NetWare (Software-Based) Fault Tolerance

You will need to recover both the DOS partition and the data.

Recovering DOS Partitions

If your system is not using hardware fault tolerance and the failed drive contains the DOS partition that is used to boot your server, NetWare cannot read the data on the partition. In this case, you will not be able to restart the server after it has been turned off.

To recover the DOS partition, follow these steps:

1. Enter the command REMOVE DOS at the console to prevent NetWare from attempting to read from or write to the failed device.

2. Power down your server.

3. Replace the failed drive.

4. Reboot the system and run the System Configuration Utility (see Chapter 7).

5. On the SCU menu, select the option to Install a System Partition on your DOS Boot Device. This partition should contain the System Configuration Utility and the Compaq Diagnostic Utility.

6. Exit the System Configuration Utility.

7. Locate a DOS bootable diskette that contains the DOS FDISK and FORMAT programs.

8. Use the FDISK program to create a primary DOS partition of at least 100 MB on the replaced drive.

9. Set the active partition to the DOS partition you just created.

10. Use the FORMAT command to format the DOS partition to include the necessary files to make the partition bootable. For example:

    FORMAT C: /s

11. Copy these files onto the DOS partition from the Novell SSD:

    ❑ *SERVER.EXE*

    ❑ *STARTUP.NCF*

    ❑ Utility NLMs

    ❑ LAN drivers

❑ Required disk drivers

12. Copy any other necessary information to the DOS partition, then reboot your system. You can now start your NetWare server. You may need to recreate your *STARTUP.NCF* file.

Recovering Data

If you have chosen NetWare mirroring or NetWare controller duplexing, perform the following steps to recover data after a drive failure:

1. Record the device number and device name of the failed logical drive. This information is shown on the server console and recorded in the server error log file, which may be viewed using the NWADMIN utility. For example:

   NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

   You will use this information later to create a valid partition.

2. Load *INSTALL.NLM* and *NWCONFIG* for NetWare v5 and select the Disk Options Mirroring menu.

3. Select the mirrored logical partition that was affected by the drive failure (See Step 1). Record the device number and partition number of the operational logical drive in this mirrored group. This information will be used later to remirror the repaired logical drive. For example:

   NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

4. Delete the unavailable (possibly out of sync) device from the Mirror Partition group. This device is unavailable due to the drive failure.

5. Record the drive bay location of the failed physical drive. The new physical drive must be inserted in this drive bay.

6. If the failed drive is hot-pluggable, go directly to the next step. Otherwise, schedule server down time, take the server offline, and power off the unit.

7. Remove the failed drive and insert the replacement physical drive in the same drive bay. The physical drive must be of the same capacity as the failed drive. Be sure that all cable connections are secure.

   When a hard drive in a ProLiant server or storage system is replaced, the LEDs on the drive each light once in an alternating pattern to indicate that the connection was successful. The Online LED then turns green, indicating that the controller has recognized and successfully initialized the replacement drive. If the Online LED does not light after a few minutes, verify that you added the new drive in the same slot as the failed drive and that the drive capacity is the same as the failed drive.

8. Use the *MONITOR.NLM* Disk Information option to select the replaced device.

   Some versions of NetWare will automatically activate the device when this option is chosen. Other versions of NetWare require manual activation of the device by changing the operating status to Active.

   If reactivation of the failed logical drive is successful, the driver sends a notification to the console.

9. Use the *INSTALL.NLM* and *NWCONFIG* for NetWare v5 option Change Hot Fix (look at the information provided about the mirrored drive, not the failed drive) to determine the number of Hot Fix Redirection blocks set up for this partition.

10. Use the *INSTALL.NLM* and *NWCONFIG* for NetWare v5 to delete and recreate the partition on the repaired logical drive.

    NOTE: Although the logical drive may have a valid partition table, the data on this logical drive is no longer valid. Some data may seem valid because the failed physical drive was only a portion of the arrayed logical drive. However, there is a hole in the logical drive data at this point. Delete any old, invalid data and create a new partition on the logical drive.

11. On the *INSTALL.NLM* Disk Options menu, select the Modify Disk Partitions and Hot Fix option.

    The driver will send a console alert if reactivation is successful.

12. On the *INSTALL.NLM* Available Disk Drives menu, select the previously failed logical drive, which has now been repaired. The device information was recorded in step 1. For example:

    NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

13. Select the Delete Partition menu option. *INSTALL* may display several error messages. Since you will delete this partition, do not update any Volume Definition Table information. Continue until the partition has been deleted.

14. If *INSTALL* reports that it cannot delete the partition because another process has locked it, load *MONITOR* and look at the System Resources option to determine which NLM has locked the device. It may be *MONITOR.NLM*, so you will need to unload *MONITOR* and any other NLMs that have the partition locked. After you create the partition and volume information, reload those NLMs.

15. Create the partition on the same logical drive.

16. Return to the Disk Options Mirroring menu. Select the previously mirrored NetWare 386 Partition number (recorded in step 1).

    NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

17. Press **Insert** for a list of partitions available to remirror. Select the partition associated with the repaired device (step 1).

   NetWare will resynchronize the mirrored partitions. A console message indicates successful completion of the resynchronization step.

No Fault Tolerance

If you configured your system for no fault tolerance, data must be recovered from backup media. Perform the following steps:

1. Record the device number and device name of the failed logical drive. This information is shown on the server console and recorded in the server error log file, which may be viewed using the *NWADMIN* utility (4.x). For example:

   NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

   You will use this information later to create a valid partition.

2. Failed hot-pluggable drives in a ProLiant server or storage system are identifiable by a glowing amber LED on the drive tray. Record the location of the drive bay containing the failed physical drive. This is where the new physical drive must be inserted.

3. If the failed drive is hot-pluggable, go directly to the next step. Otherwise, schedule server down time, take the server offline, and power off the unit.

4. Remove the failed drive and insert the replacement physical drive in the same drive bay. The physical drive must be of the same capacity as the failed drive. Be sure that all cable connections are secure.

   When a hard drive in a ProLiant server or storage system is replaced, the LEDs on the drive each light once in an alternating pattern to indicate that the connection was successful. The Online LED then turns green, indicating that the controller has recognized and successfully initialized the replacement drive. If the Online LED does not light after a few minutes, verify that you added the new drive in the same slot as the failed drive and that the drive capacity is the same as the failed drive.

5. Use the *MONITOR.NLM* Disk Information option to select the replaced device.

   Some versions of NetWare will automatically activate the device when this option is chosen. Other versions of NetWare require manual activation of the device by changing the operating status to Active.

If reactivation of the failed logical drive is successful, the driver sends a notification to the console.

6. Use the *INSTALL.NLM* and *NWCONFIG* for NetWare v5 option Change Hot Fix (look at the information provided about the mirrored drive, not the failed drive) to determine the number of Hot Fix Redirection blocks set up for this partition.

7. Use the *INSTALL.NLM* and *NWCONFIG* for NetWare v5 to delete and recreate the partition on the repaired logical drive.

   NOTE: Although the logical drive may have a valid partition table, the data on this logical drive is no longer valid. Some data may seem valid because the failed physical drive was only a portion of the arrayed logical drive. However, there is a hole in the logical drive data at this point. Delete any old, invalid data and create a new partition on the logical drive.

8. On the *INSTALL.NLM* Disk Options menu, select the Modify Disk Partitions and Hot Fix option.

   The driver will send a console alert if reactivation is successful.

9. On the *INSTALL.NLM* Available Disk Drives menu, select the previously failed logical drive, which has now been repaired. The device information was recorded in step 1. For example:

   NWPA: [V503-A2-D1:0] Compaq SMART-2 Slot 8 Disk 2 NFT

10. Select the Delete Partition menu option. *INSTALL* may display several error messages. Since you will delete this partition, do not update any Volume Definition Table information. Continue until the partition has been deleted.

11. If *INSTALL* reports that it cannot delete the partition because another process has locked it, load *MONITOR* and look at the System Resources option to determine which NLM has locked the device. It may be *MONITOR.NLM*, so you will need to unload *MONITOR* and any other NLMs that have the partition locked. After you create the partition and volume information, reload those NLMs.

12. Create the partition on the same logical drive.

13. Create and mount the volume.

14. Locate the recent backup media and restore the data to this server volume.

Moving Drives and Arrays

⚠️ **CAUTION:** Back up all data before removing drives or changing configurations. Failure to do so could result in permanent loss of data.

Drives can be moved to other ID positions on the same array controller. You may also move a complete array from one controller to another, even if the controllers are on different servers. Arrays on different controllers can also be combined into one larger array on a single controller.

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 should be in its original configuration with no active spare drives.

■ Capacity expansion is not running.

■ Controller firmware is the latest version (recommended).

Before moving an array, these additional conditions must be met:

■ All drives in the array must be moved at the same time.

■ Positions of drives on the destination controller must not be changed during relocation of the array.

When the appropriate conditions are met, follow this procedure:

1. Power OFF the system.

2. Move the drives.

3. Power the system ON.

   A 1724 POST message should be displayed, indicating that drive positions were changed and the configuration was updated. If a 1785 (Not Configured) POST message is displayed, turn the system OFF immediately to avoid data loss, and return the drives to their original locations.

You can now check the new drive configuration by running ORCA or the Array Configuration Utility (see Chapter 7).

Upgrading Disk Drive Capacity

You can increase the storage capacity on a system even if there are no available drive bays, as long as a fault-tolerance method is running.

1. Replace any drive. The data on the new drive is recreated from redundant information on the remaining drives. *Do not replace any other drive until data rebuild is complete.*

2. 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.

3. When all drives have been replaced, you can use the extra capacity to create new logical drives or extend existing logical drives. See the following sections on array capacity expansion and logical drive capacity extension for more details.

Expanding and Extending Capacity

Array Capacity Expansion is the addition of physical drives to an array that has already been configured. The capacity of these added physical drives may then be added to an existing logical drive on the array (capacity *extension*; see the next paragraph), or it may be configured into a new logical drive.

Logical Drive Capacity Extension is the enlargement of an existing logical drive after the corresponding array has undergone capacity expansion.

Capacity expansion and extension are carried out using ACU (Chapter 7). A data backup and restoration cycle is not required, even in non-fault-tolerant configurations. Online reconfiguration can only take place if ACU is running in the same environment as the normal server applications.

If you are using hot-pluggable drives, expansion can be performed online (that is, without shutting down the operating system). Online *extension* can only be performed with some operating systems. See Chapter 7 for details.

> **IMPORTANT:** When using logical drive extension under Windows 2000, upgrade the disk to DYNAMIC *before* creating a partition on that disk. If the disk already has a partition when it is upgraded to DYNAMIC, Windows 2000 may not allow logical drive extension. Refer to the Windows 2000 documentation for details about DYNAMIC and BASIC disks.

The expansion process is illustrated in Figure E-3, where the original array (containing data) is shown with a dashed border, and the newly added drives are shown unshaded (they contain no data). The array controller redistributes the original logical drive over the enlarged array, using the same fault-tolerance method. The unused capacity on the new (enlarged) array can then be used to create an additional logical drive, with a different fault tolerance setting if necessary. Alternatively, the extra capacity can be used to increase the size of the original logical drive (capacity extension).
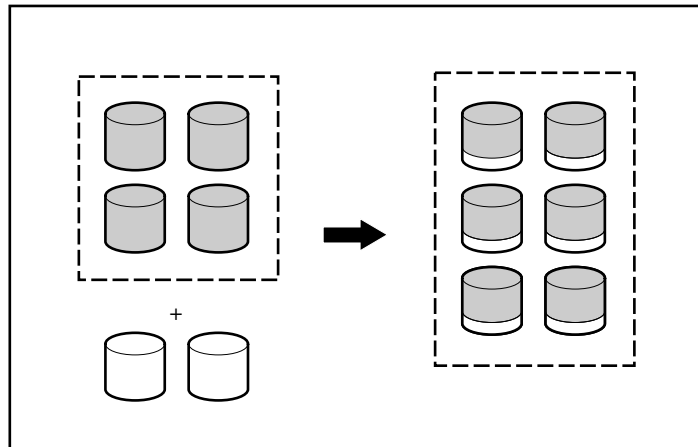
Figure E-3. Array capacity expansion

If you are expanding an array that has several logical drives, data will be redistributed one logical drive at a time. Newly created logical drives will not become available until capacity expansion has finished.

Appendix **F**

Reliability Data

Figure F-1 shows the relative probability of logical drive failure for different RAID settings and different logical drive sizes, assuming no online spares are present. With RAID 0, the logical drive will fail if only one physical drive fails; with RAID 5, two physical drives must fail; and with RAID ADG, three hard drives must fail.

The situation is more complex for RAID 0+1. The *maximum* number of hard drives that can fail without failure of the logical drive is *n*/2. This will happen only if none of the failed drives are mirrored to each other. In practice, logical drive failure will usually occur before this maximum number is reached, since the probability of a newly failed drive not being mirrored to a previously failed drive becomes increasingly small as the number of failed drives increases. Also note that a RAID 0+1 logical drive may fail if only two hard drives fail, if they are mirrored to each other; the probability of this happening decreases as the number of mirrored pairs in the array increases.

An online spare can be added to any of the fault-tolerant RAID levels to further decrease the probability of logical drive failure to about a thousandth of the previous level.

For RAID 5, Compaq recommends that no more than 14 physical drives be used per logical drive. However, logical drive failure is much less likely with RAID ADG, and Compaq supports the use of up to 56 physical drives per logical drive when running this fault-tolerance method.
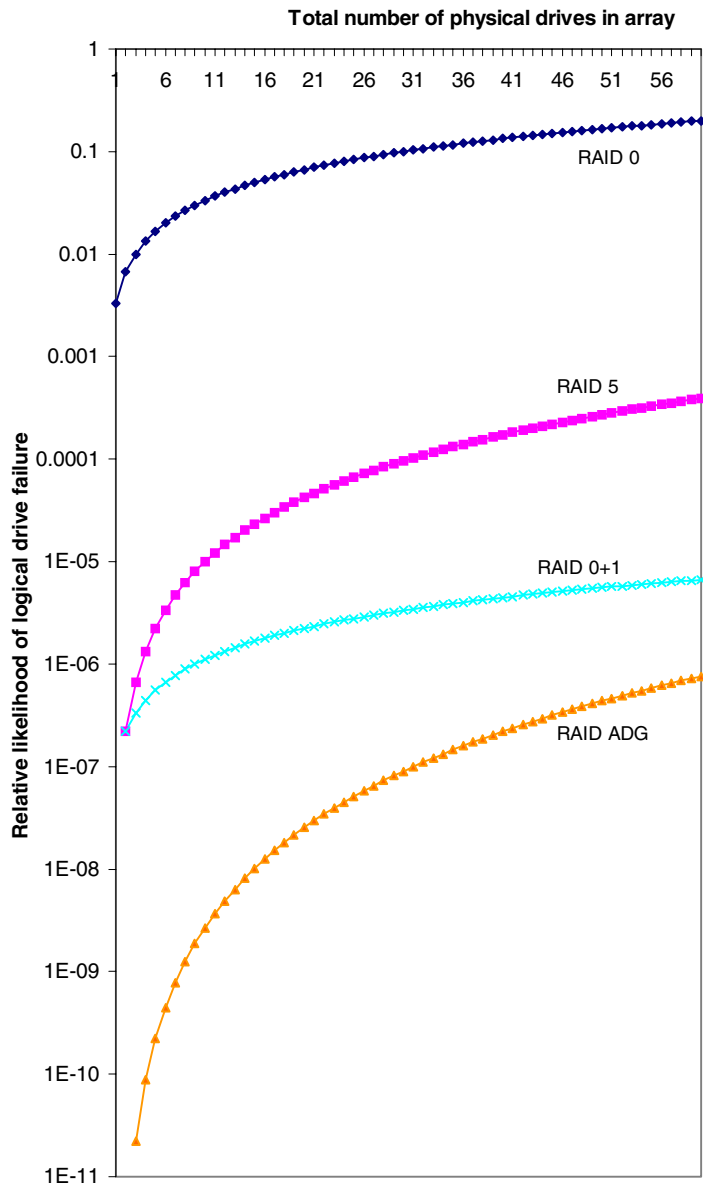
Figure F-1. Probability of logical drive failure for different RAID levels

Appendix **G**

POST Error Messages

The Smart Array 5300 produces diagnostic error messages at reboot. Many of these Power-On Self-Test (POST) messages are self-explanatory and suggest corrective actions for troubleshooting. Detailed information and corrective actions are listed below.

Table G-1
POST Error Messages

Message	Meaning	Recommended Action
1702	SCSI cable error detected. System halted.	This message indicates a termination or cabling problem with the system board integrated SCSI controller. Refer to cabling information in the Installation Guide.
1711	Slot x Drive Array – RAID ADG logical drives present but cache size is less than or equal to 32 MB.	This configuration is not recommended. Migrate the logical drive (or drives) to RAID 5 or upgrade the Array Accelerator cache module.
1712	Slot x Drive Array – RAID 5 logical drives present with 56 drives or more, but cache size is less than or equal to 32 MB.	This configuration is not recommended. Migrate the logical drive (or drives) to RAID 0 or 1, reduce the number of drives in the array, or upgrade the Array Accelerator cache module.
1713	Slot x Drive Array – Redundant ROM reprogramming failure.	Replace the controller if this error persists after restarting the system.
1714	Slot x Drive Array – Redundant ROM checksum error.	Backup ROM has automatically been activated. Check the firmware version.

Table G-1
POST Error Messages *continued*

Message	Meaning	Recommended Action
1720	Slot x Drive Array – SMART Hard Drive Detects Imminent Failure: SCSI Port x: SCSI ID x	The indicated drive has reported a SMART predictive-failure condition. It may fail at some time in the future. **Do not replace the drive unless all other drives on the array are on-line!** Back up data before replacing drive(s).
1721	Slot x Drive Array – Drive Parameter Tracking Predicts Imminent Failure The following device(s) should be replaced when conditions permit:	**Do not replace the drive unless all other drives on the array are on-line**! Back up data before replacing drive(s). M&P predictive failure threshold exceeded condition. The indicated drive may fail at some time in the near future.
1723	Slot x Drive Array – to improve signal integrity, internal SCSI connector should be removed if external drives are attached to the same SCSI port (followed by further details).	Follow the remaining instructions in the POST message.
1724	Slot x Drive Array – Physical Drive Position Change(s) Detected – Logical drive configuration has automatically been updated.	This message indicates that logical drive configuration has been updated automatically following physical drive position changes. Press the **F1** key to resume.
1726	Slot x Drive Array - Array Accelerator Memory Size Change Detected – Array Accelerator configuration has automatically been updated	This message appears if the controller is replaced with a model that has a different amount of cache memory.
1727	Slot x Drive Array - New Logical Drive(s) Attachment Detected (if >32 logical drives, this will be followed by Auto-Configuration Failed: Too Many Logical Drives)	This message indicates the controller has detected an additional array of drives that was attached when the power was off. The logical drive configuration information has been updated to add the new logical drives. The maximum number of logical drives supported is 32 - additional drives will not be added to the configuration if this number is exceeded. Press the **F1** key to resume.

Table G-1
POST Error Messages *continued*

Message	Meaning	Recommended Action
1728	Slot x drive array – abnormal shutdown detected with write cache enabled. No Array Accelerator battery backup on this model array controller. Any data that may have been in Array Accelerator memory has been lost.	This POST message should never occur unless the write cache is somehow enabled on a controller that does not have batteries.
1729	Slot 1 Drive Array - disk performance optimization scan in progress – RAID 4/5 performance may be higher after completion.	This message is normal following the initial configuration of RAID 4 or RAID 5 logical drives. This POST message will go away and performance of the controller will improve after the parity data has been initialized by ARM (an automatic process that runs in the background on the controller).
1753	Slot x drive array – array controller maximum operating temperature exceeded during previous power up.	This message appears at the next power-up if the controller locks due to excessive temperature. Check for proper operation of the server cooling fan.
1754	Slot z drive array – RAID ADG drive(s) configured but ADG Enabler Module is detached or defective. Please check for detached ADG Enabler Module. Array Accelerator is temporarily disabled.	An operational ADG Enabler Module must be attached whenever RAID ADG volumes are configured or the Array Accelerator will be disabled. Replace the ADG Enabler Module.
1755	Slot z drive array – ADG Enabler Module appears to be defective. Please replace the ADG Enabler Module.	Replace the defective ADG Enabler Module, or remove it if unneeded (that is, if no RAID ADG logical drives are configured).
1756	Slot x redundant controllers are not the same model.	The redundant controllers are not of the same model. Use two like model controllers for redundancy.
1757	Slot x Array Accelerator daughterboard incompatible. Please replace 4MB array accelerator card with a 16MB or 64MB card.	The controller does not support the attached Array Accelerator card. Attach the correct Array Accelerator daughterboard.
1758	Slot x drive array – Array Accelerator size mismatch between controllers. 64MB array accelerator should be attached to both controllers.	The size of Array Accelerator cards is different between two controllers in a redundant controller configuration. Use Array Accelerator cards of the same size on both controllers.
1759	Slot x drive array – redundant controller error	Replace controller or server motherboard.

Table G-1
POST Error Messages *continued*

Message	Meaning	Recommended Action
1762	Redundant controller operation is not supported in this firmware version. Please remove redundant controller or upgrade controller firmware. (Controller is disabled until this problem is resolved.)	Remove the redundant controller or visit the Compaq website and get the latest upgrade for the controller firmware.
1763	Array accelerator daughtercard is detached; please reattach. (Controller is disabled until this problem is resolved.)	This controller model cannot operate if the Array Accelerator card is detached. Reattach the card.
1764	Slot x drive array – capacity expansion process is temporarily disabled (followed by a cause).	The capacity expansion process has been temporarily disabled for the reason indicated, and will automatically resume. If the array accelerator has been removed, you must reinstall it for capacity expansion to continue.
1765	Slot x drive array Option ROM appears to conflict with an ISA card – ISA cards with 16-bit memory cannot be configured in memory range C0000 to DFFFF along with SMART-2/E 8-bit Option ROM due to EISA buffer limitations. Please remove or reconfigure your ISA card.	Remove or reconfigure the conflicting ISA card, referring to the directions provided with the ISA card. Alternatively, the Option ROM can be disabled on the SMART-2/E controller via the System Configuration Utility if a SMART-2/E is not the primary (boot) controller.
1766	Slot x drive array requires System ROM upgrade. Run System ROMPaq Utility.	Run the latest version of System ROMPaq.
1768	Slot x drive array – resuming logical drive expansion process.	No action required. This message appears whenever a controller reset or power cycle occurs while array expansion is in progress.
1769	Slot x drive array – drive(s) disabled due to failure during expansion (possibly followed by additional details).	Data has been lost while expanding the array; therefore, the drives have been temporarily disabled. Press **F2** to acknowledge the data loss and re-enable the logical drives. Restore data from backup. If the Array Accelerator has failed, replace the Array Accelerator board after the capacity expansion process has terminated. NEVER turn off the system and replace the Array Accelerator board if capacity expansion is in progress.

Table G-1
POST Error Messages *continued*

Message	Meaning	Recommended Action
1770	Slot x Drive Array – Critical Drive Firmware Problem Detected – Please upgrade firmware on the following drive(s) using Options ROMPaq (available from www.compaq.com): SCSI Port (y) SCSI ID (*x*)	The indicated drives are running firmware that may cause intermittent problems. Use Options ROMPaq to upgrade firmware on all drives to the latest revision.
1774	Slot x drive array – obsolete data found in Array Accelerator. Data found in accelerator was older than data found in drives. Obsolete data has been discarded.	Data found in Accelerator is older than data found on drives due to drives having been disconnected, used on another controller, then reconnected. Press **F1** to discard older data.
1775	Slot x Drive Array – ProLiant Storage System Not Responding SCSI Port (y): Check storage system power switch and cables. Turn the system power off while checking the ProLiant power and cable connections, then turn the system power back ON to retry.	Turn off power to system. Check external ProLiant power switch - external drives must all be powered up before or at the same time as the main system. Check cables. If retry does not help, update the ProLiant System firmware, or try replacing the cable, ProLiant storage backplane, or the array controller.
1776	Slot x Drive Array – SCSI Bus Termination Error – Internal and external drives cannot both be attached to the same SCSI port. SCSI port (y): Check cables	The internal and external connectors of the specified SCSI port(s) are both attached to drives. The SCSI bus is not properly terminated when internal and external drives are attached concurrently to the same SCSI bus. The indicated SCSI bus is disabled until this problem is resolved. Turn off the server power and check the cabling to the specified SCSI port

continued

Table G-1
POST Error Messages *continued*

Message	Meaning	Recommended Action
1777	Slot x Drive Array – ProLiant Drive Storage Enclosure Problem Detected (followed by one or more of the following): ■ SCSI Port (y): Cooling Fan Malfunction Detected ■ SCSI Port (y): Overheated Condition Detected ■ SCSI Port (y): Side-Panel must be Closed to Prevent Overheating ■ SCSI Port (y): Redundant Power Supply Malfunction Detected ■ SCSI Port (y): Wide SCSI Transfer Failed ■ SCSI Port (y): Interrupt Signal Inoperative	Check cooling fan operation by placing hand over fan. Check internal plenum cooling fan in tower servers or storage systems. If fan is not operating, check for obstructions and check all internal connectors. Replace unit side panel if removed. If the ProLiant Storage System power LED is amber instead of green, this can indicate a fan failure, redundant power supply failure, or thermal problem. Check SCSI cables. If the message indicates to check SCSI cables, please verify your cabling against the diagrams in this User Guide. If the routing is correct, replace cables on the specified port until the POST message is eliminated.
1778	Slot x Drive Array resuming Automatic Data Recovery process.	No action required. This message appears whenever a controller reset or power cycle occurs while Automatic Data Recovery is in progress.
1779	Slot x Drive Array – Replacement drive(s) detected OR previously failed drive(s) now appear to be operational: Port (*y*): SCSI ID (*x*): Restore data from backup if replacement drive *x* has been installed.	If this message appears and drive *x* (identified by its SCSI ID) has not been replaced, this indicates an intermittent drive failure. This message also appears once immediately following drive replacement before data is restored from backup.
1783	Slot x Drive Array Controller Failure.	If this message appears immediately following a ROM installation, the ROM is defective or not installed properly. Check that the controller is firmly inserted in its slot. Check for improper cabling or SCSI ID conflicts. Try upgrading the System ROMs. Otherwise, replace the array controller.
1784	Slot x Drive Array Drive Failure. The following SCSI drive(s) should be replaced: SCSI port (*y*) SCSI ID (*x*)	Check for loose cables. Replace defective drive *x* and/or cable(s).

Table G-1
POST Error Messages *continued*

Message	Meaning	Recommended Action
1785	Slot 1 Drive Array not Configured (may be followed by one of the following messages): (1) No drives detected. (2) Drive positions appear to have changed. Run Drive Array Advanced Diagnostics if previous positions are unknown, then turn system power OFF and move drives to their original positions. (3) Configuration information indicates drive positions beyond the capability of this controller. This may be due to drive movement from a controller that supports more drives than the current controller. (4) Configuration information indicates drives were configured on a controller with a newer firmware version.	(1) Turn off the system and check SCSI cable connections to make sure drives are attached properly. (2) Run Drive Array Advanced Diagnostics if previous positions are unknown. Then turn system power OFF and move drives to their original positions. (3) To avoid data loss, turn system power OFF and reattach drives to the original controller. (4) To avoid data loss, reattach drives to the original controller or upgrade the controller firmware to the version on the original controller using Option ROMPaq. Press the **F1** key to resume.
1786	Slot x Drive Array Recovery Needed. The following SCSI drive(s) need Automatic Data Recovery: SCSI Port (y): SCSI ID (x) Select **F1** to continue with recovery of data to drive(s). Select **F2** to continue without recovery of data to drive(s). *-or-* Slot x Drive Array Recovery Needed. Automatic Data Recovery Previously Aborted! The following SCSI drive(s) need Automatic Data Recovery (Rebuild): SCSI Port (y): SCSI ID (x) Select **F1** to retry Automatic Data Recovery to drive. Select **F2** to continue without starting Automatic Data Recovery.	The message normally appears when a drive was replaced in a fault-tolerant configuration when system power was OFF. In this case, press **F1** to start the automatic data recovery process. The "previously aborted" version of the 1786 POST message will appear if the previous rebuild attempt was aborted for any reason. Run the Array Diagnostics Utility (ADU) for more information. If the replacement drive was failed, try using another replacement drive. If rebuild was aborted due to a read error from another physical drive in the array: 1. Back up all readable data on the array. 2. Run Diagnostics Surface Analysis 3. Restore your data
1787	Slot x Drive Array Operating in Interim Recovery Mode. The following SCSI drive(s) should be replaced: SCSI Port (y): SCSI ID (x)	Following a system restart, this message reminds you that drive x is defective and fault tolerance is being used. Drive x needs replacement as soon as possible. A loose or defective cable may also cause this error.

Table G-1
POST Error Messages *continued*

Message	Meaning	Recommended Action
1788	Slot x Drive Array Reports Incorrect Drive Replacement. The following SCSI drive(s) should have been replaced: SCSI Port (*y*): SCSI ID (*x*). The following SCSI drive(s) were incorrectly replaced: SCSI Port (*y*): SCSI ID (z). Select **F1** to continue – drive array will remain disabled. Select **F2** to reset configuration - all data will be lost. *-or-* Faulty power cable connection to the drive. *-or-* Defective SCSI cable.	The drives indicated were installed in the wrong place, so they have been disabled. Reinstall the drives correctly. Press **F1** to restart the computer with the drive array disabled. *-or-* Press **F2** to use the drives as configured and lose all the data on them. Repair the connection and press **F2**. If this message is not eliminated by pressing **F2**, run the Drive Array Advanced Diagnostics Utility. Contact your Authorized Compaq Service Provider.
1789	Slot x Drive Array Physical Drive(s) Not Responding. Check cables or replace the following SCSI drives: SCSI Port (y): SCSI ID (x) Select **F1** to continue - drive array will remain disabled. Select **F2** to fail drives that are not responding – Interim Recovery Mode will be enabled if configured for fault tolerance.	This message indicates that previously operating drives are missing or inoperative following a cold or warm reset. Turn off system and check cable connections. If cables are connected, replace the drive. Press **F1** to restart the computer with the drive array disabled. *-or-* If you do not want to replace the drives now, press **F2**.
1792	Slot x valid data found in Array Accelerator. Data automatically written to drive array.	Power was interrupted while the system was in use, or the system was restarted while data was in the Array Accelerator memory. Power was restored within four days.

continued

Table G-1
POST Error Messages *continued*

Message	Meaning	Recommended Action
1793	Slot x drive array – Array Accelerator battery depleted. Data in Array Accelerator has been lost. (Error message 1794 is also displayed.)	While the system was in use, power was interrupted while data was in the Array Accelerator memory. Power was not restored within four days, so the batteries were depleted and data in the Array Accelerator was lost. Check all files for potential data corruption. *-or-* The Array Accelerator batteries have failed.
1794	Slot x drive array – Array Accelerator battery charge low. Array Accelerator is temporarily disabled. Array Accelerator will be re-enabled when battery reaches full charge.	The battery charge is below 90%. Posted writes are disabled. When the batteries are fully charged, the Array Accelerator will automatically be re-enabled and this POST message will no longer be displayed. Replace the Array Accelerator or the Smart Array Controller if batteries do not recharge within 36 power-on hours.
1795	Slot x drive array – Array Accelerator configuration error. Data does not correspond to this drive array. Array Accelerator is temporarily disabled.	The data stored in the Array Accelerator does not correspond to this drive array. Match the Array Accelerator to the correct drive array. *-or-* Run the Compaq System Configuration Utility to clear data in the Array Accelerator.
1796	Slot x drive array – Array Accelerator is not responding. Array Accelerator is temporarily disabled.	Replace the Array Accelerator or the Smart Array Controller.
1797	Slot x drive array – Array Accelerator read error occurred. Data in Array Accelerator has been lost. Array Accelerator is disabled.	Replace the Array Accelerator or the Smart Array Controller. Restore data from backup.
1798	Slot x drive array – Array Accelerator write error occurred. Array Accelerator is disabled.	Replace the Array Accelerator or the Smart Array Controller. Restore data from backup.
1799	Slot x drive array – drive(s) disabled due to Array Accelerator data loss. Select **F1** to continue with logical drives disabled. Select **F2** to accept data loss and re-enable logical drives.	Data stored in the Array Accelerator has been lost; therefore, the drives have been temporarily disabled. Press **F2** to acknowledge the data loss and re-enable the logical drives. Restore data from backup.

Questions and Answers

This Appendix includes common questions about the Smart Array 5300 Controller and RAID ADG.

Q: How many Smart Array 5300 Controllers can I install in my system, and how many internal and external drives?

A: The maximum number of Smart Array 5300 Controllers that you can install in your system depends on your server and several other factors specific to your configuration. Generally, it will be restricted to the number of PCI slots not used for other peripherals.

Another limiting factor is the power rating of your system. Each Smart Array 5300 requires 21.2 W (or 24.9 W if four-channel); your server must be capable of supplying every controller with this amount of power.

Each Smart Array 5300 has two SCSI buses (one internal and up to two external), upgradeable to four SCSI buses (two internal and up to four external). Each bus can support up to a maximum of 14 drives. Your choice of server and the hard drive heights also affect the maximum number of internal and external drives that you can install in your system.

Q: Does the Smart Array 5300 Controller support SCSI tape drives and CD-ROM drives?

A: The Smart Array 5300 Controller supports the Compaq Universal Hot Plug tape drive. However, it does not support any CD-ROM drives.

Q: I installed the hard drives in my server. Must I now terminate each drive?

A: No. If you installed hard drives in a server with a Smart Array 5300 Controller, all termination requirements are met by the I/O board and the hot-plug backplane in the server. Individual hot-pluggable drives should already have termination removed.

Q: What is the data transfer rate for Wide Ultra3 SCSI?

A: Wide Ultra3 SCSI has a data bandwidth of 160 MB per second. Most server applications do not generally take advantage of the full Ultra3 bandwidth, so performance results will vary from customer to customer.

Q: What is the difference between LVD and Ultra3 SCSI?

A: Low-Voltage Differential (LVD) is a signaling level for SCSI protocols. Ultra3 is a SCSI protocol that uses LVD signaling. Ultra2 also uses LVD signaling, but earlier SCSI protocols used Single-Ended (SE) signaling.

Q: Are Single-Ended SCSI and Low-Voltage Differential SCSI compatible?

A: Yes. SE and LVD are compatible in as much as when mixing SE drives and LVD drives on a single SCSI channel, all drives will switch down to SE SCSI mode and operate under SE SCSI rules. To maintain a true LVD SCSI bus with its associated performance advantages, a LVD SCSI channel should only be connected to LVD SCSI drives.

Q: I have several hard drives in my server and in the Compaq ProLiant Storage System. What SCSI IDs do I assign for these drives?

A: If you are using hot-pluggable drives in a Compaq ProLiant Server or Storage System /U, the SCSI IDs are set **automatically** according to the bay in which the drives are installed and do not need to be manually set.

If your drives are installed in a Compaq *ProSignia*™ or if you are using non-hot-pluggable drives in a ProLiant Server, you must manually set the SCSI ID jumpers. Each hard drive must have a unique SCSI ID for each controller port.

Q: Should SCSI IDs in my system be consecutive?

A: It is not required that the IDs of devices on each SCSI bus be consecutive. However, IDs must still be unique for each device on a single SCSI bus.

Q: I am planning to install several 2.1, 4.3, and 9.1 GB hard drives in my Compaq servers. Can I install each drive in any drive bay?

A: Yes. In the ProLiant and ProSignia Servers, you may install these drives in any drive bay; they do not need to be installed in contiguous bays.

Q: I ordered my server with a pre-installed Smart Array 5300 Controller. How do I order cables to connect to my Compaq external storage enclosure?

A: The required cable is supplied with the external storage enclosure. If you lose or misplace an external cable, review the cable information in this manual, or see the cable guide on the Compaq website for a complete listing of correct cables for your array controller and enclosure.

Q: I do not have any hard drives in my server, but I am connecting it to a Compaq ProLiant Storage System, which has several hard drives. Which SCSI port do I use?

A: If you have *no* hard drives installed in your server, you can connect the Compaq ProLiant Storage System to any of the four available external ports (SCSI connectors).

If hard drives are installed in your server and connected to the Smart Array 5300, determine the number of externally available ports by subtracting the number or internal ports used from the 2 or 4 total ports on the controller. For example, if you are using one internal port, you should have one or three externally available SCSI ports.

Q: I want to connect four Compaq external storage enclosures to my SA-5300 Controller in my server. Can I also connect the internal hard drives in my server to the Smart Array 5300 Controller?

A: Not to the same array controller. The SA-5302 has two ports, and the SA-5304 (or SA-5302 with attached adapter) has four ports. You will need to add another controller, omit the internal drives, or use only three external storage enclosures.

Q: What must I do with System ROMPaq?

A: Run System ROMPaq to upgrade the firmware in your server to the latest revisions prior to installing a Smart Array 5300 Controller in an existing system. Otherwise, the system may not reboot if the Smart Array 5300 is the primary controller.

Q: **How do I interpret a POST error message referring to the Smart Array 5300 Controller?**

A: First, copy down the POST error message for later reference. See Appendix G, "POST Error Messages," for detailed information about each POST error message. If you still do not know what to do, run the Array Diagnostics Utility.

Q: **Can I use third party (not Compaq) drives on the Smart Array 5300 Controller?**

A: Yes. However, Compaq offers a unique Pre-Failure Warranty for all drives—valid only when using Compaq Drives, Compaq array controllers, and Compaq Insight Manager. Contact your dealer for more information on Compaq Pre-failure Warranty.

Although you *can* use third party drives, experience in Compaq testing laboratories reveals that you might have problems such as time-outs or data corruption. The Smart Array 5300 Controller takes full advantage of tagged-command queuing, something that can be a problem in the firmware of many third party drives.

Q: **Why do the drive activity LEDs light up on some drives when my system is idle?**

A: The Smart Array 5300 performs several different background activities on the drives when the controller is otherwise idle. For example, Auto Reliability Monitoring scans fault-tolerant volumes for defects and verifies the consistency of parity data, and Drive Parameter Tracking periodically checks the performance of all drives on the controller (normally on an hourly basis).

Q: **What is RAID ADG?**

A: RAID ADG is an extension of RAID 5 that allows additional fault tolerance by using two different and independent parity schemes. Data is striped across a set of hard drives, just as with RAID 5, and the two sets of parity data are calculated and written across all the drives in the array.

RAID ADG provides an extremely high level of fault tolerance, and can sustain two simultaneous drive failures without downtime or data loss. This is a perfect solution when data is mission-critical.

Q: **What does the abbreviation RAID ADG mean?**

A: ADG is an abbreviation for Advanced Data Guarding, the term Compaq uses for this type of fault tolerance.

Q: When should RAID ADG be used?

A: There are three primary reasons for using RAID ADG.

- ❑ When a higher level of fault tolerance is needed than with RAID 5 and high drive capacity usage is also required.

- ❑ When a higher level of drive capacity usage is required than with RAID 0+1 while maintaining a high level of fault tolerance.

- ❑ When a large logical drive is needed, incorporating from 10 to 56 hard drives.

Q: What is the difference between RAID ADG and RAID 0+1?

A: RAID ADG uses the capacity of only two hard drives for fault tolerance, regardless of the size of the RAID volume. This means a lower cost of implementation for six or more drives.

RAID ADG also provides a higher level of fault tolerance, since the mathematical probability of suffering a second drive failure in the same mirror set as an already-failed drive (in RAID 0+1) is higher than the probability of a third drive failure in RAID ADG. However, RAID 0+1 is the highest-performance RAID level.

Q: What is the difference between RAID ADG and RAID 5?

A: RAID ADG allows two drives to fail simultaneously without downtime or data loss. Data is also preserved if one drive fails and another simply has a few bad sectors. With RAID 5, however, only one drive can fail without data loss. RAID ADG thus provides a much higher level of fault tolerance than RAID 5.

Due to this higher level of protection, users can set up larger RAID volumes, spanning up to 56 physical drives. With RAID 5, the maximum recommended number of drives per volume is only 14.

RAID 5 and RAID ADG have equal performance when reading data, but RAID ADG is slower when writing data due to the extra parity set that it uses. The exact difference in performance will vary from one situation to another.

Q: What products support RAID ADG?

A: RAID ADG is available with controller model SA-5304/128. It is also supplied with the 128-MB cache module available as an option for the SA-5302/32 and SA-5302/64 controllers.

Q: Does RAID ADG support online spares?

A: Yes. Customers can incorporate online spares for added data protection.

Q: How is RAID ADG activated?

A: Both a hardware key and a firmware upgrade are required. If the hardware key (referred to as the RAID ADG Enabler Module) is missing or faulty, the write cache is disabled and the user cannot configure any further RAID ADG volumes.

Customers who buy SA-5304/128 controllers will be able to download the firmware upgrade to activate RAID ADG from the Compaq website at www.compaq.com/smartarray.

Glossary and Acronyms

ACU (Array Configuration Utility)

A configuration utility useful for both novices and more experienced RAID users. Obtained either from the SmartStart and Support Software CD or by downloading from the Compaq web site.

ADU (Array Diagnostic Utility)

A diagnostic tool that collects comprehensive information about the array controllers in a system and lists any problems detected.

**ARM
(Auto-Reliability Monitoring)**

Also known as surface analysis. A fault management feature whereby hard drives are scanned for bad sectors, and data in the faulty sectors is remapped onto good sectors. Parity data consistency is also checked for drives in RAID 5 or RAID ADG configurations. Operates as a background process.

Array

A set of physical drives configured into one or more logical drives. Arrayed drives have significant performance and data protection advantages over non-arrayed drives.

Array Accelerator

A component of the Smart Array Controller that dramatically improves performance during disk read and write operations by providing a buffer. Data integrity is protected by a backup battery and ECC memory.

Automatic Data Recovery

Also known as rebuild. A process that automatically reconstructs data from a failed drive and writes it onto a replacement drive. Rebuild time depends on several factors, but at least 15 minutes should be allowed per gigabyte.

Cache

A high-speed memory component, used to store data temporarily for rapid access.

Capacity expansion	An increase in storage capacity of a drive array by adding physical drives and creating more logical drives. This feature is only available with Compaq array controllers that have a battery-backed Array Accelerator installed. Abbreviation for array capacity expansion.
Capacity extension	An increase in storage capacity of a drive array by adding physical drives and enlarging existing logical drives (without creating more logical drives). Same as logical drive extension. Abbreviation for logical drive capacity extension.
Controller duplexing	A type of fault tolerance that requires two Smart Array Controllers. Each controller has its own set of drives, and the drive sets have identical data. When one controller fails, the other automatically takes over the servicing of requests. Controller duplexing is only available for some operating systems.
Compaq Insight Manager	An easy-to-use and powerful server management utility, capable of collecting, analyzing and transmitting data about the condition of a server. It is also useful for managing server fault conditions, monitoring server performance, and remotely controlling, reconfiguring or restarting your system.
Compaq Management Agents	Server-based software that transmits data about the server to SNMP-based management tools, such as Compaq Insight Manager.
CPQONLIN	An array configuration utility for NetWare that can be used online.
Data guarding	See **RAID.**
Data striping	Data written to logical drives in interleaved chunks (by byte or by sector) to improve system performance.
Drive mirroring	See **RAID.**
ECC (Error Correction and Checking) memory	A type of memory that checks and corrects single-bit or multi-bit memory errors (depending on configuration) without causing the server to halt or corrupt data.
Fault tolerance	The ability of a server to recover from hardware problems without interrupting server performance or corrupting data. Hardware RAID is most commonly used, but there are other types of fault tolerance – for example, controller duplexing and software-based RAID.

Flashing	Updating the flash memory on a system. Flash memory is non-volatile memory that is used to hold control code such as BIOS information. It is also very fast because it can be rewritten block by block, rather than byte by byte.
Hot spare	See online spare.
Logical drive (or **logical volume)**	A group of physical drives, or part of a group, that behaves as one storage unit. Each constituent physical drive contributes the same storage volume to the total volume of the logical drive. Has performance advantages over individual physical drives.
Logical drive extension	Abbreviation for logical drive capacity extension. An increase in the size of a logical drive without disruption of the data on the drive. There must be free space on the array; if required, physical drives can be added to the array to create free space and allow the logical drive to be extended. Drive extension is only available with some operating systems.
LVD (Low Voltage Differential)	A type of SCSI signaling that allows a maximum transfer rate of either 80 MB/s or 160 MB/s, conforming to either the Wide Ultra2 or Wide Ultra3 SCSI standards respectively.
Online spare	Also known as a hot spare, this is a drive in a fault-tolerant system that normally contains no data. When another drive in the array fails, the controller automatically rebuilds data that was originally on the failed drive onto the online spare. Four online spares are allowed per Smart Array 5300 controller.
ORCA (Option ROM Configuration for Arrays)	A ROM-based configuration utility for users who have simple configuration requirements.
POST (Power-On Self-Test)	A series of diagnostic tests that run automatically each time the server is booted or reset.
RAID (Redundant Array of Independent Disks)	A form of fault tolerance. **RAID 0** (no fault tolerance) uses data striping to distribute data evenly across all physical disks in the array, but has no redundant data. **RAID 1** (drive mirroring) duplicates data from one drive onto a second drive; if more than one pair of drives is involved, this is termed **RAID 0+1** (or RAID 10). **RAID 5** (distributed data guarding) distributes parity data across all drives in the array, and uses the parity data and data on remaining drives to reconstruct data from a failed drive. **RAID ADG** (advanced data guarding) is similar to RAID 5, but uses two independent sets of parity data. See Appendix D for more detail.

Rebuild	See Automatic Data Recovery.
ROMPaq	A utility for updating the system or option firmware, available on the SmartStart and Support Software CD or from the web. Flashing must be supported to be able to take advantage of ROMPaq.
SCSI ID	A unique ID number assigned to each SCSI device connected to a SCSI channel. The ID number determines the device priority on the SCSI bus; ID 7 is the highest priority, and is always assigned to the SCSI controller.
SE (Single-Ended)	A type of SCSI signaling that allows a maximum transfer rate of 40MB/s. Conforms to the Wide-Ultra SCSI standard.
S.M.A.R.T. (Self-Monitoring And Reporting Technology)	Hard drive firmware that provides advance warning of mechanical drive failure by monitoring critical drive attributes and providing system alerts when an attribute moves out of tolerance.
SmartStart	An abbreviation for the Compaq SmartStart and Support Software CD. A collection of software for updating system drivers, configuring arrays or a system, diagnosing problems with arrays or a system, and updating firmware for the system or options. (The latest version of any of these software packages can be obtained by downloading a SoftPaq from the Compaq website.) SmartStart can also create or update the system partition on your hard drive.
SNMP (Simple Network Management Protocol)	Governs network management and the monitoring of network devices and functions.
SoftPaq	A compressed, self-extracting executable file available on the Compaq website that contains the latest version of a particular support software package. Can be downloaded to diskettes or directly to a hard drive.
Spare	See online spare.
Surface analysis	See ARM.
VHDCI (Very High Density Cable Interconnect)	A type of external SCSI connector used by Ultra SCSI controllers.
Wide-Ultra; Wide Ultra2; Wide Ultra3	A set of SCSI standards that support maximum signal transfer rates of up to 40 MB/s, 80 MB/s, and 160 MB/s, respectively.

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